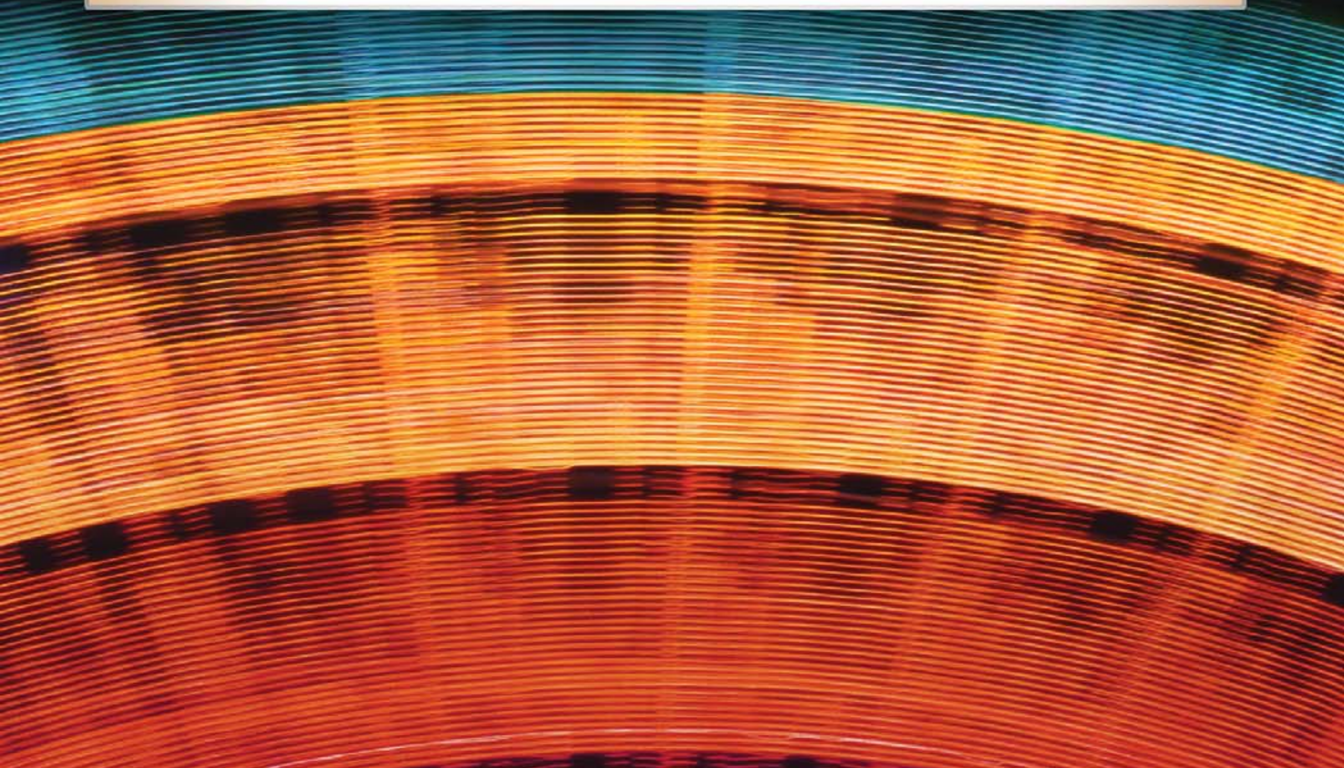
HANDBOOK OF EMOTIONS

FOURTH EDITION

edited by
Lisa Feldman Barrett, Michael Lewis,
and Jeannette M. Haviland-Jones



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PREFACE

Since the first edition of the *Handbook of Emotions* was published in 1993, the field of affective science has expanded significantly, becoming ever more vibrant and interdisciplinary. Several new journals were founded (*Emotion* in 2001; soon followed by *Cognitive, Affective, and Behavioral Neuroscience*; *Social Cognitive and Affective Neuroscience*; and *Emotion Review*), and a new scientific society, The Society for Affective Science, emerged to complement the International Society for Research on Emotion. According to PsycINFO, the number of journal articles related to the study of affective phenomena has skyrocketed over 600% over the past 40 years, with the growth rate accelerating markedly over the past 15 years as publications on affect and emotion have grown faster than other historically comparable topics. New fields of study have emerged, such as affective computing, affective neuroscience, neuroeconomics, and positive psychology. So much research is conducted on emotion regulation that it is virtually its own field of study. The topic of emotion has seen a resurgence in humanities fields like history and philosophy. Even legal scholars are getting into the act with an entirely new field of emotion and law. The success of our second and third editions of the *Handbook* (published in 2000 and 2008, respectively) testifies to the surging interest in emotions and related phenomena. Research in affective science is a hub for many other sciences, owing to the increasing recognition that affective phenomena play a central role in every facet of life.

This fourth edition of the *Handbook* reflects this excitement. Several third edition chapters have been revised to include new material from pioneers in the field, and many new chapters reflect the changing focus and theoretical innovations of a vibrant scientific field. Virtually every section has expanded with the inclusion of cutting-edge work on novel topics. This edition breaks new ground with chapters on the mechanisms, processes, and influences that contribute to emotions, such as genetics, the brain, neuroendocrine processes, language, eating, and exercise; on the changes in emotion across the lifespan, from childhood into adolescence and older age; on neurodegenerative disorders; on methodological innovations like computational modeling of emotion; and on the ways in which emotion is related to closely allied topics such as stress, health, and empathy. We have also captured an emerging dialogue on the nature of emotion perception with three chapters reviewing different points of view. Prior editions of the *Handbook* have showcased the broad interdisciplinary scope of our field, and this edition is no different. Whether you are a scientist, a clinician, or an interested student of human nature, we hope you find this fourth edition as generative and instructive as we did while assembling it.

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PART I

Interdisciplinary Perspectives

CHAPTER 1

THE PHILOSOPHY OF EMOTIONS AND ITS IMPACT ON AFFECTIVE SCIENCE

Andrea Scarantino

Philosophers' fascination with the emotions is as old as philosophy itself. A great many leading philosophers since Ancient Greece and throughout the Middle Ages, the Early Modern Period and up to the present time have proposed complex theories of emotions and of their value or disvalue with respect to knowledge, the good life, and morality, three historically dominant philosophical concerns. What has changed over time is the degree to which philosophical and scientific investigations of the emotions have differed from one another.

Many of the major figures in the history of Western philosophy were philosopher–scientists, namely pioneers of *natural philosophy*, the subfield of philosophy devoted to the inquiry into nature that in the 19th century started being singled out as "science." Since the 19th century, science and philosophy have differed in their methods, conceptual tools, and research questions, and the extent to which they should be separate intellectual pursuits is itself a topic of continuing philosophical reflection.

At first blush, there are some differences between the research programs of contemporary philosophers of emotions and affective scientists. Philosophers of emotions seem more inclined than affective scientists to engage in the armchair analysis of emotion concepts. They often explicitly aim to vindicate common-sense ideas about emotions, and find inspiration in the history of philosophy or in literary texts. Philosophers' standard method is to rely on reflective intuitions, developed through personal experiences of emotions and thought experiments, and try to come up with a theory of emotions that is all-encompassing, elegant, intuitively compelling, and capable of shedding light on other concepts of philosophical interest.

Affective scientists, on the other hand, generally do not consider the preservation of common-sense ideas about emotions to be a valuable objective, citing a litany of cases in which science has proven common sense wrong, as exemplified for instance by the conflict between folk physics and modern physics. The standard operating procedure of affective scientists is to form and test scientific hypotheses, typically modest in scope, through intersubjectively available empirical methods. When they engage in more general theorizing about emotions, affective scientists are often content to formulate theories of emotions that accommodate a particular set of empirical data, and are helpful for scientific explanation, prediction, and control in a given subfield of inquiry.

Despite these prima facie differences, it would be a mistake to conclude that the philosophy of emotions is not relevant to the present-day concerns of affective scientists. First, a sizable proportion of contemporary philosophers of emotions are self-described *naturalists*, in the sense that they reject the pertinence of the broad methodological divide I have outlined so far, suggesting instead that the type of knowledge about the world revealed by philosophy should not differ in kind from the type revealed by affective science.

These naturalistic philosophers consider the empirical data about emotions to be both a constraint on, and an inspiration for, philosophical theorizing. Unlike specialized affective scientists, who favor depth over breadth, naturalistic philosophers of emotions tend to become conversant in a variety of empirical literatures, learn to translate their disciplinary concerns and terminologies into a common language, and try to mediate among competing scientific viewpoints, often with the ultimate objective of integrating them into a coherent whole.

Second, many of the questions contemporary philosophers ask about emotions overlap with questions asked by affective scientists. Principal among those is the question of what emotions are. But several more specific issues at the forefront of affective science are attracting the attention of philosophers of emotions as well, including the nature of emotional experience (e.g., Ratcliffe, 2008), the structure of collective emotions (e.g., von Scheve & Salmela, 2014), the influence of emotions on decision-making (e.g., Elster, 2010), the impact of emotions on action (e.g., Döring, 2007), the role of emotions in morality and art (e.g., Prinz, 2007; Matravers, 1998), the possibility of unconscious emotions (e.g., Lacewing, 2007), the power of music to elicit emotions (e.g., Robinson, 2005), the use of emotions in film (e.g., French, Wettstein, & Saint, 2010), the influence of emotions in the law (e.g., Nussbaum, 2004), the natural kind status of folk emotion categories (e.g., Charland, 2002; Griffiths, 2004a), the ability of emotions to deliver epistemic information (e.g., Brady, 2013), the connection between emotional expressions and the origins of language (e.g., Green, 2007; Bar-On, 2013), and the nature and value of specific emotions (e.g., Haybron, 2008, on happiness; Steuber, 2006, on empathy; Brogaard, 2015, on love; Kelly, 2011, on disgust; D'Arms, 2013, on envy; Deigh, 1999, on guilt; Clark, 2010, and Velleman, 2001, on shame; Macnamara, 2012, on gratitude; Martin, 2014, on hope).

We can make significant progress on all these topics by applying theoretical tools developed in various areas of philosophy (see also Deonna, Teroni, & Tappolet, 2015). Just to mention a few examples, distinctions between dispositions and occurrences developed in metaphysics can help draw more refined emotion taxonomies, distinctions among varieties of consciousness developed in philosophy of cognitive science can clarify the various senses in which an emotion can be unconscious, distinctions between historical and forward-looking notions of function developed in philosophy of biology can provide a solid foundation for functional accounts of emotions, and theories of mental content developed in philosophy of mind can shed light on whether and how emotions have representational qualities.

Finally, the history of the philosophy of emotions, intertwined as it is with the history of affective science up to the 19th century, is a key resource for reconstructing where the "big ideas" that shape contemporary emotion research come from. A historical approach can help us better articulate and evaluate these ideas, and develop a sharp understanding of the costs and benefits of alternative theories of emotions. In this chapter, I trace the origin of the three ideas that have historically constituted the primary attractors in the project of defining emotions: the idea that emotions are *feelings*, the idea that emotions are *motivations*, and the idea that emotions are *evaluations*.

I begin by illustrating how these ideas have been introduced and developed by philosophers, and then highlight a few examples of how they continue to influence debates in emotion theory writ large. In the course of this exploration, it will become apparent that the science and the philosophy of emotions are deeply interconnected and can put their proprietary theoretical tools at the service of projects of common interest. It will also emerge that, although the area of consensus on the distinctive characteristics of emotions has increased over time, we are far from having reached consensus on what emotions are. I suggest in conclusion that failure to define emotions despite centuries of cross-disciplinary efforts demands significant changes in the methodological presuppositions of emotion research.

As we consider theories introduced at different times and in different languages, a caveat on terminology is in order. A variety of terms have been used over the centuries to designate what we now call "emotion," a term that came into use in the English language during the 17th and 18th centuries as a translation of the French term *émotion* but did not designate "a category of mental states that might be systematically studied" until the mid-19th century (Dixon, 2012, p. 338; see also Dixon, 2003; Solomon, 2008). Such alternative terms include, among others, "passion," "sentiment," "affection," "affect," "disturbance," "movement," "perturbation," "upheaval," "appetite," and their Greek, Latin, German, or French cognates.

None of these terms was used precisely as we use it today, none overlaps completely with our contemporary "emotion" category, and none was used in the exact same way by different authors. In the interest of simplicity, I disregard the nuances of translation between alternative terminologies, and count as emotion theories all theories that focus on affective categories that are "close enough" to what we call emotions today, in the sense that they comprise a sufficient number of the more specific states (e.g., joy, anger, fear) we count as emotions in contemporary taxonomies.

Emotions as Feelings, Motivations, and Evaluations

Theorists of emotions disagree vigorously on what emotions are, but they tend to concur on what I call the *diagnostic features* of emotions. These are the features we commonly use to infer that an emotion is under way, and they involve causes, constituents, and effects of emotions. An example can help us draw out our intuitions. Suppose the chair of your department pops by your office one day to nonchalantly tell you that you were denied tenure, after 6 years of strenuous efforts and despite having met all publicly stated tenure requirements. Further suppose that this piece of dreadful news makes you extremely angry. Which features are involved in this episode of anger?

First, it seems likely that you engaged in a certain type of *evaluation* of the events that unfolded: you appraised them as constituting a major slight to you. Second, a sequence of *physiological changes* is likely to take place, involving, say, slight tremors, decrease in saliva flow, and increases of heart rate, blood pressure, rate of respiration, and gastric activity. Third, your face, body, and voice are likely to manifest distinctive *expressions*: eyes locked on the department chair, eyebrows lowered and pulled together, expanded chest, stiff posture, and loud and high-pitched voice. Fourth, you are likely to undergo an unpleasant *subjective experience* that involves feeling hot and ready to engage in aggressive action. Fifth, your *mental processes* and *behavioral dispositions* are likely to change from their baseline states.

You immediately interrupt whatever else you were doing and focus your attention on the interaction at hand, first heatedly stating that denying you tenure is completely unfair and misguided and then, as soon as the department chair urges you not to take it personally, yelling at him to get out of your office. You then briefly close your eyes, try to calm down your breathing, imagine what your spouse's reaction to the news is going to be, consider where else you could apply, and immediately form an intention to appeal the decision. Your judgment of your department as a whole changes ("What a snake pit!"), and you come to realize how deeply you cared about tenure, despite your prior claims to the contrary.

Which of the many features of this prototypical anger episode *is* your anger? Is it the evaluation, the subjective experience, the expressions, the physiological changes, the disposition to engage in mental and physical actions, or a combination of all such features, plus perhaps some other ingredient? Furthermore, is getting angry beneficial or detrimental to you? These are some of the questions that have divided emotion theorists for centuries, leading to a plethora of competing accounts of emotions and their functions. Although such accounts differ across multiple dimensions, they can be usefully sorted into three broad traditions with deep philosophical roots, which I call the *feeling tradition*, the *motivational tradition*, and the *evaluative tradition*. Such traditions identify emotions with, respectively, distinctive conscious experiences, distinctive motivational states, and distinctive evaluations of the eliciting circumstances.

Each tradition comes in several varieties, and some theories do not fit comfortably within any one tradition. Furthermore, most theories combine aspects of several traditions. Nevertheless, it is helpful to sort theories into traditions of primary membership. This can allow us to highlight similarities among theories over time and across disciplines, and to unveil persistent theoretical challenges faced by each tradition. Most importantly, the historical investigation reveals that no tradition has developed a clear lead over its competitors. As a result, no view about what kind of psychological structures emotions are has gained widespread consensus. This remarkable fact sets affective science apart from other scientific pursuits, and it demands an explanation I provide in the chapter's methodological coda.

Aristotle at the Crossroads among Traditions

A good place to start our historical journey is Aristotle's account of emotions, which anticipates many of the themes of the three traditions I wish to distinguish and has exerted a major influence on the subsequent history of emotion theory. Aristotle's account is a rich hybrid that could be slotted into either the *feeling tradition, motivational tradition, or evaluative tradition*, depending on which aspect one decides to emphasize. This is due in part to the fact that Aristotle never provided a systematic theory of emotions (Cooper, 1999, pp. 406–407), offering instead a number of insightful but disjointed reflections on the nature and function of emotions throughout his ethical treatises (*Nicomachean Ethics*, *Eudemian Ethics*), his book on the nature of the soul (*On the Soul*), his writings on poetry (*Poetics*), and most prominently, his work on the art of public speaking (*Rhetoric*).

Aristotle's discussion of the emotions begins with a distinction between passions (*pathê*) and actions (*praxeis*) that has been taken for granted by most emotion theorists ever since (but see the section "The Motivational Tradition" for a discussion of some important exceptions). Whereas actions are things we *do*, Aristotle tells us, "in respect of the passions we are said to be moved" (*Nicomachean Ethics*, 1106a4–5). As pointed out by Kosman (1980, p. 105), the distinction between *praxeis* and *pathê* in Aristotle is a "special instance of a more general structural duality, that of *poiein* and *pashein*, doing and being done," which are for Aristotle distinct "categories of being." The identification of emotions with things that happen to us, or things by which we are acted upon, or things we undergo, is one of the most enduring legacies of Aristotelianism.

It strongly influenced early modern accounts of emotions (James, 1997) and it is still embedded in the very metaphors we use to speak about emotions in ordinary language. For example, "we 'fall' in love, are 'consumed' by envy, 'haunted' by guilt, 'paralyzed' by fear" (Averill, 1980, p. 267). Many of the adjectives we deploy to refer to the emotions are "derived from participles" (Gordon, 1987, p. 373)—"frightened," "surprised," "joyed," "irritated," "upset"—another sign of how ingrained the idea of passivity is in our folk conceptualization of emotions.

Initially, Aristotle may seem to be a straightforward founder of the *feeling tradition*. Besides emphasizing that the passions are things that happen to us, as feelings do, Aristotle explicitly identifies passions with feelings. As he puts it, the "passions [are] all those feelings that so change men as to affect their judgments, and that are also attended by pain [*lupe*] or pleasure [*hedone*]" (*Rhetoric*, 1378a19–21). Pain and pleasure must be understood here as having bodily underpinnings, since Aristotle tells us that "all the affections of soul involve . . . a concurrent affection of the body" (*On the Soul*, 403a16–19). Examples of passions discussed in some detail by Aristotle include anger, calmness, friendliness, hatred, fear, confidence in the face of danger, shame, kindness, pity, indignation, envy, and emulation.[1]

Aristotle's interest in how feelings "change men as to affect their judgments" was related to his primary rationale for studying them. His most detailed account of the passions is in the *Rhetoric*, whose practical objective was to help public speakers become more persuasive, especially in the context of political oratory and lawsuits. The ability to control one's own and the audience's passions, Aristotle thought, would make the orator more effective.

This makes Aristotle an early emotion regulation theorist, and a sophisticated one at that. He implicitly distinguishes between what regulation theorists now call *extrinsic regulation* (the regulation of other people's emotions) and *intrinsic regulation* (the regulation of one's own emotions; Gross, 1998). With respect to intrinsic regulation, Aristotle recognizes that we cannot choose our passions the way we choose our actions, but adds that the dispositions to undergo the passions can be chosen. This is because such dispositions are associated with *character*, something that according to Aristotle can be voluntarily shaped over time by means of a process of *habituation*. The objective of the sage should be for Aristotle *metriopatheia*—namely, moderation in the passions—which requires experiencing them with respect "to the right person, to the right extent, at the right time, with the right motive, and in the right way" (*Nicomachean Ethics*, 1109a25).

Concerning extrinsic regulation, Aristotle suggests that the regulation of other people's passions demands learning what kind of frame of mind is typical of people who experience a certain passion, what kinds of people are such that a certain passion is experienced toward them, and what kinds of circumstances characterize the experience of a passion.

This explains Aristotle's interest in the *evaluations* associated with the passions, which are for him ultimately feelings caused, and possibly partially constituted by, distinctive evaluations. For example, fear is "pain or disturbance due to imagining some destructive or painful evil in the future" (*Rhetoric*, 1382a23); shame is "pain or disturbance in regard to bad things, whether present, past or future, which seem likely to involve us in discredit" (1383b15); and envy is "pain excited by the prosperity of . . . people who are like us or equal with us" (1387b21).[2]

Aristotle insightfully points out that since emotions have both an evaluative dimension and a bodily dimension underlying the feelings of pleasure and pain, two options are available for defining them. For example, a "physicist would define an affection of soul differently from a dialectician; the latter would define e.g. anger as the appetite for returning pain for pain, or something like that, while the former would define it as a boiling of the blood or warm substance surrounding the heart. The latter assigns the material conditions, the former the form" (*On the Soul*, 403a29–403b2). For Aristotle, an emotion is a combination of *matter* and *form*, where the matter is what makes up the entity, and the form is the structuring principle that shapes the matter to constitute a certain type of entity.

Aristotle's distinction between types of interest-dependent definitions raises the question of whether being caused by a particular evaluation is essential to being a passion, or whether a passion can just be a feeling of pleasure and pain with its attendant bodily underpinnings. I do not take a position on this thorny issue here, but note that whether evaluations merely cause the emotions or partially constitute them matters for establishing whether Aristotle can be counted as one of the founders of the *evaluative tradition*, which is also often traced back to his work (e.g., Power & Dalgleish, 2008; Nussbaum, 2001).

Finally, passions are for Aristotle closely associated with actions, although once again, whether being a motive for action is constitutive of being a passion is up for debate. At the very least, we can count Aristotle as an early sympathizer of the *motivational tradition*. In some cases, Aristotle makes the tie with action explicit. For example, he tells us in the *Rhetoric* that (as defined by the dialectician) anger is "an impulse, accompanied by pain, to a conspicuous revenge for a conspicuous slight directed without justification towards what concerns oneself or towards what concerns one's friends" (*Rhetoric,* 1378a31–1378b1). Similarly, a friendly feeling toward someone amounts to "wishing for him what you believe to be good things, not for your own sake but for his, and being inclined, so far as you can, to bring these things about" (1380b36–1381a2). This being said, it is notable that no other accounts of the passions in the *Rhetoric* include explicit mention of an impulse or motivation (*orexis*) for action (Cooper, 1999, p. 420).

In the rest of this chapter, I explore how different authors have articulated the identification of emotions with feelings, motivations, and evaluations, and highlight a handful of especially interesting contributions. I emphasize from the beginning that in some cases a different reading of the multiply interpretable textual evidence is possible with respect to specific authors. Historical scholarship will have to be the ultimate arbiter of where various theories of emotions stand in terms of their tradition of primary membership. My main interest here is not to contribute to historical scholarship, but to sketch in broad strokes a historically plausible family tree in light of which contemporary attempts to define emotions in philosophy and affective science can be better connected and understood. I present the resulting family tree in Figure 1.1, and will proceed to illustrate its various parts in what follows.

The Feeling Tradition

The *feeling tradition* holds that emotions are feelings of a distinctive type, where a feeling is a conscious experience or a sensation or a subjective quality or a quale or a what-it-is-likeness. This view has largely dominated the study of emotions from Ancient Greece to the 20th century, and it has never stopped being influential, in part because it seems to capture folk intuitions about emotions better than its alternatives. When asked to rank in order of importance five "attributes" of emotion—facial expressions, vocal expressions, feeling states, cognitive changes, and autonomic changes—English speakers reliably pick feelings as most important (Panksepp, 2000).[3]

Although many emotion theorists since Aristotle have identified emotions with feelings, I begin my discussion of the modern feeling tradition with René Descartes. Besides having formulated what became the orthodox theory of emotions from the 17th century to roughly the end of the 19th century (with some exceptions along the way), Descartes offers the first rigorous formulation of one of the two main approaches to the *feeling tradition* that still influence contemporary research. I characterize the approach followed by Descartes, and later by Hume, Locke, and several other early modern philosophers, as the *atomistic perceptualist approach*. This approach identifies emotions with types of perceptual feelings, and assumes that such feelings are, as William James later put it, "psychic atoms."

The second approach of contemporary relevance is James's *constructionist approach*, according to which emotions are feelings that can be further

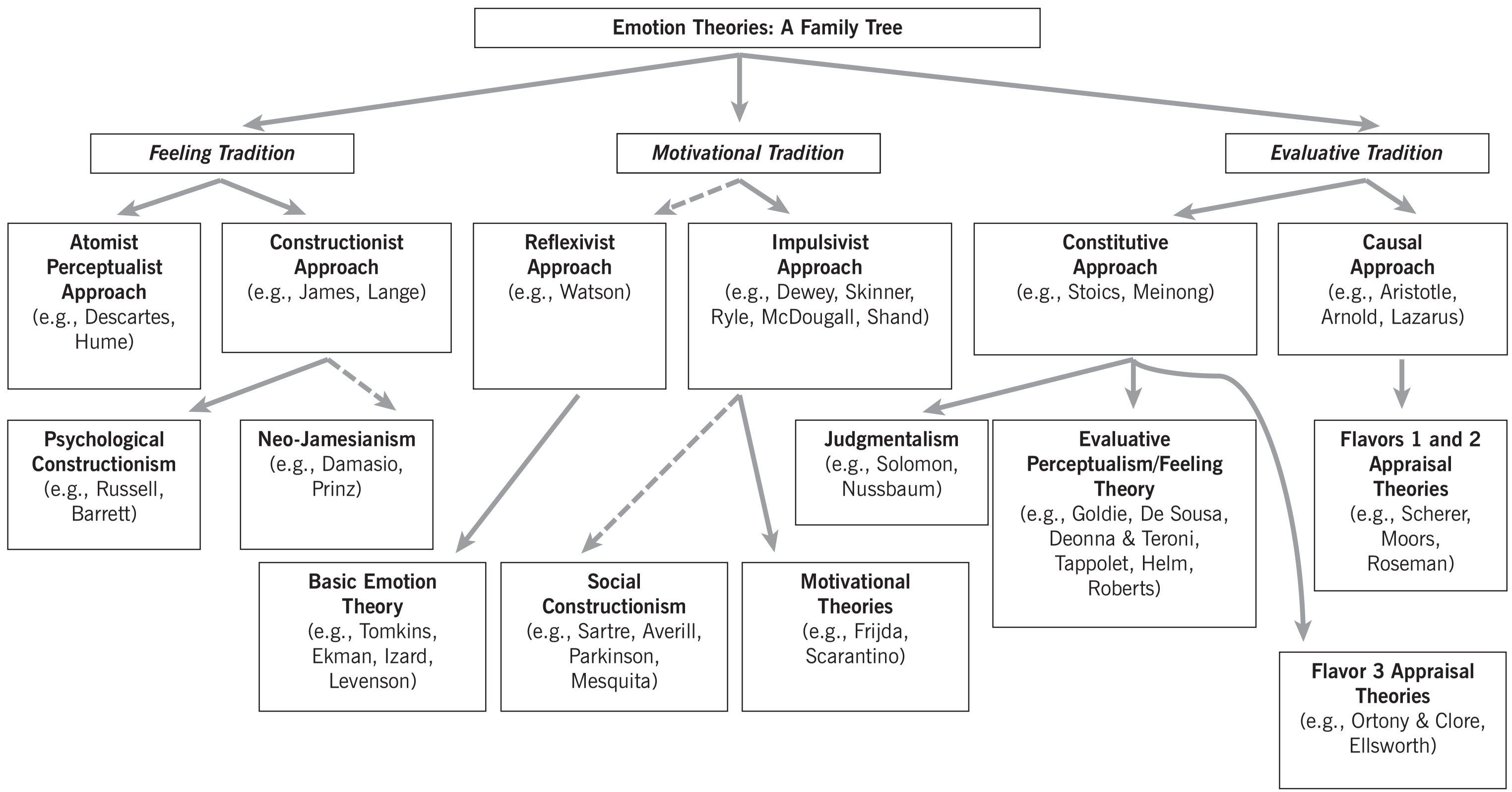

FIGURE I.1. A family tree for theories of emotions. Dashed lines are meant to signal more tenuous connections among traditions, approaches, and research programs than solid lines.

decomposed into building blocks, a view meant to usher psychology into a new scientific phase. I first illustrate these two approaches, and then consider two research programs in contemporary affective science which carry the Jamesian torch in different ways—namely, psychological constructionism and neo-Jamesianism (see Figure 1.2).

Cartesian Passions: The 17th- to 19th-Century Orthodoxy

Descartes presents his theory in *The Passions of the Soul* (1984), a treatise that begins with a sweeping dismissal of all emotion theories that came before: "the defects of the sciences we have from the ancients are nowhere more apparent than in their writings on the passions" (PA, a.1). Descartes, a dualist, decries their failure to distinguish between soul and body as distinct substances, and to investigate separately the functions of each. The functions of the body are for Descartes motion and heat. The function of the soul is the production of thoughts, of which two varieties can be distinguished: actions and passions. The actions of the soul are "acts of will" (e.g., the will to love God, the will to go for a walk), whereas the passions of the soul—in the broadest sense—are "perceptions . . . found in us," rather than willed.

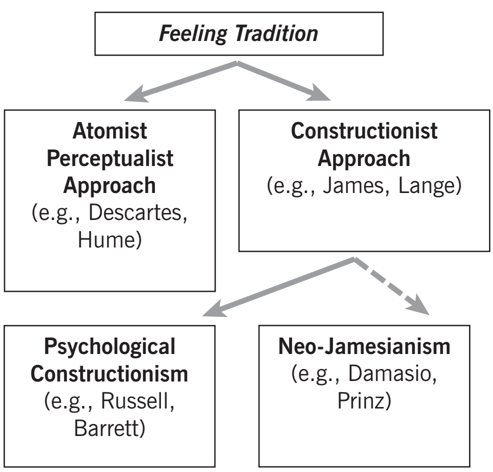

FIGURE 1.2. The *feeling tradition* and some related contemporary developments. The dashed line between the *constructionist approach* and *neo-Jamesianism* indicates that, although neo-Jamesianism is inspired by James's analysis of emotions, it is not a variety of constructionism.

Perceptions found in us come in two varieties: some are caused by the soul (e.g., the perception of an act of will) and some are caused by the body. And here we come to the key distinction: for Descartes, some of the perceptions caused by the body are referred to external objects, some are referred to the body, and some are referred to the soul itself. The first are sensory perceptions (e.g., visual perceptions, auditory perceptions), the second are bodily perceptions (e.g., pain, thirst, hunger), and the third are the passions properly understood. Cartesian passions in this narrower sense are "perceptions we refer only to the soul [and] whose effects we feel as being in the soul itself" (PA, a.25). The idea is that whereas our sensory experiences are of external objects (e.g., we perceive red apples) and our bodily experiences are located in the body (e.g., we perceive a pain in the foot), we experience our passions directly in the soul. For example, we may be afraid of a tiger and facial movements may accompany our fear, but for Descartes the feeling of fear is in the soul itself rather than in the external world or in the body.

As a result, Descartes thinks, emotions are "so close and so internal to our soul that [we] cannot possibly feel them unless they are truly as it feels them to be" (PA, a.26). What he means is that, since the passions do not involve implicit causal hypotheses about which external objects caused them or where in the body they are located, they cannot be felt in the soul without actually being in the soul. A corollary of this view is that the passions become objects of infallible introspective access: we may be wrong about what causes our passions, but we cannot be wrong about the very existence of our passions (see Kenny, 1963).

Descartes distinguishes among six primitive passions (admiration, love, hatred, desire, joy, and sadness) and an open range of nonprimitive passions, which are species of primitive passions (e.g., cheerfulness is a species of joy) or compounds of primitive passions (e.g., pride is a compound of joy and love). Since animals, unlike humans, do not have a soul, Descartes concludes that none of these passions is available to them.

Descartes makes it clear that the distal cause of the passions is an *evaluation*, whereas their proximal cause is the motions of the pineal gland brought about by "animal spirits" (the finest particles of matter). For instance, Descartes tells us that "wonder" is a "sudden surprise of the soul" which is caused by "an impression in the brain . . . which represents the object as something unusual and consequently worthy of special consideration"

(PA, a.70).[4] Love and hatred are instead caused by evaluating an object as, respectively, "agreeable" or "harmful" (PA, a.79). Descartes also emphasizes that the passions have an important function: "they move and dispose the soul to want the things for which they prepare the body." So the feeling of fear "moves the soul to want to flee," the feeling of courage "to want to fight," and so on (PA, a.40). But neither the evaluative nor the motivational elements, although part of the causal chain from perception of external objects to behavior, are part of the passions. For Descartes, "only the final, culminating, reactive, simple and unitary mirror-feeling in the soul of all that [is] going on in the body, could be called 'the emotion' " (Lyons, 1999, p. 28). It is the very idea of feelings as *simple* and *unitary* "atoms" that James's constructivist psychology called into question at the end of the 19th century.

Hume's Rejection of the Reason–Passion Dichotomy

As Anthony Kenny (1963) put it, "it was Descartes' formulation of the problems concerning the emotions which was to influence the later history of philosophy and the early attempts to make psychology into an experimental science" (p. 11). Descartes' influence on the philosophy of emotions is revealed by the fact that most early modern philosophers, despite significant differences in their overall philosophy, thought of emotions as species of perception (e.g., Locke, 1690/1975, describes them as "internal sensations"; Hume, 1739/1992, describes them as "secondary impressions"; Hutcheson, 1728/2002, describes them as "perceptions of pleasure and pain"). Classical British empiricists like David Hume, and especially John Locke, strongly emphasized the atomistic aspect of the passions, trying to show that, just like all other mental states, they are either simple mental states or reducible to a combination of simple mental states (see Deigh, 2010, for further discussion).

Hume's analysis is especially notable because it calls into question the divide between reason and passion that most emotion theorists had taken for granted until then. Hume begins by describing the passions as "impressions of reflection"—namely, perceptions caused either by other impressions or by ideas, which are copies of impressions. But the passions themselves are not ideas and consequently have "no more a reference to any other object, than when I am thirsty, or sick, or more than five foot high" (T 2.3.3.5).[5] What follows is that the passions cannot be "contradictory to truth and reason." For Hume, "this contradiction consists in the disagreement of ideas, considered as copies, with those objects, which they represent" (T 2.3.3.5). But since the passions are not copies of anything, the conflict between reason and passions cannot take place.[6]

And since the passions are for Hume the only psychological entities that can direct the will to action, reason cannot affect actions except by courtesy of the passions. This is what lies behind Hume's trademark claim that "reason is, and ought only to be the slave of the passions, and can never pretend to any other office than to serve and obey them" (T 2.3.3.4). Reason can determine what is the best means for achieving a practical end picked out by the passions, but it cannot pick out a practical end of its own, because it has no access to the direction of the will.

Notably, this approach to action explanation is still dominant in contemporary philosophy, and it has been enshrined in the so-called *Humean theory of motivation*, according to which all intentional actions are caused and rationalized by pairs of beliefs and desires, which are regarded as distinct, mutually irreducible kinds of mental states (Smith, 2010). Beliefs have a mind-to-world direction of fit, because their aim is to fit what the world is like (cognitive direction of fit), and desires have a world-to-mind direction of fit, because their aim is to change the world so as to be satisfied (conative direction of fit; Searle, 1983).

The dominance of this model is testified by the attempt made by several philosophers to explain *emotional actions* in terms of beliefs and desires, on the assumption that the only way for emotions to affect actions is by causing, or by being constituted by, belief and desire pairs. This Humean model has been influentially criticized by Hursthouse (1991), who focuses on the counterexample offered by "arational actions"—namely, "weird" emotional actions like jumping up and down out of joy or kicking a door out of anger or gouging the eyes out in someone's picture out of hatred.

In such cases, Hursthouse (1991) argues, the Humean model collapses, because we cannot find any belief–desire pair that would cause and rationalize such emotional actions. In Hursthouse's view, a better explanation of arational actions is that they are performed because one is in the grip of an emotion, which has a distinctive motivational force irreducible to belief and desire psychology. The debate on whether the *Humean theory of motivation* can explain emotional actions has flourished in recent philosophy of emotions, and a number of proposals, both in favor of and against Humeanism, are available (see Smith, 1998; Goldie, 2000; Döring, 2003, 2007; Kovach & De Lancey, 2005; Scarantino & Nielsen, 2015).

Descartes' assumption that the mind consists in what lies within one's consciousness also had a profound impact on the emerging science of psychology. Early champions of experimental psychology like Wilhelm Wundt and Edward Titchener took it for granted that introspection offers us privileged access to the inner world of conscious experience, and they defined psychology as the science that studies consciousness through properly trained introspection, a view that oriented the young science of psychology until the rise of behaviorism in the early 20th century.

The Jamesian Revolution: Feelings as Constructions

The second approach I distinguish within the *feeling tradition* is the *constructionist approach* associated with James's theory of emotions, presented in "What Is an Emotion?" (1884), in the 25th chapter of *The Principles of Psychology* (1890), and in "The Physical Basis of Emotion" (1894).[7] James believed that a truly scientific theory of the emotions required understanding their *physiological* causes rather than treating them as *psychic* and *atomic* phenomena that take place in the soul, a characterization applicable to the theories offered by Descartes, Hume, Locke, and many other early modern philosophers.

James complained that emotions had been described until then as "the internal shadings of emotional feeling," where feelings were understood as "psychic entities" whose bodily underpinnings, although perhaps typical, were not essential. "The trouble with the emotions in psychology," he wrote, "is that they are regarded too much as absolutely individual things. So long as they are set down as so many eternal and sacred psychic entities, like the old immutable species in natural history, so long all that *can* be done with them is reverently to catalogue their separate characters, points, and effects" (1890, p. 449).

James judged the "merely descriptive literature of the subject, from Descartes downwards, [as] one of the most tedious parts of psychology" (James, 1892, p. 374). Besides being tedious, James (1890) believed that theorizing about the emotions in terms of internal shadings of emotional feeling resulted in endless classification lacking in scientific rigor. What the scientific theory of emotion needed was a "generative principle" that could only be discovered by regarding the emotions as "products of more general causes" rather than individual psychic entities to be introspectively distinguished and labelled (1890, p. 449).

Since "the general causes of the emotions are indubitably physiological," James concluded that focusing on physiology offered emotion theorists the promise of a generative principle that could do for the understanding of emotions what the generative principle of heredity and variation had done for the understanding of species—namely, allow it to get "on to another logical level" (1890, p. 448).

According to Mandler (1990, p. 180), James developed "the first constructionist psychology, attempting to understand the processes that generate and construct behavior and conscious experiences." Mandler notes an important change in scientific psychology between the 19th and the 20th century. Nineteenth-century psychology was "generally atomistic—mental phenomena were seen as the concatenation of nuclear ideas, feelings, and thoughts," whereas 20th-century psychology was interested in the "mechanisms and processes that produced or generated feelings and thoughts, and when there was an interest in basic building blocks, it rarely invoked ideas, feelings, or thoughts" (1990, p. 179).

James pioneered this very transition, suggesting that emotional feelings are not "simple and unanalyzable," as generally assumed within the *feeling tradition*, but rather constructed out of more basic ingredients. For James (1884), an emotion is a "secondary feeling indirectly aroused" when organic changes occur in a reflex-like fashion as a result of being exposed to an exciting stimulus. This approach makes it possible to conceive of emotions "as something other than individual sensations or feelings each identifiable by a distinctive sensory tone or quale" (Deigh, 2001, p. 1249). Most importantly, this approach allows James to explore how these secondary feelings are *constructed* out of the combination and integration of more basic processes not specific to emotions.

On James's original account, there is no *psychic entity* (e.g., no evaluation) that mediates between the mental perception of some exciting fact and the bodily expression. Rather, "*the bodily changes follow directly the PERCEPTION of the exciting fact*" and "*our feeling of the same changes as they occur IS the emotion*" (1884, p. 190).[8] This amounts to a reversal of common sense, according to which we cry because we are sorry, we run because we are afraid, and we strike because we are angry. On the contrary, according to James, "we feel sorry because we cry, angry because we strike, afraid because we tremble" (p. 190). On this view, since emotions are feelings resulting from perceiving changes in expressions, physiology and behavior, and such changes must occur prior to being perceived, emotions do not cause the diagnostic changes associated with them (see Deigh, 2014, for further discussion).

In developing his theory, James makes a distinction between what he calls the *standard* or *coarser* emotions and the *intellectual* or *subtler* emotions. The former are those in which the bodily disturbance is clear, and they include surprise, curiosity, rapture, fear, anger, lust, greed, grief, rage, and love. However, James acknowledges that there are also emotions "whose organic reverberation is less obvious and strong" (1890, p. 449). For these subtler emotions, which include "moral, intellectual, and aesthetic feelings," as well as "feelings of pleasure and displeasure, of interest and excitement," James's theory seems at first sight less apt. However, James insists that, although muted, the bodily sounding board must be at work for the *subtler* emotions as well, lest they simply amount to "a cold and neutral state of intellectual perception" (p. 451). To support his claim that bodily feelings are necessary for emotions, James simply argues that nothing emotional is left once we subtract bodily changes from emotions. As he puts it, "emotion dissociated from all bodily feeling is inconceivable" (p. 452).

Contemporary Developments: Neo-Jamesianism and Psychological Constructionism

James's theory has arguably had a more profound impact on 20th-century emotion theory and research than any other previous theory, either as an inspiration or as a foil. Contemporary neo-Jamesians and psychological constructionists have both singled out James as a central predecessor, but they have found inspiration in different aspects of his work. Neo-Jamesians like Antonio Damasio and Jesse Prinz have focused on the *bodily side* of James's theory, whereas psychological constructionists like James Russell and Lisa Feldman Barrett have focused on the *constructionist side*. Let us briefly consider these developments in turn.

James thought of bodily changes primarily in terms of autonomic bodily changes, which comprise physiological reactions such as changes in heart rate, blood pressure and blood flow distribution, respiration, and activity of the sweat glands (but note that James, 1890, had also included changes in expressions and emotional actions). Neo-Jamesians have added to this list *hormonal changes* such as changes in the catecholamine hormones epinephrine and norepinephrine, *musculoskeletal changes* such as changes in muscle tension and feedback from facial expressions of emotion, and, most importantly, *neural changes* consisting of the activation of the somatosensory brain areas. On this view, emotional feelings need not be caused by feedback from peripheral bodily changes, and can (at least in some cases) simply consist of brain activations (Damasio, 1994, calls these "as-if" bodily changes).[9]

An additional difference is that many neo-Jamesians have rejected James's identification of *emotions* with *feelings*, and suggested that emotions and feelings have importantly different functions. Damasio argues that "an emotion is a collection of changes in body state connected to particular mental images" (1994, p. 145), with the function of initiating automatic and stereotyped bodily responses. Feelings are instead the "experience of such changes in juxtaposition to the mental images that initiated the cycle [emphasis removed]" (p. 145) and their function is to "open the door for some measure of willful control of the automated emotions" (Damasio, 2003, p. 80). They do so through their role in practical reasoning. When deliberative options are considered, they elicit memories of past emotions experienced in comparable situations. Such memories activate *somatic markers*—namely, "gut feelings" that mark options as positive or negative in light of their expected emotional consequences, and aid the decision process.

Damasio (1994) posits somatic markers to explain the intriguing correlation between ventromedial (VM) prefrontal cortex damage and the incapacity to make rational decisions in a variety of domains. Patients with VM damage have been characterized as irrationally Hamlet-like when faced with trivial decisions such as choosing a date for their next doctor's appointment, irrationally risk prone when faced with gambling decisions, irrationally impatient when faced with decisions demanding deferred gratification, and irrationally antisocial when faced with decisions involving respect for norms.

Damasio's (1994) *somatic marker hypothesis* is that all these forms of irrationality are due to the loss of the ability to "mark" options as positive or negative in the prefrontal cortex. The debate on whether the empirical evidence supports Damasio's somatic marker hypothesis is still ongoing (see, e.g., Dunn, Dalgleish, & Lawrence, 2006; Reimann & Bechara, 2010). Another important recent advance is Prinz's addition to the neo-Jamesian toolbox of a theory of intentionality applicable to perceptions of bodily changes, a development I discuss in the section "Contemporary Developments I: Evaluative Theories in Philosophy and Their Challenges."

A second descendant of James's theory is *psychological constructionism*, which has followed James in emphasizing that emotions are put together out of building blocks that are not specific to emotions (Gendron & Barrett, 2009). Constructionists deviate from James in assuming more (and partly different) building blocks. One is especially common: *core affect*. As Russell (2003, p. 147) puts it, core affect is a "neurophysiological state that is consciously accessible as a simple, nonreflective feeling that is an integral blend of hedonic (pleasure–displeasure) and arousal (sleepy–activated) values." Different constructionists describe how affective episodes are built out of core affect and other ingredients in different ways.

For example, in the work of Barrett (2006, 2009, 2012, 2015), conceptualization plays a key role. On her view, being afraid amounts to categorizing a core affective state of high arousal and high displeasure under the "fear" concept. Being happy amounts to categorizing a core affective state of high arousal and high pleasure under the "happiness" concept. This view has been criticized for conflating emotions with verbal labeling, for making it impossible for adult humans to mislabel their own emotions, and for preventing infants and animals from having emotions in the first place (e.g., Scherer, 2009; Scarantino, 2015; see Barrett, 2015, for a reply).

Russell, another prominent psychological constructionist, allows emotion episodes to be constructed without the involvement of categorization, since on his view conceptualization only affects the *meta-experience* of emotion, that is, the experience corresponding to the realization that one is afraid (see Scarantino, 2012a; Russell, 2012a, 2012b, for further discussion).

What most varieties of psychological constructionism accept is James's view that emotions do not *cause* their diagnostic features but rather *emerge* from them. This shift corresponds to a transition between measurement models of emotions. The traditional *latent variable model*, according to which emotions precede and cause the variation in their diagnostic indicators, is replaced by psychological constructionists with an *emergent variable model*, which "posits that emotions do not cause, but rather *are caused by*, their measured indicators" (Coan & Gonzalez, 2015, p. 213).

For example, Russell (2003) criticizes the "traditional view of an emotion episode," according to which the "antecedent [stimulus] causes the emotion, which causes all its various 'manifestations'" (p. 151). If emotions were internal entities with such causal powers, Russell (2009, p. 1262) continues, it would follow that "because the various components stem from a single [causal] entity, they [would] cohere in tight packages." The empirical evidence tells us that they do not, and that there is major variability with respect to each component (see the section "Contemporary Developments I: Basic Emotion Theory and Social Constructionism"). Russell concludes that this calls into question the view that emotions are "internal entities [with] certain powers, such as the power to cause their own components" (2015, p. 432).

Some Challenges for the Feeling Tradition

As we have seen, various elements of the *feeling tradition* have been incorporated into contemporary research programs in affective science. Yet, the *feeling tradition* as a whole progressively lost its dominance in the course of the 20th century. Many challenges were raised to the idea that emotions are essentially feelings, but three stand out for their long-term impact and for how they are shaping contemporary attempts to revive the feeling tradition (see the section "The Evaluative Tradition").

The first is the *problem of differentiation*—that is, the problem of distinguishing among different emotions. Against James's bodily feeling theory, for example, Cannon (1929) objects that "the responses in the viscera seem too uniform to offer a satisfactory means of distinguishing emotions" (pp. 351–352; see also Baldwin, 1894). More generally, critics of feeling theories argue that—regardless of the nature and origin of the emotional feelings postulated by different feeling theories—not all differences among distinct emotions are reflected in differences among the subjective experiences associated with them.

One reason for this is that different emotions like, say, indignation and annoyance may involve indistinguishable feelings (Bedford, 1957). Another reason is that some emotions may not be felt in the first place, and so cannot differ from other emotions in light of the quality of the subjective experiences associated with them. This possibility became prominent when Freud (1915/1997) rejected the Cartesian assumption that the mind consists of what we are conscious of, and proposed instead that consciousness is just the tip of an iceberg, with the bulk of mental processes occurring below the surface of consciousness.

Specifically with regard to emotions, Freud points out that "in psychoanalytic practice we are accustomed to speak of unconscious love, hate, anger, etc." (1915/1997, p. 126). Notably, however, Freud himself does not recommend a literal interpretation of this way of speaking, because "it is surely of the essence of an emotion that we should feel it, i.e. that it should enter consciousness" (1915/1997, p. 126).[10]

On Freud's view, an unconscious emotion is a feeling that is "perceived, but misconstrued" (1915/1997, p. 126), in the sense that "by the repression of its proper presentation it is forced to become connected with another idea, and is now interpreted by consciousness as the expression of this other idea" (1915/1997, p. 110). An example of such a misconstrued feeling would be an episode of romantic love for a first-degree cousin with its attendant feelings but whose phenomenology is mistaken for one of, say, friendly attachment. In such case, there are feelings associated with being in love with one's cousin, but the *idea* that one loves one's cousin never gets a "proper presentation" to the person's conscious mind, due to repression. Later theorists have argued that emotions themselves, rather than just ideas connected to emotions, can be unconscious, although the debate on the possibility of unconscious emotions is still unsettled in both philosophy and affective science (e.g., Lacewing, 2007; Winkielman & Berridge, 2004; Winkielman, 2013).

The second problem for feeling theories of emotion is the *problem of intentionality*. I consider this problem to comprise two related subproblems. The first is the problem of *aboutness*: emotions appear to be about objects. For example, we are not just angry, sad, or afraid, but angry, sad, or afraid *about* particular things. The second is the problem of *correctness*: emotions appear to be *correct* or *incorrect* with respect to the objects they are about. For example, it seems correct to be angry about having been cheated on by one's spouse, sad about the death of one's mother, and afraid of a deadly snake nearby. This view of intentionality conceives of the relation between the emotion and what the emotion is about as a representation relation: emotions are about objects in the sense that they *represent* them in a particular way and can do so correctly or not.

As several analytic philosophers argued in the late 1950s and early 1960s (and as was argued in the 19th century by Franz Brentano and his students, such as Alexius Meinong and Carl Stumpf), Hume was simply wrong about the fact that an emotion "contains not any representative quality." If being afraid were just like being "thirsty, or sick, or more than five foot high" (T 2.3.3.5), as Hume had put it, it would be mysterious why fear is *about*, say, a tiger and what makes it *appropriate* with respect to it. One is not "thirsty, sick, or more than five foot high" about anything, and being thirsty, sick, or more than five feet tall are not the sorts of things that can be appropriate or inappropriate. The attempt to explain why emotions are about objects that they can represent correctly or incorrectly—the problem of intentionality as I understand it in what follows—was one of the primary reasons for the emergence of the evaluative tradition in emotion theory (see the section "The Evaluative Tradition").

The third problem is the *problem of motivation*—namely, the problem of accounting for how emotions can motivate actors to pursue certain ends (e.g., to flee danger in the case of fear, to help a needy person in the case of pity). This problem was especially significant for James's theory. According to James, emotions are caused by bodily changes, but they have no causal influence on action. James gave the job of motivating action to *instincts*, where an instinct is "defined as the faculty of acting in such a way as to produce certain ends, without foresight of the ends, and without previous education in the performance" (1890, p. 383).

Once actions are brought about by instincts, the bodily changes they involve are perceived, giving rise to emotions. From this it follows that "every object that excites an instinct excites an emotion as well."[11] But "the emotional reaction usually terminates in the subject's own body," James adds, whereas "the instinctive reaction is apt to go farther and enter into practical relations with the exciting object" (1890, p. 442). This very assumption was called into question by the proponents of the *motivational tradition*, who argued that if emotions terminated in the subject's own body and had no practical relations with the exciting object, they would lack the significance that we commonly ascribe to them (e.g., Dewey, 1894, 1895; McDougall, 1908; Shand, 1920).

The final straw for the *feeling tradition* was the emergence of behaviorism in the early 20th century, which undermined the core idea at the foundation of the tradition—namely that emotions should be conceptualized as special states of consciousness. As Watson put it in a brusque putdown, "nearly 40 years ago James gave the psychology of the emotions a setback from which it has only recently begun to recover" (1925, p. 140). But feeling theories have since become fashionable again and are making a comeback in new and more powerful forms, as contemporary feeling theorists try to answer the challenges of explaining how emotions as feelings can be differentiated, intentional, and motivationally powerful (see the section "The Evaluative Tradition").

The Motivational Tradition

The *motivational tradition* holds that emotions are motivational states of a distinctive type, or patterns of behavior of a distinctive type. I distinguish two approaches within the *motivational tradition*. The *impulsivist approach*, which identifies emotions with behavioral impulses (i.e., states of being set or disposed or ready for a certain pattern of behavior), and the *reflexivist approach*, which identifies emotions with reflex-like behaviors (see Figure 1.3). Generally speaking, talk of motivation is appropriate only when the reflex connection between stimulus and response is broken. But since *reflexivist* and *impulsivist* approaches both identify emotions as "modes of behavior" in a broad sense of the term, it makes sense to discuss them as members of the same tradition.

After introducing some highlights from the history of the *motivational tradition*, I explore how it has inspired various developments in contemporary emotion theory, most significantly the emergence of basic emotion theory, of motivational theories of emotions and of social constructionism.

Dewey between Darwin and James: Emotions as State of Action Readiness

Many in the history of emotion theory have emphasized that emotions involve impulses to behave, starting as we have seen with the Aristotelian accounts of anger and friendly feelings. Philosophers throughout the Middle Ages were especially keen on developing the "motivational side" of Aristotle's theory, characterizing emotions as types of "willings" (Augustine), "wantings" (Anselm, Abelard), or "motions" (Aquinas), although the extent to which such accounts give primacy to motivations over feelings and evaluations is up for debate (see King, 2010; Lyons, 1980; Power & Dalgleish, 2008).

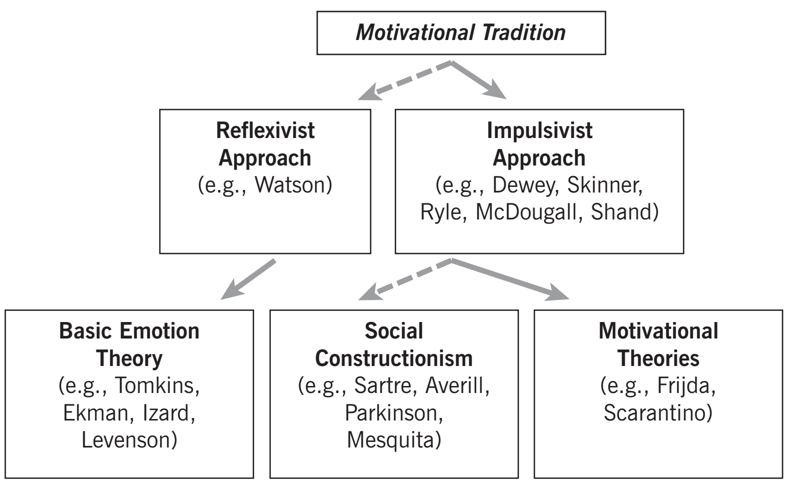

FIGURE 1.3. The *motivational tradition* and some related contemporary developments. The dashed line between the *motivational tradition* and the *reflexivist approach* is meant to signal that talk of motivation is strictly speaking inappropriate when it comes to reflexes. The dashed line between the *impulsivist approach* and *social constructionism* indicates that, although social constructionists are inspired by the idea that emotions have an active side, they do not necessarily identify emotions with motivational states.

The first to provide a detailed theory of emotions as motivational states is arguably John Dewey (1894, 1895), with whom I associate the beginning of the *impulsivist approach*. Dewey's general aim in his "The Theory of Emotion. (I) Emotional Attitudes" (1894) and "The Theory of Emotion. (2) The Significance of Emotions" (1895) was to propose a synthesis of Charles Darwin's (1872) theory of emotional expressions with William James's (1884) theory of emotions.

Darwin, in *The Expressions of the Emotions in Man and Animals* (1872/1965), had proposed three principles for explaining emotional expressions, suggesting that they often operate in concert. A great many emotional expressions emerge for Darwin according to the principle of *serviceable associated habits*. Consider the baring of the teeth, produced by various species when in anger. For Darwin, this expression is an involuntary vestige of a voluntary action—biting—that used to be serviceable in the ancestral past of the species and kept being associated to the state of mind that brought it about by force of habit or by reflex.

Once an expression has been established through the principle of serviceable associated habits, other expressions can be generated through the subsidiary principle of *antithesis*. According to it, states of mind opposed to those that elicited expressions according to the principle of serviceable associated habits recruit expressions in morphological antithesis to them. For example, if a dog in an angry state of mind displays a fixed stare, walks tall, and holds its tail stiff and upright, a dog in a placid state of mind will not look intently, crouch, and lower and wag its tail. Finally, according to the principle of the *direct action of the nervous system*, some emotional expressions are the direct result of the excitation of the nervous system. Darwin cites as examples the "trembling of the muscles, the sweating of the skin, the modified secretions of the alimentary canal and glands" (Darwin 1872/1965, p. 81).

Dewey (1894) notes that Darwin's theory of expressions is incompatible with James's theory of emotions. According to James, an emotion emerges once an expression (and other bodily changes) is perceived: the agent first bares his or her teeth, and then anger ensues. According to Darwin, the emotion comes first, and the expression follows: the agent first gets angry, and then the teeth are bared as a means of expressing anger. Dewey makes two main suggestions to improve upon both accounts and make them compatible.

In opposition to Darwin, Dewey rejects the view that we should "start from the emotion and attempt to derive the movements as its expression" (1894, p. 564). Expression for Dewey only makes sense from the point of view of the observer, which takes facial and postural movements to be *signs* of the emotion. Since Darwin's principles do not assume that being a sign of emotion relative to an observer explains the origin of the sign, Dewey suggests focusing on facial movements *qua* movements, and explore how such movements relate to practical ends.[12] As Dewey notes, in the case of serviceable associated habits the "principle of explanation *actually* used . . . is that of survival . . . of acts originally useful not *qua* expressing emotion, but *qua* acts—as serving life" (p. 555, emphasis in original).

The principle of antithesis poses a bigger challenge, because movements are alleged to have emerged simply because they are opposite of movements that used to be serviceable, without having been serviceable themselves. Dewey rejects this interpretation, because it turns antithesis into a mysterious causal force. As an alternative, Dewey argues that the movements Darwin proposes to explain through the principle of antithesis can also be explained in light of the practical ends they serve. For example, he suggests that the movements of a dog in a placid state of mind were serviceable because they helped the dog receive "favor and food" from the master. Dewey acknowledges that the kinds of facial movements Darwin explained through the principle of direct discharge are a "breakdown of . . . teleological coordination" (p. 560), thereby allowing for exceptions to the rule that facial movements must be serviceable as portions of some useful activity.

The second suggestion, contra James, is to stop thinking of emotions merely in terms of how they feel, and construe them instead as "modes of behavior." As Dewey puts it, emotions "are too important and too relevant in our lives to be in the main . . . the 'feel' of bodily attitudes which have themselves no meaning" (1894, p. 563). For Dewey, an emotion "in its entirety" is "a mode of behavior which is purposive" (an idea Dewey gets from his revision of Darwin) and "which also reflects itself into feeling" (an idea Dewey gets from his revision of James; Dewey, 1895, p. 15).

Since James focuses only on the phenomenological dimension of emotions while neglecting the teleological one, Dewey concludes that James never intended to deal with "emotion as a concrete whole of experience, but with an abstraction from the actual emotion of that element which gives it its differentia—its feeling *quale*" (1895, p. 16). This interpretation allows Dewey to remove from

James's theory its "paradoxical air." When James tells us that "we feel sorry because we cry, angry because we strike, afraid because we tremble," Dewey points out, "the very statement brings out the idea of *feeling* sorry, not of *being* sorry" (p. 15). But when we say that someone is sorry or angry or afraid, Dewey continues, "we do not simply, or even chiefly, mean that [such person] has a certain 'feel' occupying his consciousness." Rather, "[w]e mean he is in a certain practical attitude, has assumed a readiness to act in certain ways" (pp. 16–17).

Dewey adds that there is yet another important element in emotions, besides feelings and modes of behavior, namely, the "'object' or intellectual content" of the emotion, which is "always 'about' or 'toward' something" (1895, p. 17)—for instance, an episode of fear may be about a frightening bear. But Dewey emphasizes that "the mode of behavior is the primary thing," in the sense that it "carrie[s] with it the—concept of the bear as a thing to be acted towards in a certain way, and of the 'feel' of our reaction" (p. 24). This is to say that the mode of behavior of running away from a bear at the same time endows the bear with the property of being an object to be run away from, and it generates the feeling of fear.

McDougall, Shand, and the Emergence of Evolutionary Accounts

The *impulsivist approach* was further articulated by William McDougall in *An Introduction to Social Psychology* (1908/2001) and by Alexander Shand in *The Foundations of Character* (1920 see also Stout, 1899; Mead, 1934; Young, 1943; Leeper, 1948; Bull, 1951). These two monographs share the distinction of being the first book-length accounts to characterize emotions as evolutionary adaptations selected for their ability to motivate behavior toward ends.

McDougall and Shand reaffirm the tight connection between emotions and instincts already proposed by James and Dewey, but formulate two different accounts of how emotions and instincts relate. Shand argues that instincts are subordinate to emotions, which are "penetrated throughout by an impulse" (1920, p. 179) that organizes the instincts and directs them to an end (e.g., the instincts of flight and concealment are directed by fear toward protection from danger). Shand adds that, as we "cannot understand the organs of the body without a knowledge of their functions," so we cannot understand "the emotions without a knowledge of their ends" (p. 197). He singles out six primary emotions (fear, anger, disgust, curiosity, joy, and sorrow), and describes them in ways that are very reminiscent of contemporary accounts of basic emotions (Ekman, 1999): they appear early in ontogeny, they are present in animals, they are independent of other emotions, they can be evoked by innate stimuli, and they are manifested in instinctive behaviors.

McDougall (1908/2001) understands emotions as "emotional excitement[s] of specific quality" that emerge as a result of the operation of instincts already "directed to some particular mode of action" (p. 285; e.g., fear is the emotional excitement associated with the instinct to flee, which is directed toward protection from danger). For McDougall, there are seven primary emotions (fear, anger, tender-emotion, disgust, positive self-feeling, negative self-feeling, and wonder) and they are primary because they are the "immediate inevitable result and subjective expression of the excitement of an instinct, an innate disposition specifically directed to some particular mode of action" (p. 285). McDougall (1923, pp. 316–317) eventually distinguishes between a broad and narrow meaning of "emotion." According to the narrow meaning, the emotion is the feeling; according to the broad meaning, the emotion is the complete instinctive process.

The relevance of the pioneering efforts of McDougall and Shand is that they added an evolutionary dimension to the *motivational tradition* and opened the door for functionalist accounts of emotions, which characterize emotions not just in terms of their diagnostic features but also in terms of the evolutionary problems they solve. This research program came to maturity with the emergence of basic emotion theory in the 1970s (see the section "Contemporary Developments I: Basic Emotion Theory and Social Constructionism").

The Behaviorist Detour: Emotions as Behavior Patterns

Behaviorism dominated psychology roughly from the second decade of the 20th century to the cognitive science revolution in the 1960s (see Bechtel, Abrahamsen, & Graham, 1998). Its core commitment was that psychology is the science of behavior rather than the science of consciousness. As a result, psychology should change its methodology, and replace introspection of conscious states with observation of behaviors. In the initial phase of behaviorism, it was assumed that facts of behavior can be wholly explained without invoking internal psychological processes. This is the sort of behaviorism championed for instance by John B.

Watson, the first pioneer of *classical behaviorism*, and by B. F. Skinner, arguably the most influential developer of the research program and the father of what came to be known as *radical behaviorism*.

In the later *neo-behaviorist* phase of the movement, behaviorists like Edward Tolman and Clark Hull rejected the blanket opposition to internal states advocated by classical and radical behaviorists, and allowed the positing of internal states understood as "intervening variables" that mediate the stimulus–response connection (see, e.g., Mowrer, 1947; Miller, 1951, for a neo-behaviorist analysis of emotions as motivations). Behaviorism also had a philosophical wing focused on the meaning of mental terms (*analytical behaviorism*). This variety of behaviorism, best represented by Gilbert Ryle's (1949/2009) work, held that sentences ascribing mental states can be translated into sentences ascribing behavioral dispositions (see also Carnap, 1959; Hempel, 1935/1980; Wittgenstein, 1953).

Although I am including all behaviorist accounts within the *motivational tradition*, it is clear that classical and radical behaviorism are at best *sui generis* members of the tradition because of their staunch opposition to internal states. The rationale for including not only neo-behaviorism but classical and radical behaviorism as well into the *motivational tradition* is that even ruthlessly anti-mentalistic theories such as the ones offered by Watson and Skinner tried to identify emotions with behavior patterns, which is what motivational states predispose one to. It consequently seems fitting to consider such theories closer to the *motivational tradition* than to either the *feeling tradition* or the *evaluative tradition*.

With these caveats in mind, we can distinguish two approaches to the study of emotions within behaviorism. The *reflexivist approach*, paradigmatically associated with Watson, identifies emotions with reflexive behavioral patterns (on a broad interpretation of what counts as behavior). The *impulsivist approach*, best exemplified by the convergent work of Ryle and Skinner, identifies emotions with, respectively, behavioral dispositions or changes in the probabilities of operant behaviors.

According to Watson, emotion is a "hereditary 'pattern-reaction' involving profound changes in the bodily mechanism as a whole, but particularly of the visceral and glandular systems. By pattern reaction we mean that the separate details of response appear with some constancy, with some regularity, and in approximately the same sequential order each time the exciting stimulus is presented" (1919a, p. 195). In this model, emotions are inherited physiological pattern reactions, which are basically Jamesian emotions without the attendant feelings. Watson contrasts reflexive *emotional* reactions with *instinctive* reactions, which are not "internal and confined to the subject's body" but lead to "adjustment of the organism as a whole to objects" (p. 197). Watson therefore limits the notion of emotional behavior in two important ways: the "behavior" consists primarily of physiological changes (but see below), and such changes are reflexive in nature.

The problem Watson had to face is that emotions in adults rarely if ever manifest such distinctive physiological patterns. So he focused on the emotions of infants, for which he thought reflexive patterns are more easily detectable. Watson distinguishes between three emotional stimulus–response patterns allegedly present in infants: fear, rage, and love, where love is understood "in approximately the same sense that Freud uses sex" (1919a, p. 199). He proposes that all kinds of adult emotions result from infant fear, rage, and love through complex processes of classical conditioning, although his suggestions on this point remained very vague.

For example, fear in an infant is the pattern of responding to loud sounds and loss of support with the unconditioned emotional responses of "catching of the breath, clutching randomly with the hands (the grasping reflex invariably appearing when the child is dropped), blinking of the eyelids, puckering of the lips . . . crying" (1919b, p. 170). Rage is the pattern of responding to restraint with "crying . . . quickly followed by screaming . . . [while] the body stiffens and . . . slashing or striking movements of the hands and arms result; the feet and legs are drawn up and down; the breath is held" (p. 170). Love is the pattern of responding to the striking of the skin or sex organs or to patting and rocking with "a smile . . . attempts at gurgling, cooing" (p. 171).

But Watson is not entirely consistent on limiting emotional reactions to physiological changes. For example, he tells us that in "older children" the reactions of fear include "flight and hiding" (1919b, p. 170), those of rage include "kicking, slapping, and pushing" (p. 171), and those of love include "the extension of the arms which we should class as the forerunner of the embrace" (p. 171). This enlargement in the scope of behavior beyond mere physiological changes was brought to fruition by other behaviorists, who included physical actions in the class of emotional behaviors, and abandoned the assumption that such reactions had to be reflexive.

Whereas Watson acknowledges that ordinary emotion terms refer to mental states (feelings) but argues that psychology, if it wants to be a true science, must redefine emotions in terms of behaviors and the stimuli that cause them (Watson 1913, 1919a), philosophical behaviorists like Ryle (1949/2009) argue that a close study of emotion ascriptions in ordinary language reveals that emotion terms in most cases do not refer to feelings at all, but rather to dispositions to behave. This claim, which Ryle generalizes to all mental state ascriptions, becomes the centerpiece of his attack on Cartesian dualism, grounded in the idea that the language of mental states does not (at least not primarily) refer to a realm of private mental occurrences.

To have a disposition, Ryle (1949/2009, p. 31) tells us, "is not to be in a particular state, or to undergo a particular change; it is to be bound or liable to be in a particular state, or to undergo a particular change, when a particular condition is realized." The dispositions to which (most) emotion terms refer, Ryle emphasizes, are "indefinitely-heterogeneous," in the sense that they have an open range of manifestations of different kinds.[13] For example, "When Jane Austen wished to show the specific kind of pride which characterized the heroine of 'Pride and Prejudice,' she had to represent her actions . . . thoughts and feelings in a thousand different situations" (p. 32). Being proud involves being disposed to engage in actions like rejecting an invitation from someone who slighted us in the past, in thoughts like reminiscing about one's own successes, in painful feelings when one is snubbed, plus innumerable other manifestations depending on the circumstances. On this view, describing a person as proud is not saying that he or she is having a feeling (or any other kind of occurrent mental state), but that he or she is disposed to engage in an open range of actions, thoughts, and feelings.[14]

Skinner (1953, 1957) offers an account of emotions that combines reflexivist and impulsivist elements. He suggests that emotions either consist of behavioral reflexes or behavioral dispositions, where the latter are understood as "change[s] in probability that the organism will behave in a given way" (1957, p. 158). For example, a stimulus can either elicit "the emotional reflex pattern of anger" or "a predisposition to attack someone," which amounts to an increase in the "probability of abusive, bitter, or other aggressive behavior" and a "decrease [in] the probability of generous or helpful behaviour" (1957, p. 215). The behaviors to which emotions predispose are operant behaviors, that is "active behaviors that *operate* upon the environment to generate consequences" (1953, p. 65, emphasis in original). In another reminder of the fact that classical and radical behaviorists belong to the motivational tradition only in an "inverted commas sense," Skinner concludes by describing the emotions as "excellent examples of the fictional causes to which we commonly attribute behavior" (1953, p. 160).

Behaviorism collapsed as a research program in the 1950s. Already in the 1920s and 1930s psychologists such as Edward C. Tolman and Wolfgang Köhler had argued against the stimulus–response paradigm for its dismissal of intervening variables, pointing out that the mentalistic notion of *purpose* was constitutive of the very notion of behavior. However, the nail in the coffin of behaviorism came with an influential review of Skinner's (1957) *Verbal Behavior* by Chomsky (1959), who argued that "verbal behavior" (i.e., the production of speech) cannot be explained without reference to the mental mechanisms generating it, more specifically to a "mental grammar" (a set of rules that specify syntactically correct utterances). Chomsky's critique of Skinner generalizes to all behaviors that were the focus of behaviorist psychology: it seems impossible even to characterize behaviors as being of the same kind without making at least implicit assumptions about the mental states and processes that cause them (e.g., intentions).

Contemporary Developments I: Basic Emotion Theory and Social Constructionism

Following the demise of behaviorism, the *motivational tradition* was soon revived by several authors, in particular by Robert Plutchik (1962, 1970; Plutchik & Kellerman, 1980), who proposed an emotion theory rather similar to that of McDougall, as well as by other psychologists such as Silvan Tomkins (1962–1992/2008), Paul Ekman (1980, 1992a, 1992b, 1994, 1999, 2003; see also Ekman & Friesen, 1969), and Carrol Izard (1969, 1971, 1977, 1980, 1992).

Tomkins offers a theory of *affects* intended to show that "the primary motivational system is the affective system," whereas "the biological drives have motivational impact only when amplified by the affective system" (2008, p. 4). Tomkins suggests that the motivational power of affects comes from their feeling pleasurable or painful. His core assumption is that such hedonic feelings emerge from the perception of facial changes providing "motivating feed-back."

Reminiscent of James, Tomkins claims that "affect is primarily facial behavior [and] [s]econdarily bodily behavior, outer skeletal and inner visceral behavior" (2008, p. 114). These behaviors, Tomkins proposes, are organized by subcortical *affect programs*, which evolved partly because the facial behaviors they produce are communicative. Note that this is an important departure from Darwin's (1872/1965) original proposal that facial changes are vestiges of serviceable actions that did not evolve in order to communicate.

The task of providing empirical evidence for the claim that affects are associated with distinctive facial expressions was left largely to Ekman and Izard, who were then Tomkins's students and developed contemporary basic emotion theory. Basic emotion theory's core commitment is that basic emotions are solutions to recurrent evolutionary tasks: "each basic emotion prompts us in a direction that, in the course of our evolution, has done better than other solutions in recurring circumstances that are relevant to our goals" (Ekman & Cordaro, 2011, p. 364).

This is an idea that, although already present in Shand and McDougall, became especially prominent in emotion theory with Plutchik's (1970) work. "In order to provide a general definition of emotion," Plutchik argued, "we need to use the functional or adaptational language." On his view, "an emotion is a patterned bodily reaction of either protection, destruction, reproduction, deprivation, incorporation, rejection, exploration or orientation, or some combination of these, which is brought about by a stimulus" (p. 12). These eight biological functions individuate Plutchik's eight primary emotions (fear, anger, joy, sadness, acceptance, disgust, anticipation, and surprise), from which all other emotions can be derived as "all colors can be considered to result from a mixture of just a few primary colors" (p. 9).

Ekman (1980, 1992, 1994) further develops the idea that emotions must be defined in adaptationist terms, and starts referring to a subset of the emotions we distinguish in folk psychology (happiness, sadness, anger, fear, disgust, and surprise) as *basic emotions*, to emphasize that he regards them (or more precisely, the mechanisms that underlie them) as "biologically basic"—that is, as domain-specific evolutionary adaptations. Over time, Ekman expands the roster of basic emotions, suggesting that evidence of biological basicness is likely to also be found for amusement, contempt, embarrassment, excitement, guilt, pride in achievement, relief, satisfaction, sensory pleasure, and shame (Ekman & Cordaro, 2011).

But Ekman (1999) also adds, "I do not allow for 'non-basic' emotions" (p. 57), implying that he is unwilling to regard anything as an emotion if its generating mechanisms did not develop during evolutionary time as a solution to a fundamental life task. Accordingly, other items commonly called "emotions" in folk psychology are reclassified by Ekman as belonging to other psychological categories that, while having affinities to emotions, are not themselves emotions. These other categories include "emotional plots" (e.g., love), moods (e.g., depression), and affective personality traits (e.g., hostility).

To illustrate his understanding of evolutionary life tasks, Ekman (1992b) started relying on evolutionary psychologists Tooby and Cosmides, who give the following examples: "fighting, falling in love, escaping predators, confronting sexual infidelity, experiencing a failure-driven loss in status, responding to the death of a family member" (Tooby & Cosmides, 2008, p. 117; see also Keltner & Haidt, 2001). Besides being defined as domain-specific evolutionary adaptations, basic emotions are associated by Ekman with 11 diagnostic characteristics. They include distinctive universal signals, distinctive physiology, automatic appraisals tuned to distinctive universals in antecedent events, distinctive developmental appearance, presence in other primates, quick onset, brief duration, unbidden occurrence, distinctive thoughts, memories and images, and distinctive subjective experiences (Ekman 1999).[15] However, with the possible exception of distinctive universal signals, none of these characteristics is deemed to be a necessary feature of a basic emotion (see, e.g., Russell, Bachorowski, & Fernández-Dols, 2003; Matsumoto, Keltner, Shiota, Frank, & O'Sullivan, 2008; Cordaro, Fridlund, Keltner, Russell, & Scarantino, 2015, for a summary of the debate on facial expressions).

Ekman's crucial assumption is that, as soon as the basic emotion program is activated, a "cascade of changes (without our choice or immediate awareness) occurs in split seconds in: the emotional signals in the face and voice; preset actions; learned actions; the autonomic nervous system activity that regulates our body; the regulatory patterns that continuously modify our behavior; the retrieval of relevant memories and expectations; and how we interpret what is happening within us and in the world" (Ekman & Cordaro, 2011, p. 366).

These changes, Ekman emphasizes, are "inescapable," in the sense that "the instructions in the affect programs run until they have been executed" (Ekman & Cordaro, 2011, p. 367). Although the list of behaviors activated is broader than the list invoked by Watson, the assumption of inescapability makes Ekman a member of the reflexivist strand of the motivational tradition. This connection must be qualified, however, because Ekman explicitly denies that basic emotions are full-fledged reflexes. This qualification emerges in his discussion of the difference between surprise (a basic emotion) and startle (a physical reflex; Ekman, Friesen, & Simons, 1985). Ekman tells us that reflexes such as startle, unlike emotions such as surprise, are easy to elicit, are shown reliably by every subject, cannot be totally inhibited, and cannot be simulated with the correct latency.

Yet, the differences posited by Ekman are differences of degree rather than kind. The inescapable responses activated by affect programs are reflex-like, as they manifest the very features singled out by Watson in his description of emotional reflexes: they "appear with some constancy, with some regularity and in approximately the same sequential order each time the exciting stimulus is presented" (Watson, 1919a, p. 195). An important qualification is that, in the case of basic emotions, an *appraisal process* mediates between the stimulus and the cascade of responses, which for Ekman follow inescapably only after the stimulus is appraised as exciting. A corollary is that in the case of basic emotions, unlike in the case of physical reflexes, a stimulus that elicits a basic emotion in one subject may not elicit it in another due to differences in the appraisal processes.

In addition, Ekman makes it clear that the inhibition of basic emotions is never complete, from which it follows that neither full-fledged reflexes nor basic emotions can be totally inhibited. Rather, the cascade of inescapable behavioral changes can be *regulated* after it has occurred, with a swiftness that depends on the feature under consideration. Facial changes, Ekman suggests, can be regulated within less than a second. But "the changes in our respiration, perspiration, and cardiac activity . . . have a longer time line, some stretching out to 10 or 15 seconds" (Ekman & Cordaro, 2011, p. 367), during which they cannot be interrupted.[16]

This assumption—that basic emotions are associated with an inescapable cascade of bodily changes—has been heavily criticized by psychological constructionists, who have pointed out that the empirical evidence does not support it (Russell, 2003; Barrett, 2006). Specifically, psychological constructions have argued that, contrary to what the hypothesis of an inescapable cascade of changes would predict, there is no one-to-one correspondence between anger, fear, happiness, sadness, or any other basic emotion, and any neurobiological, physiological, expressive, behavioral, or phenomenological responses, and that such diagnostic markers are not strongly correlated with one another. This variability, psychological constructionists conclude, calls into question the very idea that "emotions have ontological status as causal entities [and that they] exist in the brain or body and cause changes in sensory, perceptual, motor, and physiological outputs" (Barrett, 2005). As we have seen in the section "Contemporary Developments: Neo-Jamesianism and Psychological Constructionism," skepticism about the causal powers of emotions has motivated emergent models of emotions, according to which emotions are the effects of changes in sensory, perceptual, motor, and physiological outputs, rather than their causes (Coan & Gonzalez, 2015).

The social constructionist approach found its first advocates in the 1920s, 1930s, and 1940s, when a number of anthropologists and social scientists started questioning Darwin's (1872/1965) evidence for the universality of emotional expressions (e.g., Allport, 1924; Landis, 1924; Klineberg, 1940). These researchers initiated what we may call the "cultural variability" strand of social constructionism, related to the thesis that emotions are different in several essential respects in different cultures. These differences have since been shown with respect to both the emotion lexicon (e.g., Russell, 1991; Wierzbicka, 1999) and the diagnostic features of emotions (Mesquita & Frijda, 1992), which vary to some extent across cultures.

The strand of social constructionism that is more germane to the *motivational tradition* is the "social role" strand, related to the thesis that emotions fulfill social functions by virtue of which they should be considered actions or roles or moves rather than passions.[17] Jean Paul Sartre (Sartre & Frechtman, 1948) can be considered the first to offer a general, although idiosyncratic, theory of emotions as social roles, a view further developed in the early 1980s by philosophers (e.g., Harré, 1986; Armon-Jones, 1986), psychologists (e.g., Averill, 1980), and anthropologists (e.g., Lutz, 1980). In recent times, Parkinson (1995, 2008, 2009), Parkinson, Fischer, and Manstead (2005), Griffiths (2004b), Mesquita and Boiger (2014), and Van Kleef (2009) and others have developed sophisticated social constructionist proposals that add to the social constructionist approach themes from the evolutionary tradition.

Sartre argues that an emotion is "an organized system of means aiming at an end" (Sartre & Frechtman, 1948, p. 32). This "finality" gives emotions their significance and it is what physiological accounts in the style of James miss out on, because "physiological facts . . . taken by themselves and in isolation . . . signify almost nothing" (p. 17). What distinguishes emotions from straightforward actions is for Sartre the way they go about fulfilling their ends: they do so in a *masked* or *covert* fashion. As Sartre puts it, "[emotion] is called upon to mask, substitute for, and reject behavior that one cannot or does not want to maintain. By the same token, the explanation of the diversity of emotions becomes easy; they represent a particular subterfuge, a special trick, each one of them being a different means of eluding a difficulty" (p. 32). Sartre's central idea is that we emote when the opportunity to pursue our ends in nonemotional ways turns out to be unavailable or unappealing. On this view, we emote by substituting a behavior that is openly instrumental with one that is covertly instrumental. Emotion researchers have since explored this Machiavellian aspect of emotions from a variety of research perspectives (e.g., Frank, 1988; Solomon, 1980; Griffiths & Scarantino, 2009; Slaby & Wüschner, 2014).

The idea that emotions are covertly instrumental was further developed within the social constructionist camp by Averill, who argues that "an emotion is a transitory social role (a socially constituted syndrome) that includes an individual's appraisal of the situation, and is interpreted as a passion rather than as an action" (1980, p. 139). The idea here is that emotions are means of resolving conflicts among norms at the social level, and they do so in part because of the widely shared Aristotelian assumption that we are overcome by our passions. This is what Averill calls the "myth of passions," a self-deceiving assumption that comes from having "limited self-awareness" about the social functions of emotions (see also Peters, 1962). For example, Averill tells us that anger is a way to solve the conflict between societal norms that prohibit violence, and societal norms that demand protection of one's own rights from wrongdoers. By being "overcome" by anger, individuals manage to protect their rights by inflicting violence, and they are justified in doing so because they inflict violence while being acted upon by a passion that partially suspends responsibility (Averill, 1980, p. 66).

In more recent times, social constructionism has shifted from an understanding of emotions as solutions to *social-level* problems to an understanding of emotions as solutions to *interpersonal* problems. These efforts are inspired in part by influential work on the strategic dimension of emotional expressions by Fridlund (1994), Russell (1997), Fernández-Dols and Carroll (1997), and Fernández-Dols and Ruiz-Belda (1997) among others. Parkinson (1995) states for instance that "many of the occasions for emotion arise from local negotiations in the course of everyday personal interaction and do not directly reflect societally prescribed norms" (p. 162). On this view, anger is not a solution to a conflict between societal norms but a solution to a local problem of negotiation between parties who are interfering with each other's goals. The social transaction relies on emotional expressions that convey assessments (you are to blame) and behavioral intentions (I will hurt you unless you stop). This shift from the societal to the interpersonal is accompanied by a new attention to the dynamic unfolding of emotions, understood as open-ended interactive processes in which emotional responses are not preordained at the beginning of the sequence, but rather shaped over time by each interactant's ongoing responses.

Contemporary Developments II: Motivational Theories of Emotions

The *impulsivist approach* has been further articulated by Nico Frijda (1986, 2007, 2010), who has described emotions as "modes of relational action readiness, either in the form of tendencies to establish, maintain, or disrupt a relationship with the environment or in the form of mode of relational readiness as such" (1986, p. 71; see also Frijda, Ridderinkhof, & Rietveld, 2014; Ridderinkhof, 2014). The first mode of *relational action readiness* is that of an *action tendency*, which is a state of readiness "to execute a given kind of action." What *kind* of action it is will depend on what *kind* of "end result" is being pursued. For example, fear is associated with the action tendency of "avoidance," characterized by the end of achieving one's "own inaccessibility" with respect to a certain stimulus. Disgust is associated with the action tendency of "rejecting," characterized by the end of "removal of object."

States of "readiness as such," the second variety of modes of relational action readiness, come in two flavors: "null states" and "activation modes." According to Frijda (1986), sadness is a *relational null state* [emphasis added], namely, a state of "explicit absence of relational activity" (p. 22). Joy, on the other hand, is the "manifestation of *free activation* [emphasis added]" (p. 38). Frijda emphasizes that "null states, activation modes, and action tendencies proper . . . all are modifications of action tendency in a general sense: they all represent modes of readiness, unreadiness included, for relational action" (p. 71).

Frijda's (1986) most distinctive contribution is his claim that emotions should be identified not just with generic states of action readiness but with states of action readiness that have *control precedence*. Emotion, he tells us, "has action control precedence in two senses." First, "it can interrupt other processes and block access to action control for other stimuli and other goals." Second, "it invigorates action for which it reserves control and invests that control with the property of indistrability or persistence" (p. 460).

Scarantino (2014) has developed a self-described "motivational theory of emotions" that is in many ways similar to Frijda's own, but is more closely integrated with basic emotion theory, and, most importantly, includes a theory of intentionality suitable for motivational theories. On Scarantino's view, emotion systems are behavioral programs that are flexible on the input and output sides, and provide solutions to recurrent evolutionary problems in the form of "motive states" with control precedence—namely, states of readiness to achieve a prioritized goal while allowing for some degree of rational control.

Emotion episodes correspond to the activations of such programs. Such episodes are shaped over time by the interaction between prioritized modes of action readiness (a domain-specific adaptation) and rational control (a domain-general capacity). This interaction can lead either to the inhibition of the action readiness or to its variable and context-dependent manifestation.

This proposal aims to combine two insights: (1) the idea that (a great many) emotions are evolved solutions to fundamental life tasks, and (2) the idea that the distinctive design advantage of emotions stems from their ability to combine speed and flexibility of execution. Scarantino (2015) argues that basic emotion theory in its traditional, Ekman-inspired formulations only heeds to the first insight while neglecting the second.

As a result, a fundamental tension is created within the research program, because it makes little evolutionary sense to assume both that basic emotions are solutions to abstract problems like avoiding dangers or removing obstacles and that they elicit responses in a reflex-like fashion (see also Scarantino & Griffiths, 2011).

This is because abstract problems like avoiding dangers or removing obstacles require different adaptive responses in different circumstances. To account for this fact, the traditional assumption that affect programs activate a cascade of inescapable responses (Traditional BET) must be replaced by the assumption that they inescapably activate "motive states" with control precedence (the New BET; Scarantino, 2015).

A motive state is a goal-oriented "general direction for behavior [that operates] by selectively potentiating coherent sets of behavioral options" (Gallistel, 1980, p. 322; see also Morgan, 1957; Pacherie, 2001). The determination of which behavioral option, if any, is ultimately chosen is left to rational control, which operates under the constraints of urgency and limited informational access that define control precedence.

In addition, Scarantino (2014) argues that emotion systems can have intentionality, or the capacity to represent, by virtue of their functions. The background philosophical theory of representation being assumed here is *teleosemantics*, according to which traits represent what they have the function of indicating (Dretske, 1988; Prinz, 2004b). On this view, the fly detection system in a frog represents flies or edible objects because it has the function of indicating them. By the same token, fear represents danger because it has the function of selectively potentiating avoidance options in the presence of danger. Similarly, anger represents slights because it has the function of selectively potentiating attack options in the presence of slights (see Scarantino, 2014, 2015, for further examples and discussion).

Some Challenges for the Motivational Tradition

While the *motivational tradition* continues to influence the contemporary emotion debate in the ways described and others, it faces its own share of problem cases. Some critics have questioned whether defining emotions as modes of behavior, or states of action readiness, can solve the problem of differentiation. As Bedford (1957, p. 84) puts it, "the same, or similar, behavior, can be differently, yet correctly, interpreted in different circumstances, for example as anger, indignation, annoyance, exasperation, or resentment." The idea, once again, is that behaviors are not sufficiently fine grained to distinguish among different emotions. This problem is especially biting for the *reflexivist approach*, which is committed to the assumption that behavioral responses are reflex-like, but has failed to marshal convincing evidence for the existence of biobehavioral signatures for different discrete emotions.

But the problem also affects the *impulsivist approach*, which faces a variety of potential counterexamples to the claim that any two emotions are differentiated by the action tendencies they involve. First, many emotions do not appear to motivate actions at all. Grief and depression, for example, seem to involve a general depotentiation of the will to act. Second, regarding "backward-looking" emotions like regret, it is unclear which action tendency they could elicit, because they focus on what happened in the past, which cannot be changed. Third, emotions like existential joy involve the selective potentiation of behavioral options, but the range of these options is so wide that it is difficult to pinpoint which action tendency is associated with them. Fourth, it seems possible for the same action tendency to be associated with different emotions (e.g., avoidance may be associated with both anger and unrequited love), and for different action tendencies to be associated with the same emotion (approach and avoidance may both be associated with anger), provided such tendencies are described at a sufficiently abstract level of analysis.

One option for dealing with some of these problem cases, as mentioned before, is the one suggested by Frijda (1986), who introduced the hypothesis of modes of "relational readiness as such." Frijda's proposal can in principle take care of the cases of grief and depression, arguably associated with a "null state" and existential joy, arguably associated with a state of "free activation." A second option is to include mental actions along with physical actions. Depression and regret may lack distinctive physical action tendencies, but they appear to be associated with distinctive mental action tendencies that have control precedence. For example, one of the symptoms of depression is compulsive mental rumination, and regret is strongly associated with a tendency to counterfactually think about what would have happened had one made different choices. A third option is to allow multiple action tendencies to be comprised within the same emotion, as proposed in Frijda and Parrott's (2011) recent theory of action tendencies as universal and biologically based *ur-emotions*. Whether or not a combination of these proposals can solve the problem of differentiation remains to be seen (see, e.g., Reisenzein, 1996; Prinz, 2004b; Tappolet, 2010; Eder & Rothermund, 2013, for critiques of motivational approaches).

The other significant liability for the *motivational tradition* is that in many of its versions it does not solve the problem of intentionality (but see Scarantino, 2014). If fear were simply a tendency to avoid, why would it be inappropriate in the absence of danger? If anger were simply a tendency to remove obstacles, why would it be inappropriate in the absence of a slight? And in what sense would fear and anger be about objects, if they were merely modes of behavior? Answering these questions requires giving evaluations a more central role in the identification of emotions, since evaluations seem to be precisely the sorts of things that are about objects and can be appropriate and inappropriate with respect to them.

These problems led the *motivational tradition* to lose ground in the 1960s and 1970s in favor of the *evaluative tradition*. The transition from one research tradition to the other was facilitated by the general shift in the understanding of minds ushered in by the cognitive revolution, which replaced the understanding of mind as behavior proposed by behaviorism with a new understanding of mind as a computer that processes information according to rules. The cognitive revolution made internal cognitive states and processes respectable again, and sent emotion theorists in search of alternatives to both behaviorist theories and feeling theories of emotions.

The Evaluative Tradition

The *evaluative tradition* holds that emotions are essentially distinguished from one another by the evaluations they involve, where an evaluation is a cognition, or an interpretation, or a judgment, or a thought, or a construal or some other kind of mental representation of the eliciting circumstances. I distinguish between two approaches within the *evaluative tradition*: the *constitutive approach*, which takes emotions to *be* evaluations of a distinctive type, and the *causal approach*, which takes emotions to be *caused by* evaluations of a distinctive type (always or typically; see Figure 1.4).

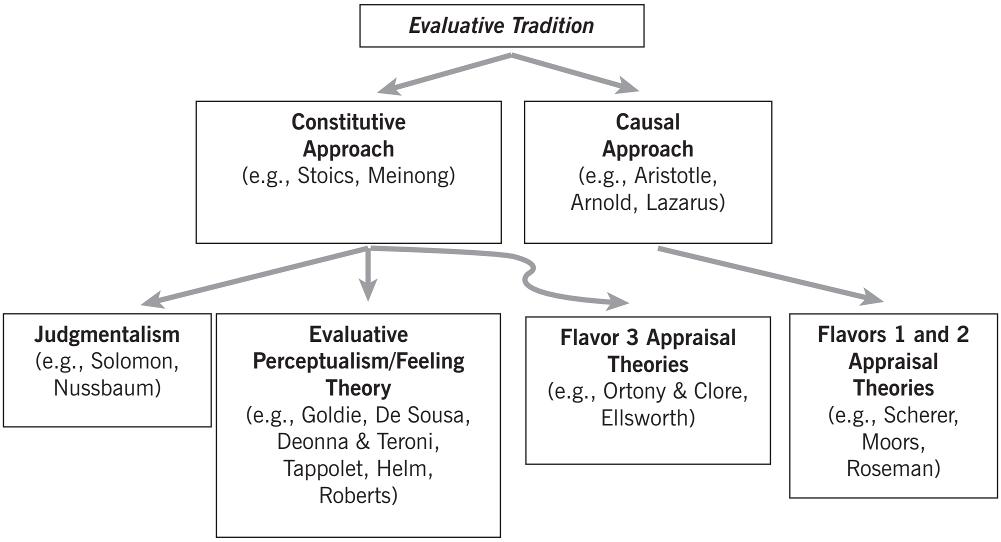

FIGURE 1.4. The *evaluative tradition* and some related contemporary developments.

The two approaches are often conflated, but they differ in their historical origins, objectives, and implications. Importantly, only the *constitutive approach* is a direct competitor of the *feeling* and *motivational traditions*. The *causal approach*, on the other hand, is at least in principle compatible with the idea that emotions are essentially feelings or motivations, because it only claims that emotions are caused by evaluations while (at least potentially) remaining agnostic on what emotions are. I illustrate some highlights from the history of the *evaluative tradition*, and then discuss some related contemporary developments, most significantly the transition from judgmentalism to other evaluative research programs in philosophy, and the emergence of appraisal theories in psychology.

The Stoics on the Passions

The *constitutive approach* has attracted most of the work in recent philosophy of emotions, and it has its roots in the Stoic theory of the passions. Although Stoicism offered a variety of views on the nature of emotions, what we now call the Stoic theory of the passions is the theory of emotions introduced by Chrysippus, the third head of the Stoic school of Athens (ca. 206 BC), and prominently defended by the Roman Stoic Seneca (4 BC–65 AD; see Sorabji, 2000). According to Chrysippus, passions are false judgments of appropriateness, a position that clearly identifies emotions with evaluations of a special type—namely, judgments.

The Stoics understood judgments as assents to impressions (*phantasiai*), and assumed that the capacity to give assent requires reason, which emerges in humans at age 14 and is not available to nonhuman animals. Unlike judgments, impressions do not require reason. An impression is that by virtue of which the world *appears to be a certain way*, prior to, and in potential opposition with, what one judges the world to be like. Chrysippus distinguishes between two forms of assent involved in undergoing a passion. First, the assent to the impression that something good or bad is happening or will happen, and second, the assent to the impression that it is appropriate to react in a certain way.

According to Chrysippus, there are four primary passions: distress (*lupe*), pleasure (*hedone*), fear (*phobos*), and appetite (*epithumia*). All other passions are subspecies of the four primary ones. Sorabji (2000) describes the primary passions as follows:

> Distress is the judgment that there is bad at hand and that it is appropriate to feel a sinking. Pleasure is the judgment that there is good at hand and that it is appropriate to feel an expansion. Fear is the judgment that there is a bad at hand and that it is appropriate to avoid it. Appetite is the judgment that there is good at hand and that it is appropriate to reach for it. (p. 30)

On this view, what is judged to be appropriate to the goodness or badness at hand are what the Stoics called *movements of the soul*, which are either bodily changes (sinking or expansion, as in the case of distress and pleasure) or action tendencies (avoiding and reaching, as in the case of fear and appetite). This indicates that the Stoics made room for diagnostic features other than evaluations, but also that they held a very peculiar notion of passion, because they assimilated having a passion with engaging in a complex evaluative judgment to the effect that something is good/bad and it is appropriate to reach for it/avoid it.

Suppose you detect a tiger, start trembling, manifest increased heart rate, develop an impulse to flee, and have feelings associated with such bodily changes and action tendency. On all theories of emotions we have considered so far, under such circumstances you would be afraid. Not so on the Stoic theory: you are not afraid as long as you do not judge avoiding getting mauled by the tiger to be good. And you should not do so, the Stoics added, because judging avoiding getting mauled by the tiger to be good would amount to considering your own life and health to be good. Nothing for the Stoics is good or bad except the presence or absence of a virtuous character. Alleged goods like life, health, wealth, honor, power, beauty, and strength, and alleged bads like death, disease, poverty, dishonor, powerlessness, ugliness, and weakness are in reality "indifferents," because they are not good or bad in all circumstances and whether we obtain or avoid them is not in our power.

The Stoic sage selects appropriately and virtuously among the indifferents, aiming at things such as health, or honor, or the well-being of one's friends. But the sage never thinks that goodness or badness are at stake in achieving the aims of these actions, so he or she reaches a state of *apatheia*, or freedom from the passions. Since the passions consist of erroneously judging these indifferents as being good or bad, they should be avoided.[18]

The Stoic doctrine of *apatheia* has exerted a major influence on debates on the value of emotions ever since, but the doctrine of emotions as evaluations was much less influential until recently, and even some of its sympathizers misrepresented it throughout the centuries (Sorabji, 2000, pp. 375–384). There were of course exceptions, constituted by theorists who, at various historical junctures, tried to understand emotions in more "cognitive" terms. A prominent example of a Stoic-inspired theory that gives pride of place to "ideas" in the identification of emotions is Baruch Spinoza's (1677/1955) theory of the passions as presented in *Ethics*. On Spinoza's view, passions are "the modifications of the body, whereby the active power of the said body is increased or diminished, aided or constrained, and also the ideas of such modifications" (p. 130). Such ideas are "confused" for Spinoza, from which it follows (on his view) that the mind entertaining them is passive rather than active, a point analogous to the Stoic proposal that emotions are false judgments. Spinoza distinguishes three primary passions: desire, joy, and sadness. All secondary passions are derived from desire, joy, and sadness in combination with ideas that distinguish one passion from the other. For example, love is joy accompanied by the idea of external cause, hatred is sadness (or pain) accompanied by the idea of external cause, and regret is desire to possess something kept alive by the remembrance of other things that exclude the existence of what is regretted.

The Rise of the Evaluative Tradition

A turning point for the *evaluative tradition* was the publication of Franz Brentano's *Psychology from an Empirical Standpoint* (1874/1995), which brought the challenge of explaining the intentionality of emotions center stage. Brentano (1874/1995, p. 88) influentially argued that "every mental phenomenon is characterized by what the Scholastics of the Middle Ages called the intentional (or mental) inexistence of an object, and what we might call, though not wholly unambiguously, reference to a content, direction toward an object." Among the paradigmatic examples of intentional states, Brentano lists the emotions: "in love [something is] loved, in hate hated, in desire desired."[19]

Brentano's (1874/1995) views mark the beginning of an important transition in psychology. For Brentano and his followers, psychology is no longer simply the science of consciousness, but also as the science of intentional or representational states. This view eventually led to modern cognitive psychology and its consuming concern with mental representations (Reisenzein, 2006). In the aftermath of Brentano's claim that all and only mental states are intentional states, the challenge of explaining why and how emotions can be about objects acquired new urgency.

In a discussion of precursors of the *evaluative tradition* of emotion theorizing in the 19th century, Reisenzein (2006) points to Stumpf (1899) and particularly Meinong (1894) (see also Reisenzein & Schönpflug, 1992). Meinong, a student of

Brentano, proceeds from Brentano's (1874/1995) assumption that emotions are object-directed. This assumption, Meinong argues, implies that emotions presuppose a "cognitive representation of [their] object" (Reisenzein, 2006, p. 923).

Meinong (1894) goes on to propose that the "cognitive representations" of emotions can be used to differentiate emotions from one another, and thereby provide an alternative solution to the problem of emotion differentiation that had plagued feeling theories and motivational theories of emotion. Although the cognitive theory of emotion developed by Meinong went largely unnoticed at the time, he indirectly influenced modern cognitive emotion theory in psychology (e.g., Weiner, 1986) through his student Frizu Heider (1958), who incorporated Meinong's analysis in his reconstruction of common-sense psychology (see Reisenzein & Mchitarjan, 2008).

However, the heyday of the *evaluative tradition* only came in the late 1950s and early 1960s, and it was the result of the convergent work of philosophers like C. D. Broad (1971), Errol Bedford (1957), George Pitcher (1965), Anthony Kenny (1963), Irvin Thalberg (1964), and R. S. Peters (1970), and psychologists like Magda Arnold (1960) and Richard Lazarus (1966). Philosophers focused on the inability of previous theories of emotions to explain how they can be object-directed and normatively assessable, whereas psychologists focused on the inability of previous theories to explain how emotions are caused. The first project led to the emergence of modern evaluative theories of emotions in philosophy, and the second project led to the emergence of appraisal theories in psychology. Let us consider these two developments in turn.

The first analytic philosopher in the English-speaking world to brand emotions as cognitions by virtue of their object-directness was Broad (1971). He argues that there are two kinds of experiences: those that have an "epistemological object" and those that do not. Experiences of the first sort are directed toward something, whereas experiences of the second kind are such that undergoing them is not being "*aware of a certain object*, real or fictitious," but rather "feeling in a certain way" (p. 283). Broad concludes that "emotions . . . are *cognitions*" because they are experiences with an epistemological object (p. 283; emphasis in original).

A related theme becomes prominent at around the same time, and it is the idea that emotions are normatively assessable, in the sense that they can be appropriate or inappropriate with respect to the objects toward which they are directed (Broad, 1971; Pitcher, 1965). Broad distinguishes between two dimensions of normative assessment: (1) an emotion is *misplaced* just in case it is felt toward an object that either does not exist or does not exist with the attributes under which it is emotionally responded to; and (2) an emotion is *inappropriate* just in case it is felt toward an object that the emotion does not fit, either in kind or in intensity.

To illustrate the first dimension of normative assessment, Broad (1971) argues that an emotion directed toward a nonexistent murderer that is the object of a *hallucinatory perception* would be *totally* misplaced, because there is no real ontological object corresponding to it. An emotion toward an existing person *falsely believed* to be an assassin would instead be *partially* misplaced, because there is a real ontological object—an existing person—but it does not have the attributes under which it is emotionally responded to.

These considerations bring to the fore an important characteristic of the emotions—namely, that they presuppose for their existence the presence of a perception, belief, memory, or other mental representation of the objects toward which they are directed. To fear a tiger, one must perceive it, or believe it about to appear, or remember it, or mentally represent it in some other way. Deonna and Teroni (2012) have referred to this as the *nonevaluative cognitive basis* of emotions. As Broad (1971) emphasizes, the cognitive basis of emotions is one possible object of normative assessment for emotions (misplacement), even though it focuses on mental states that are distinct from emotions.

With respect to the second dimension of normative assessment (inappropriateness), Broad (1971) states that once we have cognized a particular object as having certain characteristics, there is an appropriate and an inappropriate way to respond emotionally to it. For example, if an object has been cognized as threatening, fear rather than joy is the appropriate emotion toward it. If an object has been cognized as a man experiencing undeserved pain, amusement or satisfaction are not the appropriate emotions toward it. These examples raise a potential ambiguity concerning Broad's notion of appropriateness, which I illustrate by focusing on the second example.

The most likely interpretation of what Broad (1971) is suggesting is that it is *epistemically inappropriate* (or *unfitting*) to be amused or satisfied when a man experiences undeserved pain, in the sense that these forms of amusement or satisfaction violate standards that are internal to the emotions of amusement and satisfaction themselves (in a sense to be specified). But there are other ways in which these emotions may be inappropriate. For example, it is *morally inappropriate* to be amused or satisfied at another's undeserved pain, because these forms of amusement or satisfaction violate moral standards. In addition, it may be *prudentially inappropriate* to be amused or satisfied at another's undeserved pain (at least with public manifestations) because one would come across as a nasty person and possibly be sanctioned for it. One of the challenges in current philosophy of emotions is to articulate a clear and principled distinction between these varieties of appropriateness, a project that is at the core of the contemporary debate on emotions and values (see the section "Contemporary Developments II: Sentimental Values and the Situated Affectivity Movement").

Kenny on the Material and Formal Objects of Emotions

The difference between epistemic appropriateness or fittingness and other forms of appropriateness became clearer with Kenny's (1963) influential distinction between *material* and *formal* objects of emotions. Kenny's distinction is derived from scholastic philosophy, and it applies not only to emotions but also to perceptions and actions. Kenny (p. 132) introduces the distinction as follows: "Anything which can be φ-d is a material object of φ-ing . . . The formal object . . . is the object under that description which *must* apply to it if it is to be possible to φ it. If only what is P can be φ-d, then "thing which is P" gives the formal object of φ-ing." Let us unpack this philosophical mouthful.

First, the definition states that "anything which can be φ-d is a material object of φ-ing." For example, anything that can be seen, stolen, or feared is a *material object* of such perceptions, actions, and emotions. Since you can see a car, the car is a material object of seeing. Since you can steal a phone, the phone is a material object of stealing. Since you can fear a tiger, the tiger is a material object of fearing. But now ask yourself: "Which 'description . . . must apply to [a material object] if it is to be possible to φ it?'" For example, which description must apply to the car for it to be possible to see it, to the phone for it to be possible to steal it, and to the tiger for it to be possible to fear it? Kenny (1963) would answer that only what is *visible* can be seen, and only what *does not belong to you* can be stolen, and only what is *believed to be a threat* can be feared. But "if only what is P can be φ-d, then 'thing which is P' gives the formal object of φ-ing." So "thing which is visible," "thing which does not belong to you," and "thing which is believed to be a threat" describe the *formal objects* of, respectively, seeing, stealing, and fearing.

To sum up, formal objects place restrictions on what the material objects of perceptions, actions, and emotions can be, and they do so in a way that is "internal" to the mental attitude under consideration. Kenny's way of spelling out the sense in which they are internal is to suggest that the appropriateness of, say, an emotion to its formal object is *logical*: "each of the emotions is appropriate—logically, and not just morally appropriate—only to certain restricted objects" (1963, p. 134).

Kenny (1963) here is referring to the logic of the *concepts* involved, or to their conceptual entailments. For example, one may say that the very concepts of seeing, stealing, and fearing determine what the formal objects of such mental attitudes can be. It is the very concept of seeing that determines that you can only see what is visible. And it is the very concept of stealing that entails that you cannot steal what is already yours. And it is the very concept of fear, Kenny concludes, that entails that one must believe the stimulus feared to be bad.[20] As we shall see, the idea that there are conceptual connections between emotions and appraisals is at the core of one of the varieties of contemporary appraisal theory (see the section "Contemporary Developments III: Three Flavors of Appraisal Theory and Their Challenges").

The idea that emotions have material and formal objects has since become widely accepted in the philosophy of emotions. Each emotion can have an open range of material objects, which vary all the time and can be the same for different emotions. We can be afraid of different things at different times, and the same material object can be feared or admired by two different people, or by the same person at different times. The material object can be an individual (e.g., we can be afraid of Tom), or a proposition describing an event or a state of affairs (e.g., we can be afraid that Tom will try to kill us).

Formal objects, often referred to as *core relational themes* or *evaluative properties* or *values*, have found a semi-canonical formulation in Lazarus's (1991) description of core relational themes for emotions. Figure 1.5 illustrates some examples.

As pointed out by Fabrice Teroni (2007), formal

Emotion	Formal Object
Sadness	Having experienced an irrevocable loss
Anger	A demeaning offense against me and mine
Fear	Danger
Guilt	Having transgressed a moral imperative
Shame	Failing to live up to an ego ideal
Pride	Enhancement of one's ego identity by taking credit for a valued object or achievement, either one's own or that of someone or group with whom we identify

FIGURE 1.5. A representative list of *formal objects/core relational themes* (Lazarus, 1991).

objects have been assigned three main jobs in the philosophy of emotions: individuating different emotions, making emotions intelligible from the point of view of the emoter, and accounting for the conditions of epistemic appropriateness for emotions (see also Mulligan, 2007). First, formal objects can tell us how any two emotions differ from one another. For example, we may say that sadness is different from fear because the formal object of the former is having suffered an irrevocable loss, whereas the formal object of the latter is danger.

Second, formal objects can make an emotion intelligible (or justified or warranted or reasonable) from the point of view of the emoter by informing us about how the emoter describes the material object toward which his or her emotion is directed. For example, if we wonder why John responded with shame to being complimented for his degree, learning that John interpreted being complimented for a degree that he in fact had acquired using improper means as a failure to live up to an ego ideal makes shame intelligible from his point of view.

Third, formal objects provide the criteria for deciding whether emotions are epistemically appropriate or fitting. For example, when we wonder about whether it was epistemically appropriate for Jennifer to get angry at her boss's compliment on her skirt, the question we are asking is whether her boss' compliment on her skirt constitutes a demeaning offense against her. If it is, then Jennifer's anger is epistemically appropriate or fitting with respect to the unsolicited compliment.[21]

Contemporary Developments I: Evaluative Theories in Philosophy and Their Challenges

A great many contemporary philosophers of emotions are convinced that the reason why emotions are so tightly connected with formal objects is that an emotion *is* essentially an evaluation that a given formal object is instantiated by a given material object.[22] This is the core thesis of modern evaluative theories of emotions in philosophy, which hark back to the Stoic suggestion that emotions are judgments. But whereas for the Stoics emotions are judgments that a certain movement of the soul is appropriate, for contemporary philosophers emotions are evaluations to the effect that a formal object is instantiated (by some material object).

Various proposals have been made concerning what type of evaluation an emotion is. Until quite recently, the most popular option was *judgmentalism*, developed by Robert Solomon (1976, 2003) and Martha Nussbaum (2001) among others. "I still hold the claim that emotions are judgments," states Solomon (2003, p. 210), and Nussbaum (p. 4) writes that "emotions are appraisals or value judgments." Solomon gives the following examples: "'I am angry at John for taking . . . my car' entails that I believe that John has somehow wronged me . . . My anger is that judgment . . . If I do not find my situation awkward, I cannot be ashamed . . . If I do not judge that I have suffered a loss, I cannot be sad . . . to have an emotion is to hold a normative judgment about one's situation" (Solomon 2003, p. 8).

Judgmentalism became popular because it seemed to solve most of the problems that had afflicted previous traditions of emotion theorizing. Most significantly, it provided a straightforward solution to the problem of intentionality, explaining both why emotions are about objects and what makes them appropriate or inappropriate to such objects. If emotions *are* judgments, then they are about whatever the judgments with which they are identified are about, and they are appropriate whenever such judgments are true.[23] In addition, judgmentalism appeared to solve the problem of differentiation: emotions can be distinguished in terms of the *content* of the judgments with which they are identified.

These advantages notwithstanding, judgmentalism is now considered to be flawed. First, it does not provide a satisfactory solution to the problem of motivation. If emotions simply were judgments to the effect that a certain formal object is instantiated, they would lack independent motivational force. This is because judgments have a mind-to-world direction of fit, as their objective is to "fit" what the world is like rather than to motivate action directed at changing the world, as in the case of desires (Searle, 1983).

To this objection, judgmentalists have replied that desires to act are either conceptually connected to (e.g., Solomon, 2003) or caused by (e.g., Lyons, 1980; Nussbaum, 2001) the judgments with which emotions are identified.[24] These replies are *ad hoc*, however, because no convincing explanation is given for why emotion judgments are conceptually or causally connected with action desires by virtue of their content. A better strategy is to explicitly add a conative dimension to judgmentalism, and propose that emotions are combinations of beliefs/judgments and desires. Versions of this belief–desire theory of emotions have been developed by both philosophers (Marks, 1982; Green, 1992) and psychologists (Reisenzein, 2012; Castelfranchi & Miceli, 2009), but the jury is still out on whether they succeed in solving the motivational problem and are overall satisfactory (Brady, 2013; Scarantino, 2014).[25]

The problems with judgmentalism, however, go deeper. An issue that has attracted significant attention is that of *rational recalcitrance*, the phenomenon instantiated when emotions are in tension with one's judgments, as when a snake-phobic subject experiences fear of a snake picture while at the same time holding the belief that the snake picture is not dangerous (D'Arms & Jacobson, 2003). In these sorts of cases, judgmentalists are forced to describe recalcitrance as the holding of contradictory beliefs, a position many consider to ascribe to emoters the wrong kind of irrationality (Helm, 2001; Döring, 2008; Benbaji, 2012; Brady, 2007; Tappolet, 2000; Faucher & Tappolet, 2007).

Another problem with judgmentalism is that, if we identify emotions with evaluative judgments, we cannot explain how emotions sometimes precede and cause such judgments (Brady, 2013). For example, we may first feel ashamed at being seen in public with a lover who is half our age, and then form the evaluative judgment that our behavior constitutes a failure to live up to an ego ideal. But if shame were the judgment that our behavior constitutes a failure to live up to an ego ideal, it could not causally contribute to the formation of such a judgment, because nothing can cause itself.

Finally, judgmentalism has been charged with the inability to account for the emotions of infants and animals, because nonlinguistic creatures cannot make judgments on the standard understanding of judgments, and with the inability to account for the special phenomenology of emotions, because making judgments seems to lack the distinctive subjective quality of emotions, most significantly their "hotness" and their "bodily" dimension (see, e.g., Leighton, 1985; Deigh, 1994; Tappolet, 2000; Scarantino, 2010; Deonna & Teroni, 2012; Reisenzein, 2012, for further discussion of the flaws of judgmentalism).

Recent philosophy of emotions has been largely focused on replacing judgments with other evaluative constructs capable of solving judgmentalism's flaws while preserving its two main assets: the ability to provide solutions to the problems of intentionality and differentiation. The two evaluative constructs most often proposed as replacements for judgments are *evaluative feelings* (e.g., Whiting, 2011; Kriegel, 2014; Helm, 2001; Greenspan, 1988; Goldie, 2000; Salmela, 2002; Deonna & Teroni, 2012) and *evaluative perceptions* (e.g., De Sousa, 1987; Tappolet, 2000; Johnston, 2001; Roberts, 2003; Zagzebski, 2003; Prinz, 2004b; Döring, 2007; Elgin, 2008; Charland, 1995). The qualifier "evaluative" is meant to emphasize that these notions differ from the notions of feeling and perception we have considered so far in that they are constitutively linked to evaluative properties.

Popular proposals include the idea that emotions are intentional feelings of import organized around commitments (Helm, 2001), perceptions of value (Tappolet, 2000), embodied appraisals (Prinz, 2004b), feelings of comfort or discomfort directed toward thoughts (Greenspan, 1988), combinations of bodily feelings and feelings towards (Goldie, 2000), affective perceptions (Döring, 2007), concern-based construals (Roberts, 2003), and evaluative attitudes consisting of feelings of one's body being ready to act (Deonna & Teroni, 2012).

These proposals are all clear improvements over judgmentalism, but it is up for debate which of them, if any, provides a viable account of emotions. Given the current state of the debate, a viable account would need to at least explain the differentiation and intentionality of emotions, solve the motivational problem, provide a plausible account of the phenomenal side of emotions, account for emotional recalcitrance, and explain why infants and animals can have emotions. Opinions differ as to whether any evaluative theory succeeds in satisfying all these desiderata (e.g., Deonna & Teroni, 2012; Salmela, 2011; Dokic & Lemaire, 2013; Brady, 2013; Scarantino, 2014).

An important distinction within modern evaluative theories concerns the way they account for the relation between formal objects and evaluations. According to what I call the *direct strategy*, formal objects are descriptions of what is directly perceived or felt by the emoter. For example, Goldie (2002) thinks that "emotions involve two kinds of feeling," one contingent and the other essential. The contingent feeling is a *bodily feeling*, "the feeling from the inside of the condition of one's body as being a certain way or as undergoing certain changes" (p. 235). The essential feeling, which Goldie calls the *feeling toward*, is "the feeling one has towards the object of one's emotion" (p. 235). On this view, to fear an object is to feel one's body in turmoil (bodily feeling) and to directly feel the dangerousness of the object (feeling toward).

According to the *indirect strategy*, formal objects describe the conditions of appropriateness of perceptions/feelings rather than what is directly perceived or felt. An example of such a strategy is offered by Prinz's theory of emotions as "valent embodied appraisals." On Prinz's neo-Jamesian view, fear is a combination of an *embodied appraisal* consisting of "a racing heart and . . . other physiological changes" (2004b, p. 69) with the function of being elicited by dangers, and a negative *valence marker* that says "less of this."[26] As I mentioned earlier, in a teleosemantic theory of representation, mental states represent what they have the function of indicating (Prinz, 2004b; Dretske, 1988). So Prinz proposes that perceiving a racing heart represents danger because it has the function of indicating it. On this view, the agent directly perceives bodily changes (the nominal content) and indirectly perceives the core relational theme (the real content) by virtue of what the bodily changes represent.

Another example of indirect strategy is offered by Deonna and Teroni's (2012) attitudinal theory, according to which emotions are felt bodily attitudes of action readiness. On this view, fear is the feeling of one's body being poised "to act in a way that will contribute to the neutralization of what provokes the fear" (p. 80), an attitudinal feeling that is only correct in case what provokes the fear is dangerous. In this case, formal objects constitute the conditions of correctness of feelings of action readiness.

Contemporary Developments II: Sentimental Values and the Situated Affectivity Movement

I want to briefly discuss two further areas of growing debate in contemporary philosophy of emotions. The first concerns the relation between emotions and values (see Roeser & Todd, 2014; Deonna & Teroni, 2012, 2015; D'Arms & Jacobson, 2000, forthcoming). So far we have asked whether emotions are evaluations that a certain formal object or value is instantiated. For example, we have asked whether fear is the evaluation that something is dangerous. But there is another question philosophers of emotions ask, namely, whether values themselves are to be understood in terms of the emotions they elicit. For example, should we understand dangerousness in terms of fear responses, or is dangerousness a property we can make sense of independently of fear?

The two questions are not independent of one another. At a minimum, one's theory of how values are apprehended through emotions and one's theory of how values are constituted should be compatible. For example, if one thinks that emotions are required to shed light on values, emotions themselves should not be defined in terms that presuppose those very values, on pain of circularity. Several positions on the connection between emotion concepts and value concepts are available in the contemporary debate, which has focused primarily on so-called *sentimental values*, exemplified by things like the funny, the disgusting, the shameful, and the enviable.

The three main competitors are *realism*, *dispositionalism*, and *neo-sentimentalism* (Tappolet, 2000; Rabinowicz & Rønnow-Rasmussen, 2004; Jacobson, 2011; Deonna & Teroni, 2012). *Realism* is the thesis that we can make sense of what it is for some *X* to have a certain sentimental value by relying on response-independent properties *X* has. For example, suppose someone were to propose that the disgusting is whatever is contaminating, or that the funny is whatever is incongruous (Jacobson, 2011). On this view, sentimental values would be objective properties like mass, charge, and spin—namely, properties instantiated independently of any actual or potential response to the property bearer.

A challenge for *realism* is to explain away the intuition shared by many that things would continue to be contaminating or incongruous, but would stop being disgusting or funny unless there were creatures around capable of being disgusted or amused by them. A possibility would be to abandon the claim that emotional responses are irrelevant to establishing values, but stick to the view that we can make sense of the disgusting and the funny in terms of descriptive properties alone. For example, one could propose that the disgusting corresponds to whatever descriptive properties the disgust mechanism is designed to track or that the funny corresponds to whatever descriptive properties the amusement mechanism is designed to track.

This proposal faces another challenge, namely, making sense of the fact that ascriptions of sentimental values are "normatively loaded," in the sense that they "carry a claim to interpersonal authority in virtue of their putative correctness and are the subjects of significant and trenchant disagreement" (Knapp, 2003, p. 270). For example, when we state that a certain behavior is disgusting, we seem to be implying that other people should find it disgusting too, and we would engage in reasoned debate with anyone who considered the behavior not to be disgusting at all. The central point is that neither claims to interpersonal authority nor disagreements stop once all the descriptive properties of the behavior have been agreed upon. This calls into question the possibility of reducing sentimental values to descriptive properties, suggesting the presence of an inescapable evaluative dimension to sentimental values.

Dispositionalists and *neo-sentimentalists* agree that we cannot make sense of the disgusting or the funny in merely descriptive terms, but offer different recipes for connecting sentimental values with emotional responses. *Dispositionalists* propose that we can make sense of what it is for some *X* to have a certain sentimental value in terms of the emotional responses *X* is disposed to elicit. One challenge is to get clear on the nature of the relevant dispositions: What are their triggers, manifestations, and bearers? Suppose we propose that the disgusting and the funny are, respectively, what would elicit disgust and amusement in ordinary people in standard circumstances. This proposal also faces the challenge of making sense of normatively loaded ascriptions. It seems that by calling a certain behavior disgusting, people are not simply reporting on the fact that ordinary people in standard circumstances are typically disgusted by it, but that disgust is the right emotional response to it.

This is the intuition that drives *neo-sentimentalism*, according to which the only way to make sense of what it is for some *X* to have a sentimental value is to appeal to the emotional response it is *appropriate* to have toward *X*.[27] On this view, to be disgusting or funny is to be the *fitting target* of disgust and amusement, respectively. This view holds, along with *realism*, that something can be disgusting or funny even if ordinary people in standard circumstances would not be disgusted or amused by it. It follows *dispositionalism*, on the other hand, in holding that we cannot understand sentimental values except by way of the emotional responses they elicit, although it crucially adds that such responses can be mistaken.

Neo-sentimentalism seems to offer a more straightforward account of normatively loaded discourse than competing accounts, in the sense that if ascribing a sentimental value is endorsing an emotional response, it becomes clear why such ascriptions have a claim to interpersonal authority and are objects of disagreements when endorsements clash. But it faces the difficult challenge of distinguishing the right from the wrong types of appropriateness. For example, it is certainly the case that a joke may be funny even if it is morally inappropriate, from which it follows that the funny cannot be what elicits a morally appropriate response. The problem is that it has turned out to be exceedingly difficult to explain what kind of appropriateness is the *right kind* without presupposing the very sentimental values that the account is supposed to shed light on.

The second area of growing debate in contemporary philosophy of emotions is connected to *situated approaches* in the philosophy of cognitive science, also called "four-E" approaches to emphasize that their proponents see cognition as "embodied," "embedded," "enactive," and "extended" (see Robbins & Aydede, 2009; Shapiro, 2014, for an overview of the field). Recently, this literature has started paying attention to the emotions (see, e.g., Griffiths & Scarantino, 2009; Maiese, 2011; Colombetti, 2014; Colombetti & Thompson, 2008). Proponents of four-E approaches generally do not offer complete theories of emotions, but try to emphasize the intimate connection between emotions and bodily and environmental processes.

A recent extensive treatment of emotions and affectivity from this perspective is Colombetti (2014). Drawing in particular on the "enactive" approach developed by Varela, Thompson, and Rosch (1991) and Thompson (2007), Colombetti argues that the mind is pervasively affective and not neatly divided into cognition and emotion. Colombetti also draws upon dynamical systems theory to reconceptualize emotional episodes and moods as self-organizing patterns of the whole organism (see also Freeman, 2000; Lewis, 2000, 2005; Thompson, 2007).

Central to several proposals within this tradition is an emphasis on emotion and affectivity as complex *experiential* phenomena, which connects four-E approaches to the philosophical tradition of phenomenology. For example, both Ratcliffe (2008) and Colombetti (2014) draw on classic phenomenological treatment of the "lived body" found in Edmund Husserl, Maurice Merleau-Ponty, and others, to argue that emotions can involve bodily feelings while retaining their intentional relatedness to the world (see also Slaby, 2008; Hutto, 2012; Gallagher & Zahavi, 2012).

As for the relation between emotion and the world, theorists who see emotions as "embedded" or "situated" have pointed out that affective phenomena are deeply environmentally supported. Recurrent reference can be found in this literature to the metaphor of "scaffolding" (Griffiths & Scarantino, 2009; Colombetti & Krueger, 2015), which is meant to emphasize that structures in the environment (both material and social) are necessary to enable affective phenomena to develop in the specific ways they do.

More radical approaches propose that the physical machinery that realizes affective states may include not just neural and bodily processes but also parts of the environment. Emotions and other affective states, it has been suggested, can sometimes become "extended" into the world. This approach applies the hypothesis of "extended cognition" to the domain of affectivity. In a classic example, the mind of Otto, a patient afflicted by Alzheimer's disease, is said to be extended outside his brain to include the notebook entries he uses to remember facts, because Otto relates to such notebook entries in a way that is relevantly similar to how a normal person relates to his or her intracranial memories (Clark & Chalmers, 1998). In various papers, Krueger (2013a, 2013b, 2014) has argued, drawing largely on developmental psychology (especially the development of caregiver–infant interactions), that emotions can be "extended" over several agents and accordingly be "jointly owned." Stephan, Walter, and Wilutzky (2014) have proposed that physiology, expressions, and appraisals can be "extended," whereas Colombetti and Roberts (2015) argue for the "extension" of dispositional affective states (such as dispositional emotions and temperaments), and Roberts (2015) proposes that even emotional feelings can be "extended."

Contemporary Developments III: Three Flavors of Appraisal Theory and Their Challenges

The second main approach within the *evaluative tradition* is the *causal approach*. The notion of appraisal, present in the work of a great many emotion theorists starting with Aristotle, became the object of scientific investigation with the work of psychologists Magda Arnold (1960) and Richard Lazarus (Speisman, Lazarus, Mordkoff, & Davison, 1964; Lazarus, 1966, 1991, 2001).[28] Arnold argues that psychological emotion research since James has mainly focused on clarifying the causal relation between bodily changes and the experience of emotion. What only a few theories have dealt with, she states, is "the problem of how cold perception can cause either the felt emotion or the bodily upset" (1960, p. 93). Call this the *problem of causation*.

Arnold's (1960, p. 171) solution to this problem is her suggestion that "to arouse an emotion, the object must be appraised as affecting me in some way, affecting me personally as an individual with my particular experience and my particular aims." She coins the term "appraisal" to designate this process, emphasizing that her "analysis goes back to Aristotle and Thomas Aquinas" (Arnold, 1960, p. 193). Arnold also adds "that the only approach that promises a solution of the problem of how perception arouses emotion is a careful phenomenological analysis," (p. 170), of the kind offered by Sartre, among others. As Sartre put it, the phenomenological approach investigates "psychic events . . . insofar as they are significations and not insofar as they are not pure facts" deprived of an interpretation of what they signify for us (Sartre & Frechtman, 1948, p. 19).

Apart from introducing the term "appraisal," Arnold develops appraisal theory in several important respects. First, she argues that the appraisal process is usually "direct, immediate, nonreflective, nonintellectual, automatic, 'instinctive,' 'intuitive'" (1960, p. 175). This understanding of appraisal was implicitly appealed to by Lazarus (1984) in an influential debate with Zajonc (1984) on whether affective reactions necessarily require cognitions. Lazarus argues that they do, and Zajonc denies it. It became clear during the debate, however, that the two parties understood cognition in different ways: Lazarus labeled as "cognitive" even simple and "nonintellectual" forms of information processing, whereas Zajonc reserved the label of "cognition" for the more sophisticated varieties of information processing.

This led Leventhal and Scherer (1987, p. 16), in an attempt to "steer the emotion-cognition controversy away from potentially sterile semantic arguments about what is a cognition," to introduce the idea that appraisals/cognitions can occur at different levels of information processing. In the latest iteration of the theory, four such levels are distinguished (Scherer, 2009): (1) a neural circuit level, which comprises genetically determined pattern-matching mechanisms, (2) the schematic level, which comprises memory traces from prior learning experiences, (3) an associative level involving cortical association areas, and (4) a conceptual level involving propositional knowledge.

Second, Arnold (1960) begins to unveil the internal structure of the appraisal process, suggesting that appraisals are made along three dimensions: eliciting circumstances can be evaluated as good or bad, present or absent, and easy to attain or avoid. For example, according to Arnold, the cognitive cause of fear can be described as the appraisal of an event as bad, absent but possible in the future, and hard to avoid; whereas the cause of joy can be described as the appraisal of an event as good, present, and easy to maintain.

This transition from a *molar account* of appraisal, in which the appraisals of different emotions are considered unitary mental states, to a *molecular account* of appraisal, in which the appraisals are broken down into components that can be independently studied, is a key insight of psychological appraisal theories of emotion (the molecular–molar distinction was introduced by Smith and Lazarus, 1990). These theories replace the "one-sentence" philosophical analyses of evaluations in terms of formal objects with a detailed structural account that tries to shed light on their internal composition or attributes on a limited number of appraisal dimensions.

It soon became clear that the three dimensions of appraisal proposed by Arnold (1960) are not sufficient, and also not optimally chosen, for explaining the differentiation of emotions. To overcome this limitation of Arnold's theory, additional or alternative appraisal dimensions have been subsequently proposed by a number of psychologists (e.g., Smith & Ellsworth, 1985; Frijda, 1986; Lazarus, 1991; Roseman, 1996; Scherer, 2001; Ellsworth & Scherer, 2003; Roseman & Smith, 2001; Oatley & Johnson-Laird, 1987).

Lazarus (1991, 2001) proposes to distinguish between *primary appraisal*, whose function is to determine whether and how any of the subject's goals are affected by an event, and *secondary appraisal*, whose function is to determine how best to cope with the event once it has been classified as furthering or thwarting the subject's goals. More specifically, primary appraisal comprises three component processes: (1) the appraisal of *goal relevance*, (2) the appraisal of *goal congruence or incongruence*, and (3) the appraisal of *type of ego involvement*. Secondary appraisal also comprises three components: (1) the appraisal of *blame or credit*, (2) the appraisal of *coping potential*, and (3) the appraisal of *future expectancy*. On this view, guilt is caused by the appraisal of an event as goal relevant, goal incongruent, involving a moral transgression, and one for which the self is to blame (coping potential and future expectancy appraisals are left open).

Other appraisal theorists have endowed the appraisal process with even more structure. For example, Scherer (2001) distinguishes between no fewer than 16 dimensions of appraisal, called stimulus evaluation checks (SECs), which can be grouped into four classes representing "the major types or classes of information with respect to an object or event that an organism requires in order to prepare an adequate reaction" (p. 94): appraisals of relevance, appraisals of consequences, appraisals of coping potential, and appraisals of normative significance.

Agnes Moors (2014) has drawn a helpful distinction between two "flavors" of appraisal theory. Flavor 1 appraisal theories assume that the "molecular" appraisals of an event on the different appraisal dimensions are integrated into a "molar" appraisal, which is the immediate cause of emotions such as anger, fear, disgust, and so on. Lazarus (2001, p. 64) has suggested, for example, that "we should combine the partial meanings [of molecular appraisals] into a terse, integrated gestalt or whole [the molar appraisal], which is what characterizes the . . . cause of the emotion."

Flavor 2 appraisal theories, on the other hand, assume that the molecular appraisals can cause individual emotion components (e.g., the action tendency to flee), or even parts of these components (the direction of fleeing), without a prior "synthesis" into a molar appraisal. Theories of this kind often do not even try to specify the patterns of appraisal that cause anger, fear, and so on, and assume that the appraisal process can have a wide range of combinations of appraisal outputs, only some of which will lead to familiar, discrete emotion categories.

Scherer's (2009, p. 1314) *component process model* theory is an example of a flavor 2 theory, because it assumes that "emotion differentiation is the result of the net effect of all subsystem changes brought about by the outcome profile of the SEC sequence," namely, the sequence of SECs along the 16 dimensions mentioned earlier. For example, once a stimulus has been appraised as novel and goal relevant, causal effects of this (partial) appraisal can already be detected on various organismic subsystems (e.g., orienting responses, heart rate deceleration, vasomotor contraction, skin conductance responses). Depending on the further appraisals made, these effects may or may not culminate in the emergence of a familiar, discrete emotion.

Another example of flavor 2 theory is Cunningham, Dunfield, and Stillman's (2013) *iterative processing model*, a theory that combines themes from appraisal theory and psychological constructionism and seeks to ground the recurrent nature of appraisals in the heterarchical organization of the brain (see also Barrett, Ochsner, & Gross, 2007). What distinguishes this proposal from most other appraisal theories is that it draws on connectionist approaches developed in computational cognitive neuroscience (e.g., O'Reilly, Munakata, Frank, & Hazy, 2012) to model how discrepancies between expectations and experiences of the internal or external world give rise to dynamic reprocessing of information through iterative cycles that eventually lead to changes in affect and discrete emotions.

To capture all self-described psychological appraisal theories, we need to add a third "flavor" of appraisal theory to this taxonomy. Flavor 3 theories are appraisal models that, unlike flavor 1 and 2 models, deny a causal role to appraisals (e.g., Clore & Ortony, 2013; Ellsworth, 2006, 2013). Flavor 3 appraisal theories understand appraisals as being entailed by emotions, in the sense that having an emotion of a given kind (e.g., fear) necessarily requires appraising the eliciting stimulus in a particular way.

An example of flavor 3 theory is Ortony, Clore, and Collins's (1988) "OCC model." Originally, this model was proposed as a causal appraisal theory, since its goal was to "explain how people's perceptions of the world—their construals—cause them to experience emotion" (p. 12). More recently, however, (some of) the authors have reinterpreted the model differently, and it now falls squarely into the flavor 3 camp. Clore and Ortony (2013, p. 339) state that they "do not treat appraisal as a process occurring in real time that *causes* emotions." Their proposed notion of appraisal "focuses solely on structure [and] specifies the features of the prototypical situations represented by each kind of emotion." In other words, having an emotion is now understood as representing the world in a certain way, where this representation does not precede the occurrence of the emotion and consequently does not cause it.

There is an analogy between this way of thinking of emotions and philosophical judgmentalism. Instead of identifying, say, guilt, with the judgment that one has transgressed a moral imperative, as philosophical cognitivists would have it, flavor 3 appraisal theorists identify guilt with the appraisal that one's behavior is goal relevant, goal incongruent, involves a moral transgression, and the self is to blame for it. Similarly, instead of identifying fear with the judgment that danger is at hand, flavor 3 appraisal theorists identify fear with the appraisal that the stimulus is goal relevant and goal incongruent (i.e., a "bad outcome").

Crucially, the connection between emotions and appraisal outputs is presumed to be conceptual rather than empirical, just like the connection between emotions and formal objects (see the section "Contemporary Developments I: Evaluative Theories in Philosophy and Their Challenges"). This point is made explicitly by Clore and Ortony (2013, p. 339), who write that "just as no empirical research will ever disprove that bachelors are unmarried, evidence . . . cannot show that fear involves an anticipation of bad outcomes." It cannot show it in the sense that it need not show it: fear *must* involve the anticipation of bad outcomes in the same sense in which being a bachelor *must* involve being unmarried. No amount of empirical investigation is required to draw this conclusion, which is available simply by reflecting on the conceptual entailments of the terms involved.

Flavor 3 appraisal theory does not solve the problem of causation raised by Arnold (1960), because it does not tell us how the emotions come about (see Moors, 2013, for more on this point). Furthermore, the interpretation proposed by Clore and Ortony (2013) raises a worry for appraisal theory writ large. The worry is that some of the theories that claim to be flavor 1 and flavor 2 appraisal theories may rely only on evidence that allows them to establish "flavor 3" claims, namely, conceptual connections between emotions and appraisals rather than contingent causal relations.

This challenge has been raised by various researchers over the years (Oatley, 1992; Parkinson

& Manstead, 1992; Parkinson, 1997; Russell, 1987; Frijda, 1993). For example, Parkinson (1997, p. 65) argues that "much of the self-report evidence that is used to defend an empirical relationship between appraisal and emotion actually provides more direct support for a conceptual relationship because the implemented indices of emotion depend on people's everyday interpretations of the vocabulary of affect." Appraisal theorists of flavors 1 and 2 have replied that the empirical evidence for the causal version of appraisal theory relies on evidence that goes well beyond self-reports, as it includes patterns of brain activity, autonomic system changes, and facial/vocal expressions (Scherer, 2009).

Another challenge for flavor 1 and flavor 2 appraisal theories is to find a proper place for appraisal into the emotion as a whole. Specifically, causal appraisal theorists must decide whether the appraisal is also a part of the emotion or (just) its cause. Some causal appraisal theories assume that the appraisal is not part of the emotion. For example, Arnold writes that "we can now define emotion as the felt tendency toward anything intuitively appraised as good (beneficial), or away from anything intuitively appraised as bad (harmful) . . . accompanied by a pattern of physiological changes organized toward approach or withdrawal. The patterns differ for different emotions [emphasis removed]" (Arnold 1960, p. 182).

The claim that the patterns differ for different emotions implies that for Arnold (1960) appraisals are not indispensable for differentiating among emotions. On the other hand, the option of using appraisals to differentiate among emotions remains available, because emotions are defined by Arnold as felt action tendencies *caused* by emotion-specific appraisals (see also Gordon, 1987; Reisenzein, 2012). Proposals that rely on appraisals to differentiate among emotions without considering them to be parts of emotions have a long and reputable history in philosophy (see Lyons, 1980).

Other appraisal theorists, however, explicitly take appraisals to be part of the emotions (e.g., Lazarus, 1991; Scherer, 2005). For example, according to Scherer's component process model of emotions, "emotion is defined as an episode of interrelated, synchronized changes in the states of all or most of the five organismic subsystems in response to the evaluation of an external or internal stimulus event as relevant to major concerns of the organism" (p. 697). Hence, an emotion is instantiated if any three of the following five components are engaged in synchronized changes: an appraisal component, an autonomic physiology component, an action tendency component, a motor expression component, and a subjective feeling component.

A consequence of this definition is that an emotion may have an appraisal as a proper part. But this is at first blush incompatible with the claim that appraisal causes emotion, because nothing can cause itself. Various solutions have been offered for this problem (cf. Moors, 2013). The solution proposed by Moors and Scherer (2013) is that when appraisal theorists who regard appraisal as a part of the emotion state that appraisal causes emotion, this is mere *façon de parler*. What theorists like Scherer and Lazarus really mean is that appraisal causes all components of emotion other than itself—namely, autonomic changes, action tendencies, motor expressions, and subjective feelings.

It seems fair to say that the *evaluative tradition* has succeeded in at least two important respects. First, most theorists now accept that theories of emotions should account for the intentionality of emotions. A sign of this newly found realization is that contemporary feeling theories (e.g., Goldie, 2000; Prinz, 2004b) and contemporary motivational theories (e.g., Scarantino, 2014) in philosophy all offer tentative accounts of the intentionality of emotions. Second, most theorists now accept that a subject's appraisal of the eliciting situation is a major determinant of the differences among different emotions. This insight is now shared by psychological theories of emotions of all stripes, including basic emotion theory, social constructionism, and psychological constructionism. Whether the *evaluative tradition*, in both its constitutive and causal approaches, can successfully tackle its outstanding challenges remains to be seen.

Methodological Coda

At the end of this survey of emotion theories across centuries and disciplines, we may ask whether there has been significant progress in emotion theory since Ancient Greece. There seem to be both good news and bad news on this front. The good news is that there is now much greater consensus regarding the characteristics of emotions that need to be explained.

The majority of emotion theorists currently agree that (1) emotion episodes involve, at least in prototypical cases, a set of expressive, behavioral, physiological, and phenomenological features diagnostic of emotions; (2) each diagnostic feature has a range of variability; (3) evolutionary explanations can be given for at least some emotions and/or their components; (4) most aspects of emotions are affected by sociocultural factors; (5) the physical seat of emotions is the brain; (6) emotions motivate actions in distinctive ways; (7) emotions are generally object-directed; (8) emotions have a cognitive basis, consisting of other mental states they presuppose (e.g. memories, perceptions, etc.); (9) emotions can be appropriate or inappropriate with respect to their objects; (10) there are different forms of appropriateness for emotions (e.g., epistemic, moral, prudential); (11) appraisals can help differentiate emotions; (12) appraisals range from primitive to sophisticated forms of information processing; (13) at least some emotions are present in infants and animals; (14) emotions can be in tension with our reflective judgments; and (15) emotions play a functional role in a variety of domains (e.g., rational deliberation, morality, aesthetics).

Although much of this may not sound especially surprising at this stage of the game, we should keep in mind that all of these ideas have at some point in the history of emotion theory been either denied or neglected.

The bad news is that we are apparently not much closer to reaching consensus on what emotions are than we were in Ancient Greece. As soon as we try to define the emotions, or even just to transition from the generalities I have listed to the pesky details (Do emotions cause the diagnostic components, or do they emerge from them? What, exactly, can be evolutionarily explained with respect to emotions?), the consensus among today's emotion researchers abruptly ends, and competing research programs start engaging in fierce fighting. The emotion community continues to be divided on the nature of emotions, on the terminology suitable for describing them, and on the experimental techniques to study them.

Why is there still so much disagreement on what emotions are after centuries of concerted efforts? One possible explanation is that emotion theorists have not been sufficiently ingenious or lucky in the exploration of their subject matter. On this view, what they need is more time, and perhaps the insights of a Darwin or a Newton. After all, the body of common knowledge about emotions has increased over time, which gives hope that, at some point, a universal theory of emotions will emerge and command general assent.

An alternative possibility brought up at various times in the history of emotion theory by affective scientists (Duffy, 1934, 1941; Barrett, 2006; Kagan, 2007, 2010; Mandler, 1975; Russell, 2003; Zachar, 2006) and philosophers alike (Rorty, 1980; Griffiths, 1997; Scarantino, 2012b, 2012c) is that emotions simply are not all of one kind. A philosophical way to make this point is to say that the folk categories designated by English terms such as "emotion," "anger," "fear," "happiness," "sadness," "shame," and "guilt" do not designate natural kinds. A natural kind is (roughly) a category whose members are sufficiently alike to allow for extrapolation from properties of category samples to properties of the category as a whole. Emotions, it is claimed, are too heterogeneous to fit this definition.[29]

Most of the theories examined in this chapter presuppose that folk emotion categories designate natural kinds. Their central theses are presented as claims of the form "emotions are *K*" or "fear is *K*," where *K* stands for a kind of psychological structure. This formulation presupposes *universalism*, namely, the idea that a single account of emotions (or at least a single account of fear, anger, shame, etc.) can fit all cases (Scarantino, 2012c). As described, the three historically most influential ways of filling in the blank have replaced *K* with *feelings*, *motivations*, and *evaluations*, respectively. The debate on the nature of emotions has generally focused on whether any of these replacements can satisfy all scientific or philosophical constraints on, and purposes of, a theory of emotions. The result has been the fragmented family tree I have outlined in this chapter, in which no theory seems to be fully satisfactory on all dimensions of assessment.

However, if emotions are not all of one kind, *universalism* is simply the wrong methodological presupposition, and the project of filling in the blank in claims of the form "emotions are *K*" or "fear is *K*" becomes doomed to failure, even if Darwin or Newton were to take a shot at it. Fortunately, *universalism* is not the only game in town. Two methodological alternatives seem especially promising, because they have led to major progress in other areas of research. The first is what we may call *componentialism*, the view that we should search for the fundamental building blocks of natural phenomena.

An example of a successful componential strategy can be found in the search for the nature of matter, which started with pre-Socratic suggestions that all matter is ultimately constituted by a single basic element (e.g., Thales proposed water, Anaximenes air, and Heraclitus fire) or a handful of elements (e.g., Empedocles suggested four: air, fire, water, and earth), and ended with the discovery of the chemical elements in the 18th century. Chemical elements are defined as substances that cannot be further decomposed into simpler substances using common chemical processes and can combine to form an infinite number of compounds.

A similar strategy has been proposed by psychological constructionists in the affective realm. These emotion theorists believe that the emotion categories of folk psychology are too heterogeneous for purposes of scientific investigation and aim to discover "elemental—but still psychological—building blocks" (Russell, 2003, p. 146) out of which emotion episodes are constructed. The heterogeneity of folk emotion categories does not preclude the success of this strategy, because even if all things we call emotions, angers, fears, and so on cannot be captured by a common definition (or theory), their *components* may still have scientifically relevant dimensions of similarity.

The second methodological strategy I call *pluralism*. Unlike psychological constructionists, pluralists think that discrete emotion categories are still a proper object of scientific investigation, as long as we accept that they have to be heavily revised (e.g., split into subcategories) in order to do scientific or philosophical work. The core assumption of *pluralism* is indeed the belief that there is a plurality of distinct natural kinds comprised within the same folk categories.

An example of this approach can be seen in research on memory. Memory scientists started from the assumption that the folk psychological category of "memory" designates a unique information-retention mechanism, but eventually came to realize that memory needs to be "divided into multiple forms or systems-collections of processes that operate on different kinds of information and according to different rules" (Schacter, 2004, p. 644). Today, it is commonly accepted that multiple memory systems exist (e.g., short-term memory, long-term memory, procedural memory), are activated by different tasks, and differ on a number of important theoretical dimensions (e.g., duration, storage modality, capacity, neural underpinnings).

Pluralists suggest the time has come for emotion theory to undergo a similar transformation—that is, to take seriously the idea of multiple emotion systems, and possibly even multiple anger systems, multiple fear systems, multiple disgust systems, and so on (Scarantino, 2012a, 2012b, 2012c; LeDoux, 2012). Just as the fact that the folk psychological category of "memory" is not a natural kind is compatible with the existence of a plurality of more specific natural kinds of memory (e.g., short-term memory, long-term memory, procedural memory), so the fact that the folk psychological categories of "emotion," "anger," "fear," and so on are too heterogeneous to designate natural kinds is compatible with the existence of natural kinds of emotion, natural kinds of anger, natural kinds of fear, and so forth.

A possible moral of this chapter is that *universalist* theories of emotions are inadequate, although they each account for a portion of the empirical data and therefore tell us something valuable about what *some* emotions are. The inference to the best explanation for why, despite centuries of efforts, we have failed to unveil a *universalist* theory of emotions that accounts for all the empirical data on what we call emotion, fear, or anger in English while achieving all our other theoretical purposes is that there is not such theory to be found. Whether a *componential* or a *pluralist* strategy will bear more fruits in the long run remains to be seen. But as both strategies start from the shared assumption that folk emotion categories are too heterogeneous for the theoretical purposes of philosophers and affective scientists, they promise to deliver the sort of progress that has eluded universalist theories so far.

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Notes

1. Aristotle's list, as several other lists I introduce in this chapter, contains some items that in contemporary taxonomies would clearly qualify as emotions (e.g., fear), other items that would clearly not qualify (e.g., emulation), and some borderline cases (e.g., calmness). I do not discuss the origin and import of these discrepancies in what follows, but they suggest that the overlap between the contemporary emotion category and the other affective categories I consider (e.g., passion, sentiment, affect) is only partial.
2. Aristotle does not explicitly associate all passions with either pain or pleasure. For example, he does not explain whether friendliness, kindness, confidence in the face of danger, contempt, and hatred involve either pleasure or pain. This is either an oversight on Aristotle's part or evidence that feelings of pain and pleasure are not strictly necessary for an Aristotelian passion to be instantiated.
3. The solitary exception is constituted by philosophy students, who indicate instead cognitive changes as being more important attributes than feelings.
4. Descartes also offers a description of the concomitant movements of the animal spirits that function as proximal causes of such passions.
5. Hume accepts that the passions can be unreasonable, but he thinks they are so only derivatively, namely by virtue of the judgments that accompany them (what we now call the *cognitive basis* of emotions; see the section "The Rise of the Evaluative Tradition"). For example, it is for Hume unreasonable to fear a person on the false assumption that he or she exists, or to buy a gift for someone we hate on the false assumption that he or she will suffer as a result. The mistake here, Hume thinks, does not lie with the emotion, but with our judgments about what exists or about what is a good means to an end.
6. This view contrasts with Descartes' analysis, according to which emotions represent the goodness or badness of things, and do so (most of the time) in an exaggerated way (James, 1997). But note that not everyone agrees that Cartesian passions are representational (see e.g., Greenberg, 2007, for a dissenting opinion).
7. Since James's theory is very similar to Carl Lange's (1885/1922) theory, independently developed at the same time, it is common to refer to the James–Lange theory of emotions. I will disregard Lange's contribution in what follows.
8. James's mature account, as Ellsworth (1994) first emphasized, also comprises an evaluative dimension, captured by the idea that the perceptions of the exciting fact that directly cause bodily changes are evaluations of the stimulus situation (see also Reisenzein, Meyer, & Schutzwohl, 1995). This aspect was added by James only in 1894, in response to critiques his theory had received from, for instance, Worcester (1893) and Irons (1894). These writers had argued that the same stimulus (e.g., a bear) can elicit different emotions in different subjects. James acknowledged that objects can be evaluated in different ways, and consequently lead to different emotions: "The same bear may truly enough excite us to either fight or flight, according as he suggests an overpowering 'idea' of his killing us, or one of our killing him" (James, 1894, p. 518).
9. In a footnote, James himself hinted at the possibility that some emotions may correspond to neural changes that have no counterpart in real bodily changes: "it is of course possible that the cortical centres normally percipient of . . . organic sensations due to real bodily change, should become *primarily* excited in brain-disease, and give rise to an hallucination of the changes being there. . . . Trance, ecstasy, &c., offer analogous examples—not to speak of ordinary dreaming" (James, 1884, note 4; see Prinz, 2004b; Reisenzein & Stephan, 2014, for further discussion).
10. Deigh (2001) has suggested that this passage does not offer conclusive support to the interpretation that Freud did not believe in the existence of unconscious emotions. On Deigh's view, appreciating that for Freud emotions can literally be unconscious is "essential [for] understanding Freud as having . . . broken completely with the Cartesian conception of the mind" (p. 1250).
11. The converse does not hold for James, as there are emotions not generated by instincts. James (1890) writes, "emotional reactions are often excited by objects with which we have no practical dealings. A ludicrous object, for example, or a beautiful object are not necessarily objects to which we do anything; we simply laugh, or stand in admiration, as the case may be." As a result, James concludes that "the class of emotional, is thus rather larger than that of instinctive, impulses, commonly so called" (p. 442).
12. Skepticism about the usefulness of the notion of emotional expressions is at the heart of Fridlund's (1994) *behavioral ecology view* of facial displays, which focuses on how facial changes convey social motives, and rejects the assumption that automatically expressing emotions to recipients is in the evolutionary interest of emoters. The view that facial expressions are largely audience-dependent has since gained wide ascendancy in the literature on emotional expressions (see Russell, Bachorowski, & Fernández-Dols, 2003, for a review).

13. Ryle (1949/2009) acknowledges that emotion terms may also refer to *feelings* that "wax and wane in a few seconds" (p. 85), but he describes them somewhat disparagingly as "thrills, twinges, pangs, throbs, wrenches, itches, prickings, chills, glows, loads, qualms, hankerings, curdlings, sinkings, tensions, gnawings and shocks" (p. 70).
14. We must distinguish this case from the case of action readiness discussed by Dewey (1894, 1895). A person can be proud in the Rylean dispositional sense even while he or she is sleeping, by virtue of what would happen were he or she to wake up, and were other circumstances to be fulfilled. But a person cannot be angry in the Deweyan dispositional sense while sleeping, because being angry in such sense requires the actual activation of aggressive behavioral options.
15. Several basic emotion theorists also assume that basic emotions are associated with distinctive hardwired neural circuits (e.g., Izard, 2011; Levenson, 2011). The debate on the existence of such circuits is unresolved (see, e.g., Panksepp, 2000; Panksepp & Biven, 2012; LeDoux, 1996; LeDoux & Phelps, 2008; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012; Barrett & Satpute, 2013).
16. We should note the existence of a minority view within basic emotion theory that is *impulsivist* rather than *reflexivist*, in that it assumes that, except in rare cases, basic emotions lead to impulses to behavior rather than reflex-like behaviors (e.g., Levenson, 2011; Scarantino, 2014, 2015; see also Roseman, 2011).
17. Several social constructionists focus on the interpersonal social functions played by emotions while remaining agnostic on what emotions are at the intrapersonal level. But since they generally tend to emphasize the active side of emotions and the fact that emotions do not just happen to emoters but are means to fulfill ends, it seems fitting to include them as *sui generis* members of the *motivational tradition*.
18. Since the class of Stoic passions is not coextensive with our class of emotions, the claim that we should strive for *apatheia* is not equivalent to the claim that we should strive for freedom from all emotions. In fact, the Stoics explicitly admit some emotions as legitimate. The *good emotions* are labeled by the Stoics as *eupatheiai*, and three varieties of them are distinguished: joy (*khara*), will (*boulesis*), and caution (*eulabeia*).
19. Brentano (1874/1995) emphasizes a peculiar feature of the intentionality relation, namely that the object toward which a mental state is directed need not exist. This feature has led a number of philosophers to doubt that the intentionality relation can be explained in physical terms, because one of its relata need not exist in the physical world. Others have suggested instead that the intentionality relation can be naturalized despite this peculiarity (see, e.g., Mendelovici & Bourget, 2014, for further discussion).
20. As it turns out, Kenny (1963) was right on the assumption that there are conceptual entailments between emotions and formal objects, but wrong on the assumption that one must believe that a stimulus is bad in order to fear it, due to the phenomenon of rational recalcitrance (D'Arms & Jacobson, 2003). As I discuss later in the chapter, philosophers are now identifying emotions with mental representations other than beliefs to account for recalcitrance.
21. For an exploration of the complex connections between the three job descriptions for formal objects, see De Sousa (1987) and Teroni (2007). For skepticism about the usefulness of the notion of formal object, see Deigh (1994).
22. Although formal objects are generally instantiated by material objects, there are exceptions to this rule. In so-called *objectless emotions*, no material objects are seemingly present. For example, in objectless anxiety the world at large appears to be dangerous, without anything in particular appearing to be dangerous. Cases of this sort can be handled in several ways. Objectless emotions can be handed out to a theory of moods, or they can be considered to be emotions with an especially broad material object (e.g., the world at large), or they can be considered to be emotions without material objects. The discussion of these possible solutions and others lies outside the scope of this chapter.
23. See De Sousa (2002) and Salmela (2006) on the topic of emotional truth.
24. Some have also suggested that emotions provide reasons to act without motivating to act (see, e.g., Tappolet, 2010).
25. Reisenzein (2012) has recently distinguished among three main versions of the belief and desire theory in psychology and philosophy: the *causal view*, according to which beliefs and desires are causal preconditions of emotions but not constituent parts of them; the *part–whole view*, according to which beliefs and desires are parts of emotions; and the *fusion view*, according to which emotions result from the fusion between beliefs and desires.
26. Another notable neo-Jamesian account of emotions is Robinson (1995, 2005).
27. Two important formulations of the view can be found in D'Arms and Jacobson's *Rational Sentimentalism* (see D'Arms & Jacobson, 2000) and in Rabinowicz and Rønnow-Rasmussen's *Fitting Attitude Theory* (see Rabinowicz & Rønnow-Rasmussen, 2004).
28. As Scherer (2001, p. 28) puts it, all appraisal theories that have appeared in the last 40 years are

"based, at least in part, on the pioneering efforts of Arnold and Lazarus."

29. There is a rich debate in philosophy concerning whether emotions are natural kinds (see, e.g., Nussbaum, 2001; Ben-Ze'ev, 2000; Charland, 2002; Prinz, 2004a; Griffiths, 2004a; Scarantino, 2009, 2012c; Clark, 2013).

References

Allport, F. H. (1924). *Social psychology*. Boston: Houghton Mifflin.

Aristotle. (1984). *The complete works of Aristotle: The revised Oxford translation* (J. Barnes, Ed.). Princeton, NJ: Princeton University Press.

Armon-Jones, C. (1986). The thesis of constructionism. In R. Harré (Ed.), *The social construction of emotion* (pp. 32–56). Oxford, UK: Oxford University Press.

Arnold, M. B. (1960). *Emotion and personality* (Vol. I). New York: Columbia University Press.

Averill, J. R. (1980). Emotion and anxiety: Sociocultural, biological and psychological determinants. In A. O. Rorty (Ed.), *Explaining emotions* (pp. 37–72). Berkeley: University of California Press.

Baldwin, J. M. (1894). The origin of emotional expression. *Psychological Review, 1*, 610–623.

Bar-On, D. (2013). Origins of meaning: Must we "go Gricean"? *Mind and Language, 28*(3), 342–375.

Barrett, L. F. (2005). Feeling is perceiving: Core affect and conceptualization in the experience of emotion. In L. F. Barrett, P. Niedenthal, & P. Winkielman (Eds.), *Emotion and consciousness* (pp. 255–284). New York: Guilford Press.

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science, 1*, 28–58.

Barrett, L. F. (2009). Variety is the spice of life: A psychological construction approach to understanding variability in emotion. *Cognition and Emotion, 23*, 1284–1306.

Barrett, L. F. (2012). Emotions are real. *Emotion, 12*, 413–429.

Barrett, L. F. (2015). Ten common misconceptions about the psychological construction of emotion. In L. F. Barrett & J. A. Russell (Eds.), *The psychological construction of emotion* (pp. 45–79). New York: Guilford Press.

Barrett, L. F., Ochsner, K. N., & Gross, J. J. (2007). On the automaticity of emotion. In J. Bargh (Ed.), *Social psychology and the unconscious: The automaticity of higher mental processes* (pp. 173–218). New York: Psychology Press.

Barrett, L. F., & Satpute, A. B. (2013). Large-scale brain networks in affective and social neuroscience: Towards an integrative architecture of the human brain. *Current Opinion in Neurobiology, 23*, 361–372.

Bechtel, W., Abrahamsen, A., & Graham, G. (1998). The life of cognitive science. In W. Bechtel & G. Graham (Eds.), *A companion to cognitive science* (pp. 1–104). Oxford, UK: Blackwell.

Bedford, E. (1957). Emotions. *Proceedings of the Aristotelian Society, 57*, 281–304.

Benbaji, H. (2012). How is recalcitrant emotion possible? *Australasian Journal of Philosophy, 91*(3), 1–23.

Ben-Ze'ev, A. (2000). *The subtlety of emotions*. Cambridge, MA: MIT Press.

Brady, M. (2007). Recalcitrant emotions and visual illusions. *American Philosophical Quarterly, 55*, 273–284.

Brady, M. S. (2013). *Emotional insight: The epistemic role of emotional experience*. Oxford, UK: Oxford University Press.

Brentano, F. (1995). *Psychology from an empirical standpoint*. London: Routledge. (Original work published 1874; English edition published 1973; reprinted with an introduction by Peter Simons, London: Routledge 1995).

Broad, C. D. (1971). Emotion and sentiment. In D. R. Cheney (Ed.), *Broad's critical essays in moral philosophy* (pp. 283–301). London: Allen & Unwin. (Original work published 1954)

Brogaard, B. (2015). *On romantic love: Simple truths about a complex emotion*. Oxford, UK: Oxford University Press.

Bull, N. (1951). *The attitude theory of emotion*. New York: Nervous and Mental Disease Monographs.

Cannon, W. (1929). *Bodily changes in pain, hunger, fear and rage*. New York: Appleton.

Carnap, R. (1959). Psychology in physical language. In A. J. Ayer (Ed.), *Logical positivism* (pp. 165–198). New York: Free Press. (Original work published 1931)

Castelfranchi, C. & Miceli, M. (2009). The cognitive-motivational compound of emotional experience. *Emotion Review, 1*, 223–231.

Charland, L. C. (1995). Feeling and representing: Computational theory and the modularity of affect. *Synthese, 105*, 273–301.

Charland, L. C. (2002). The natural kind status of emotion. *British Journal for the Philosophy of Science, 53*, 511–537.

Chomsky, N. (1959). Review of B. F. Skinner's "verbal behaviour." *Language, 35*, 26–58.

Clark, A., & Chalmers, D. (1998). The extended mind. *Analysis, 58*, 7–19.

Clark, J. (2010). Relations of homology between higher cognitive emotions and basic emotions. *Biology and Philosophy, 25*(1), 75–94.

Clark, J. (2013). Integrating basic and higher-cognitive emotions within a common evolutionary framework: Lessons from the transformation of primate dominance into human pride. *Philosophical Psychology, 26*(3), 437–460.

Clore, G. L., & Ortony, A. (2013). Psychological construction in the OCC model of emotion. *Emotion Review, 5*, 335–343.

Coan, J. A., & Gonzalez, M. Z. (2015). Emotions as emergent variables. In L. F. Barrett & J. A. Russell (Eds.), *The psychological construction of emotion* (pp. 209–226). New York: Guilford Press.

Colombetti, G. (2014). *The feeling body: Affective science meets the enactive mind*. Cambridge, MA: MIT Press.

Colombetti, G., & Krueger, J. (2015). Scaffoldings of the affective mind. *Philosophical Psychology, 28*(8), 1157–1176.

Colombetti, G., & Roberts, T. (2015). Extending the extended mind: The case for extended affectivity. *Philosophical Studies, 172*(5), 1243–1263.

Colombetti, G., & Thompson, E. (2008). The feeling body: Towards an enactive approach to emotion. In W. F. Overton, U. Muller, & J. L. Newman (Eds.), *Developmental perspectives on embodiment and consciousness* (pp. 45–68). New York: Erlbaum.

Cooper, J. M. (1999). *Reason and emotion: Essays on ancient moral psychology and ethical theory.* Princeton, NJ: Princeton University Press.

Cordaro, D. T., Fridlund, A. J., Keltner, D., Russell, J., & Scarantino, A. (2015). The Great Expressions Debate. In A. Scarantino (Ed.), *Emotion researcher.* Available at *http://emotionresearcher.com/the-great-expressions-debate.*

Cunningham, W. A., Dunfield, K. A., & Stillman, P. E. (2013). Emotional states from affective dynamics. *Emotion Review, 5*, 344–355.

D'Arms, J. (2013). Envy. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy* (Winter 2013 ed.). Available at *http://plato.stanford.edu/archives/win2013/entries/envy/.*

D'Arms, J., & Jacobson, D. (2000). The moralistic fallacy: On the "appropriateness" of emotions. *Philosophy and Phenomenological Research, 61*, 65–90.

D'Arms, J., & Jacobson, D. (2003). The significance of recalcitrant emotions (or anti-quasijudgmentalism). In A. Hatzimoysis (Ed.), *Philosophy and the emotions* (pp. 127–145). Cambridge, UK: Cambridge University Press.

D'Arms, J., & Jacobson, D. (forthcoming). *Rational sentimentalism.* Oxford, UK: Oxford University Press.

Damasio, A. R. (1994). *Descartes error: Emotion, reason and the human brain.* New York: Grosset/Putnam.

Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness.* New York: Harcourt Brace.

Damasio, A. R. (2003). *Looking for Spinoza: Joy, sorrow, and the feeling brain.* Orlando, FL: Harcourt.

Darwin, C. (1965). *The expressions of the emotions in man and animals.* Chicago: University of Chicago Press. (Original work published 1872)

De Sousa, R. (1987). *The rationality of emotions.* Cambridge, MA: MIT Press.

De Sousa, R. (2002). Emotional truth. *Proceedings of the Aristotelian Society, 76*, 247–263.

Deigh, J. (1994). Cognitivism in the theory of emotion. *Ethics, 104*(4), 824–854.

Deigh, J. (1999). All kinds of guilt. *Law and Philosophy: An International Journal for Jurisprudence and Legal Philosophy, 18*, 313–325.

Deigh, J. (2001). Emotions: The legacy of James and Freud. *International Journal of Psycholanalysis, 82*, 1247–1256.

Deigh, J. (2010). Concepts of emotions in modern philosophy and psychology. In P. Goldie (Ed.), *The Oxford handbook of philosophy of emotion* (pp. 17–40). Oxford, UK: Oxford University Press.

Deigh, J. (2014). William James and the rise of the scientific study of emotion. *Emotion Review, 6*(1), 4–12.

Deonna, J., & Teroni, F. (2012). *The emotions: A philosophical introduction.* New York: Routledge.

Deonna, J., & Teroni, F. (2015). Values, emotions, and decision-making. In T. Brosch & D. Sander (Eds.), *Handbook of value: Perspectives from economics, neuroscience, philosophy, psychology, and sociology* (pp. 155–173). Oxford, UK: Oxford University Press.

Deonna, J., Teroni, F., & Tappolet, C. (2015). Emotion, philosophical issues about. *Wiley Interdisciplinary Reviews: Cognitive Science, 6*(3), 193–207.

Descartes, R. (1984). The passions of the soul. In J. Cottingham, R. Stoothoff, D. Murdoch, & A. Kenny (Eds.), *The philosophical writings of Descartes* (Vol. 1, pp. 325–404). Cambridge, UK: Cambridge University Press. (Original work published 1650)

Dewey, J. (1894). The theory of emotion. (I) Emotional attitudes. *Psychological Review, 1*, 553–569.

Dewey, J. (1895). The theory of emotion. (2) The significance of emotions. *Psychological Review*, 2, 13–32.

Dixon, T. (2003). *From passions to emotions: The creation of a secular psychological category.* Cambridge, UK: Cambridge University Press.

Dixon, T. (2012). "Emotion": The history of a keyword in crisis. *Emotion Review, 4*, 338–344.

Dokic, J., & Lemaire S. (2013). Are emotions perceptions of value? *Canadian Journal of Philosophy, 43*, 227–247.

Döring, S. A. (2003). Explaining action by emotion. *Philosophical Quarterly, 53*(211), 214–230.

Döring, S. A. (2007). Seeing what to do: Affective perception and rational motivation. *Dialectica, 61*(3), 363–394.

Döring, S. A. (2008). Conlict without contradiction. In G. Brun, U. Doguoglu, & D. Kuenzle (Eds.), *Epistemology and emotions* (pp. 83–104). Aldershot, UK: Ashgate.

Dretske, F. (1988). *Explaining behaviour.* Cambridge, MA: Bradford/MIT.

Duffy, E. (1934). Emotion: An example of the need for reorientation in psychology. *Psychological Review, 41*, 184–198.

Duffy, E. (1941). An explanation of "emotional" phenomena without the use of the concept "emotion." *Journal of General Psychology, 25*, 283–293.

Dunn, B. D., Dalgleish, T., & Lawrence, A. D. (2006). The somatic marker hypothesis: A critical evaluation. *Neuroscience and Biobehavioral Reviews, 30*, 239–271.

Eder, A., & Rothermund, K. (2013). Emotional action: An ideomotor model. In C. Mohiyeddini, M. Eysenck, & S. Bauer (Eds.), *Psychology of emotions* (pp. 11–38). Hauppauge, NY: Nova Science.

Ekman, P. (1980). Biological and cultural contributions to body and facial movement in the expression of emotions. In A. O. Rorty (Ed.), *Explaining emotions* (pp. 73–102). Berkeley: University of California Press.

Ekman, P. (1992a). Facial expressions of emotion: New findings, new questions. *Psychological Science, 3*, 34–38.

Ekman, P. (1992b). An argument for basic emotions. *Cognition and Emotion*, 6, 169–200.

Ekman, P. (1994). Strong evidence for universals in facial expressions: A reply to Russell's mistaken critique. *Psychological Bulletin, 115*(2), 268–287.

Ekman, P. (1999). Basic emotions. In T. Dalgleish &

M. Power (Eds.), *Handbook of cognition and emotion* (pp. 45–60). Chichester, UK: Wiley.

Ekman, P. (2003). *Emotions revealed*. New York: Times Books.

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic? *Emotion Review, 3*(4), 364–370.

Ekman, P., & Friesen, W. V. (1969). The repertoire of nonverbal behaviour. *Semiotica, 1*(1), 86–88.

Ekman, P., Friesen, W. V., & Simons, R. C. (1985). Is the startle reaction an emotion? *Journal of Personality and Social Psychology, 49*(5), 1416–1426.

Elgin, C. Z. (2008). Emotion and understanding. In G. Brün, U. Doguoglu, & D. Kuenzle (Eds.), *Epistemology and emotions* (pp. 33–50). Burlington, VT: Ashgate.

Ellsworth, P. C. (1994). William James and emotion: Is a century of fame worth a century of misunderstanding? *Psychological Review, 101*, 222–229.

Ellsworth, P. C. (2006, August). *Are appraisals causes or constituents of emotion?* Paper presented at the XV Conference of the International Society for Research on Emotion, Atlanta, GA.

Ellsworth, P. C. (2013). Appraisal theory: Old and new questions. *Emotion Review, 5*(2), 125–131.

Ellsworth, P. C., & Scherer, K. R. (2003). Appraisal processes in emotion. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 572–595). Oxford, UK: Oxford University Press.

Elster, J. (2010). Emotional choice and rational choice. In P. Goldie (Ed.), *Oxford handbook of the philosophy of emotion* (pp. 263–281). Oxford, UK: Oxford University Press.

Faucher, L., & Tappolet, C. (Eds.). (2007). The modularity of emotions. In *Canadian Journal of Philosophy: Vol. 32*. Calgary, Canada: University of Calgary Press.

Fernández-Dols, J. M., & Carroll, J. M. (1997). Is the meaning percieved in facial expression independent of its context? In J. A. Russell & J. M. Fernández-Dols (Eds.), *The psychology of facial expression* (pp. 295–320). Cambridge, UK: Cambridge University Press.

Fernández-Dols, J. M., & Ruiz-Belda, M.-A. (1997). Spontaneous facial behavior during intense emotional episodes: Artistic truth and optical truth. In J. A. Russell & J. M. Fernández-Dols (Eds.), *The psychology of facial expression* (pp. 255–294). Cambridge, UK: Cambridge University Press.

Frank, R. H. (1988). *Passions within reason: The strategic role of the emotions*. New York: Norton.

Freeman, W. J. (2000). Emotion is essential to all intentional behaviors. In M. D. Lewis & I. Granic (Eds.), *Emotion, development, and self-organization* (pp. 209–235). Cambridge, UK: Cambridge University Press.

French, P. A., Wettstein, H. K., & Saint, M. (Eds.). (2010). *Film and the emotions*. Hoboken, NJ: Wiley.

Freud, S. (1997). The unconscious. In A. Dickson (Ed.), *On metapsychology: The theory of psychoanalysis: "Beyond the pleasure principle," "the ego and the id," and other works* (p. 126). New York: Penguin. (Original work published 1915)

Fridlund, A. J. (1994). *Human facial expression: An evolutionary view*. San Diego, CA: Academic Press.

Frijda, N. H. (1986). *The emotions*. Cambridge, UK: Cambridge University Press

Frijda, N. H. (1993). The place of appraisal in emotions. *Cognition and Emotion, 7*, 357–387.

Frijda, N. H. (2007). *The laws of emotion*. Mahwah, NJ: Erlbaum.

Frijda, N. H. (2010). Impulsive action and motivation. *Biological Psychology, 84*, 570–579.

Frijda, N. H., & Parrott, W. G. (2011). Basic emotions or ur-emotions. *Emotion Review, 3*, 416–423.

Frijda, N. H., Ridderinkhof, K. R., & Rietveld, E. (2014). Impulsive action: Emotional impulses and their control. *Frontiers in Emotion Science, 5,* 518.

Gallagher, S., & Zahavi, D. (2012). *The phenomenological mind* (2nd ed.). London: Routledge.

Gallistel, C. R. (1980). *The organization of action: A new synthesis*. Hillsdale: Erlbaum.

Gendron, M., & Barrett, L. F. (2009). Reconstructing the past: A century of ideas about emotion in psychology. *Emotion Review, 1*, 316–339.

Goldie, P. (2000). *The emotions: A philosophical exploration*. Oxford, UK: Clarendon Press.

Goldie, P. (2002). Emotions, feelings and intentionality. *Phenomenology and the Cognitive Sciences, 1*, 235–254.

Gordon, R. M. (1987). *The structure of emotions: Investigations in cognitive philosophy*. Cambridge, UK: Cambridge University Press.

Green, M. (2007). *Self-expression*. New York: Oxford University Press.

Green, O. H. (1992). *The emotions: A philosophical theory*. Dordrecht, The Netherlands: Kluwer.

Greenberg, S. (2007). Descartes on the passions: Function, representation, and motivation. *Noûs, 41*, 714–734.

Greenspan, P. (1988). *Emotions and reasons: An enquiry into emotional justification*. New York: Routledge, Chapman and Hall.

Griffiths, P. E. (1997). *What emotions really are: The problem of psychological categories*. Chicago: University of Chicago Press.

Griffiths, P. E. (2004a). Is emotion a natural kind? In R. C. Solomon (Ed.), *Thinking about feeling: Contemporary philosophers on emotions* (pp. 233–249). Oxford, UK: Oxford University Press.

Griffiths, P. E. (2004b). Towards a Machiavellian theory of emotional appraisal. In P. Cruise & D. Evans (Eds.), *Emotion, evolution and rationality* (pp. 89–105). Oxford, UK: Oxford University Press.

Griffiths, P. E., & Scarantino, A. (2009). Emotions in the wild: The situated perspective on emotion. In P. Robbins & M. Aydede (Eds.), *The Cambridge handbook of situated cognition* (pp. 437–453). Cambridge, UK: Cambridge University Press.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*, 271–299.

Harré, R. (1986). An outline of the social constructionist viewpoint. In R. Harré (Ed.), *The social construction of emotion* (pp. 2–14). Oxford, UK: Oxford University Press.

Haybron, D. (2008). *The pursuit of happiness: The elusive psychology of well-being.* New York: Oxford University Press.

Heider, F. (1958). *The psychology of interpersonal relations.* New York: Wiley.

Helm, B. W. (2001). *Emotional reason: Deliberation, motivation, and the nature of value* Cambridge, UK: Cambridge University Press.

Hempel, C. (1980). The logical analysis of behavior. In N. Block (Ed.), *Readings in philosophy of psychology* (pp. 14–23). Cambridge, MA: Harvard University Press. (Original work published 1935)

Hume, D. (1992). *A treatise of human nature.* Buffalo, NY: Prometheus Books. (Original work published 1739)

Hursthouse, R. (1991). Arational actions. *Journal of Philosophy, 88*, 57–68.

Hutcheson, F. (2002). *Essay on the nature and conduct of the passions with illustrations on the moral sense* (A. Garrett, Ed.). Indianapolis: Liberty Fund. (Original work published 1728)

Hutto, D. D. (2012). Truly enactive emotion. *Emotion Review, 4*(2), 176–181.

Irons, D. (1894). Professor James' theory of emotion. *Mind, 3*, 77–97.

Izard, C. E. (1969). The emotions and emotions constructs in personality and culture. In R. B. Cattell & R. M. Dreger (Eds.), *Handbook of modern personality theory* (pp. 496–510). Washington, DC: Hemisphere.

Izard, C. E. (1971). *The face of emotion.* New York: Appleton, Century, Crofts.

Izard, C. E. (1977). *Human emotions.* New York: Plenum.

Izard, C. E. (1980). Cross cultural perspectives on emotion and emotion communication. In H. Triandis & W. Lonner (Eds.), *Handbook of cross-cultural psychology* (Vol. 3, pp. 185–221). Boston: Allyn & Bacon.

Izard, C. E. (1992). Basic emotions, relations amongst emotions and emotion—Cognition relations. *Psychological Review, 99*, 561–565.

Izard, C. E. (2011). Cognition interactions—forms and functions of emotions: Matters of emotion. *Emotion Review, 3*(4), 371–378.

Jacobson, D. (2011). Fitting attitude theories of value. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy* (Spring 2011 ed.). Stanford, CA: Stanford University. Available at *http://plato.stanford.edu/archives/spr2011/entries/fitting–attitude–theories/.*

James, S. (1997). *Passion and action: The emotions in seventeenth-century philosophy*, Oxford, UK: Clarendon Press.

James, W. (1884). What is an emotion? *Mind, IX*, 188–205.

James, W. (1890). *The principles of psychology.* New York: Holt.

James, W. (1892). *Psychology: Briefer course.* New York: Holt.

James, W. (1894). The physical basis of emotion. *Psychological Review, 1*, 516–529.

Johnston, M. (2001). The authority of affect. *Philosophy and Phenomenological Research, 53*, 181–214.

Kagan, J. (2007). *What is emotion?* New Haven, CT: Yale University Press.

Kagan, J. (2010). Once more into the breach. *Emotion Review, 2*(2), 91–99.

Kelly, D. (2011). *Yuck! The nature and moral significance of disgust.* Cambridge, MA: MIT Press.

Keltner, D., & Haidt, J. A. (2001). Social functions of emotions. In T. J. Mayne & G. A. Bonanno (Eds.), *Emotions: Current issues and future directions* (pp. 192–212). New York: Guilford Press.

Kenny, A. (1963). *Action, emotion and will.* London: Routledge and Kegan Paul.

King, P. (2010). Emotions in medieval thought. In P. Goldie (Ed.), *The Oxford handbook of philosophy of emotion* (pp. 167–187). Oxford, UK: Oxford University Press.

Klineberg, O. (1940). *Social psychology.* New York: Holt.

Knapp, C. (2003). De-moralizing disgustingness. *Philosophy and Phenomenological Research, 66*(2), 253–278.

Kosman, L. A. (1980). Being properly affected: Virtues and feelings in Aristotle's ethics. In A. O. Rorty (Ed.), *Essays on Aristotle's ethics* (pp. 103–116). Berkeley: University of California Press.

Kovach, A., & De Lancey, C. (2005). On emotions and the explanation of behavior. *Noûs, 39*(1), 106–122.

Kriegel, U. (2014). Towards a new feeling theory of emotion. *European Journal of Philosophy, 22*(3), 420–442.

Krueger, J. (2013a). Merleau-Ponty on shared emotions and the joint ownership thesis. *Continental Philosophy Review, 46*, 509–531.

Krueger, J. (2013b). Ontogenesis of the socially extended mind. *Cognitive Systems Research, 25/26*, 40–46.

Krueger, J. (2014). Varieties of extended emotions. *Phenomenology and the Cognitive Sciences*, 1–23.

Lacewing, M. (2007). Do unconscious emotions involve unconscious feelings? *Philosophical Psychology, 20*(1), 81–104.

Landis, C. (1924). Studies of emotional reactions: II. General behavior and facial expression. *Journal of Comparative Psychology, 4*, 447–509.

Lange, C. (1922). *The emotions.* Baltimore: Williams & Wilkins. (Original work published 1885)

Lazarus, R. S. (1966). *Psychological stress and the coping process.* New York: McGraw-Hill.

Lazarus, R. S. (1984). On the primacy of cognition. *American Psychologist, 39*(2), 124–129.

Lazarus, R. S. (1991). *Emotion and adaptation.* New York: Oxford University Press.

Lazarus, R. S. (2001). Relational meaning and discrete emotions. In K. R. Scherer, A. Schorr, & T. Johnstone, T. (Eds.), *Appraisal processes in emotion* (pp. 37–67). Oxford, UK: Oxford University Press.

LeDoux, J. (2012). Rethinking the emotional brain. *Neuron, 73*, 653–676.

LeDoux, J. E. (1996). *The emotional brain.* New York: Simon & Schuster.

LeDoux, J. E., & Phelps, E. A. (2008). Emotional networks in the brain. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 159–179). New York: Guilford Press.

Leeper, R. W. (1948). A motivational theory of emotion to replace "emotion as disorganized response." *Psychological Review, 55*, 5–21.
Leighton, S. (1985). A new view of emotion. *American Philosophical Quarterly, 22*(2), 133–141.
Levenson, R. (2011). Basic emotion questions. *Emotion Review, 3*(4), 379–386.
Leventhal, H., & Scherer, K. R. (1987). The relationship of emotion to cognition: A functional approach to a semantic controversy. *Cognition and Emotion, 1*, 3–28.
Lewis, M. D. (2000). Emotional organization at three time scales. In M. D. Lewis & I. Granic (Eds.), *Emotion, development, and self-organization: Dynamic systems approaches to emotional development* (pp. 37–69). Cambridge, UK: Cambridge University Press.
Lewis, M. D. (2005). Bridging emotion theory and neurobiology through dynamic systems modeling. *Behavioral and Brain Sciences, 28*(2), 169–193.
Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*, 161–162.
Locke, J. (1975). *An essay concerning human understanding* (P. Nidditch, Ed.). Oxford, UK: Clarendon Press. (Original work published 1690)
Lutz, C. (1980). *Emotion words and emotional development on Ifaluk Atoll*. Thesis. Harvard University, Cambridge, MA.
Lyons, W. (1980). *Emotion*. Cambridge, UK: Cambridge University Press.
Lyons, W. (1999). The philosophy of cognition and emotion. In T. Dalgleish & M. Power (Eds.), *Handbook of cognition and emotion* (pp. 21–44). Chichester, UK: Wiley.
Macnamara, C. (2012). "Screw you" & "thank you." *Philosophical Studies, 130*, 893–914.
Maiese, M. (2011). *Embodiment, emotion, and cognition*. Basingstoke, UK: Palgrave Macmillan.
Mandler, G. (1975). *Mind and emotion*. New York: Wiley.
Mandler, G. (1990). William James and the construction of emotion. *Psychological Science, 1*, 179–180.
Marks, J. (1982). A theory of emotions. *Philosophical Studies, 42*, 227–242.
Martin, A. M. (2014). *How we hope*. Princeton, NJ: Princeton University Press.
Matravers, D. (1998). *Art and emotion*. Oxford, UK: Oxford University Press
Matsumoto, D., Keltner, D., Shiota, M. N., Frank, M. G., & O'Sullivan, M. (2008). What's in a face? Facial expressions as signals of discrete emotions. In M. Lewis, J. M. Haviland, & L. F. Barrett (Eds.), *Handbook of emotions* (pp. 211–234). New York: Guilford Press.
McDougall, W. (2001). *An introduction to social psychology*. Kitchener, Canada: Batoche Books. (Original work published 1908)
McDougall, W. (1923). *An outline of psychology* (4th ed.). London: Methuen.
Mead, G. H. (1934). *Mind, self, and society from the standpoint of a social behaviorist* (C. W. Morris, Ed.). Chicago: Chicago University Press.
Meinong, A. (1894). Psychologisch-ethische Untersuchungen zur Werttheorie [Psychological-ethical investigations concerning the theory of value]. Graz, Austria: Leuschner & Lubensky. Reprinted in R. Haller & R. Kindinger (Hg.) (1968), Alexius Meinong Gesamtausgabe Band III (S. 3–244). Graz: Akademische Druck—und Verlagsanstalt.
Mendelovici, A., & Bourget, D. (2014). Naturalizing intentionality: Tracking theories versus phenomenal intentionality theories. *Philosophy Compass, 9*(5), 325–337.
Mesquita, B., & Boiger, M. (2014). Emotions in context: A socio-dynamic model of emotions. *Emotion Review, 6*(4), 298–302.
Mesquita, B., & Frijda, N. H. (1992). Cultural variations in emotions: A review. *Psychological Bulletin, 112*, 179–204.
Miller N. E. (1951). Learnable drives and rewards. In S. S. Stevens (Ed.), *Handbook of experimental psychology* (pp. 435–472). New York: Wiley.
Moors, A. (2013). On the causal role of appraisal in emotion. *Emotion Review, 5*, 132–140.
Moors, A. (2014). Flavors of appraisal theories of emotion. *Emotion Review, 6*, 303–307.
Moors, A., & Scherer, K. R. (2013). The role of appraisal in emotion. In M. Robinson, E. Watkins, & E. Harmon-Jones (Eds.), *Handbook of cognition and emotion* (pp. 135–155). New York: Guilford Press.
Morgan, C. T. (1957). Physiological mechanisms of motivation. *Nebraska Symposium on Motivation, 5*, 1–43.
Mowrer, O. H. (1947). On the dual nature of learning—A re-interpretation of "conditioning" and "problem-solving." *Harvard Educational Review, 17*, 102–148.
Mulligan, K. (2007). Intentionality, knowledge and formal objects. *Disputatio, 2*(23), 205–228.
Nussbaum, M. (2001). *Upheavals of thought: The intelligence of emotions*. Cambridge, UK: Cambridge University Press.
Nussbaum, M. (2004). *Hiding from humanity: Disgust, shame and the law*. Princeton, NJ: Princeton University Press.
Oatley, K . (1992). *Best laid schemes: The psychology of emotions*. Cambridge, UK: Cambridge University Press.
Oatley, K., & Johnson-Laird, P. N. (1987). Towards a cognitive theory of emotions. *Cognition and Emotion, 1*, 29–50.
O'Reilly, R. C., Munakata, Y., Frank, M. J., & Hazy, T. E. (& contributors). (2012). *Computational cognitive neuroscience* [Wiki book]. Retrieved from *http://ccnbook.colorado.edu*.
Ortony, A., Clore, G. L., & Collins, A. (1988). *The cognitive structure of emotions*. Cambridge, UK: Cambridge University Press.
Pacherie, E. (2001). The role of emotions in the explanation of action. *European Review of Philosophy, 5*, 53–91.
Panksepp, J. (2000). Emotions as natural kinds within the mammalian brain. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed., pp. 137–156). New York: Guildford Press.

Panksepp, J., & Biven, L. (2012). *Archaeology of mind: The neuroevolutionary origins of human emotions*. New York: Norton

Parkinson, B. (1995). *Ideas and realities of emotion*. London: Routledge.

Parkinson, B. (1997). Untangling the appraisal–emotion connection. *Personality and Social Psychology Review, 1*, 62–79.

Parkinson, B. (2008). Emotions in direct and remote social interaction: Getting through the spaces between us. *Computers in Human Behavior, 24*, 1510–1529.

Parkinson, B. (2009). What holds emotions together?: Meaning and response coordination *Cognitive Systems Research, 10*, 31–47.

Parkinson, B., Fischer, A. H., & Manstead, A. S. R. (2005). *Emotion in social relations: Cultural, group, and interpersonal processes*. New York: Psychology Press.

Parkinson, B., & Manstead, A. S. R. (1992). Appraisal as a cause of emotion. In M. S. Clark (Ed.), *Review of personality and social psychology* (Vol. 13, pp. 122–149). Newbury Park, CA: Sage.

Peters, R. S. (1962). Emotions and the category of passivity. *Proceedings of the Aristotelian Society, 62*, 117–134.

Peters, R. S. (1970). The education of the emotions. In M. B. Arnold (Ed.), *Feelings and emotions: The Loyola symposium* (pp. 187–203). New York: Academic Press.

Pitcher, G. (1965). Emotion. *Mind, 74*(285), 326–346.

Plutchik, R. (1962). *The emotions: Facts, theories and a new model*. New York: Random House.

Plutchik, R. (1970). Emotions, evolution and adaptive processes. In M. B. Arnold (Ed.), *Feelings and emotions* (pp. 3–24). New York: Academic Press.

Plutchik, R., & Kellerman, H. (Eds.). (1980). *Emotion: Theory, research, and experience: Vol. 1. Theories of emotion*. New York: Academic Press.

Power, M. J., & Dalgleish, T. (2008). *Cognition and emotion: From order to disorder* (2nd ed.). Hove, UK: Taylor Francis.

Prinz, J. (2004a). Embodied emotions. In R. C. Solomon (Ed.), *Thinking about feeling: Contemporary philosophers on emotions* (pp. 89–105). Oxford, UK: Oxford University Press.

Prinz, J. (2004b). *Gut reactions: A perceptual theory of emotion*. Oxford, UK: Oxford University Press.

Prinz, J. J. (2007). *The emotional construction of morals*. Oxford, UK: Oxford University Press.

Rabinowicz, W., & Rønnow-Rasmussen, T. (2004). The strike of the demon: On fitting pro-attitudes and value. *Ethics, 114*(3), 391–423.

Ratcliffe, M. (2008). *Feelings of being: Phenomenology, psychiatry and the sense of reality*. Oxford, UK: Oxford University Press.

Reimann, M., & Bechara, A. (2010). The somatic marker framework as a neurological theory of decision-making: Review, conceptual comparisons, and future neuroeconomics research. *Journal of Economic Psychology, 31*, 767–776.

Reisenzein, R. (1996). Emotional action generation. In W. Battmann & S. Dutke (Eds.), *Processes of the molar regulation of behavior* (pp. 151–165). Lengerich, Germany: Pabst Science.

Reisenzein, R. (2006). Arnold's theory of emotion in historical perspective. *Cognition and Emotion, 20*, 920–951.

Reisenzein, R. (2012). What is an emotion in the belief–desire theory of emotion? In F. Paglieri, L. Tummolini, R. Falcone, & M. Miceli (Eds.), *The goals of cognition: Essays in honor of Cristiano Castelfranchi* (pp. 181–211). London: College Publications.

Reisenzein, R., & Mchitarjan, I. (2008). The teacher who had the greatest influence on my thinking: Tracing Meinong's influence on Heider. *Social Psychology, 39*, 141–150.

Reisenzein, R., Meyer, W.-U., & Schutzwohl, A. (1995). James and the physical basis of emotion: A comment on Ellsworth. *Psychological Review, 102*, 757–761.

Reisenzein, R., & Schönpflug, W. (1992). Stumpf's cognitive–evaluative theory of emotion. *American Psychologist, 47*, 34–45.

Reisenzein, R., & Stephan, S. (2014). More on James and the physical basis of emotion. *Emotion Review, 6*, 35–46.

Ridderinkhof, K. R. (2014). Neurocognitive mechanisms of perception–action coordination: A review and theoretical integration. *Neuroscience and Biobehavioral Reviews, 46*, 3–29.

Robbins, P., & Aydede, M. (2009). *The Cambridge handbook of situated cognition*. New York: Cambridge University Press.

Roberts, R. (2003). *Emotions: An essay in aid of moral psychology*. Cambridge, UK: Cambridge University Press.

Roberts, T. (2015). Extending emotional consciousness. *Journal of Consciousness Studies, 22*(3-4), 108–128.

Robinson, J. (1995). Startle. *Journal of Philosophy, 92*(2), 53–74.

Robinson, J. (2005). *Deeper than reason: Emotion and its role in literature, music, and art*. Oxford, UK: Oxford University Press

Roeser, S., & Todd, C. (Eds.). (2014). *Emotion and value*. New York: Oxford University Press.

Rorty, A. (Ed.). (1980). *Explaining emotions*. Berkeley: University of California Press.

Roseman, I. J. (1996). Why these appraisals? Anchoring appraisal models to research on emotional behavior and related response systems. In N. H. Frijda (Ed.), *Proceedings of the Ninth International Conference of the International Society for Research on Emotions* (pp. 106–110). Toronto: International Society for Research on Emotions.

Roseman, I. J. (2011). Emotional behaviors, emotivational goals, emotion strategies: Multiple levels of organization integrate variable and consistent responses. *Emotion Review, 3*, 1–10.

Roseman, I. J., & Smith, C. A. (2001). Appraisal theory: Overview, assumptions, varieties, controversies. In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion* (pp. 3–34). New York: Oxford University Press.

Russell, J. A. (1987). Comment on articles by Frijda and by Conway and Bekerian. *Cognition and Emotion, I*, 193–197.

Russell, J. A. (1991). Culture and the categorization of emotions. *Psychological Bulletin, 110*, 426–450.
Russell, J. A. (1997). Reading emotion from and into faces: Resurrecting a dimensional–contextual perspective. In J. A. Russell & J. M. Fernández-Dols (Eds.), *The psychology of facial expression* (pp. 295–320). Cambridge, UK: Cambridge University Press.
Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*, 145–172.
Russell, J. A. (2009). Emotion, core affect and psychological construction. *Cognition and Emotion, 23*(7), 1259–1283.
Russell, J. A. (2012a). Final remarks. In P. Zachar & R. Ellis (Series Eds.), Consciousness and Emotion Book Series. *Categorical versus dimensional models of affect: A seminar on the theories of Panskepp and Russell* (pp. 279–300). Amsterdam: Benjamins.
Russell, J. A. (2012b). From a psychological constructionist perspective. In P. Zachar & R. Ellis (Series Eds.), *Consciousness and Emotion Book Series. Categorical versus dimensional models of affect: A seminar on the theories of Panskepp and Russell* (pp. 79–118). Amsterdam: Benjamins.
Russell, J. A. (2015). The greater constructionist project. In J. Russell & L. Barrett (Eds.), *The psychological construction of emotion* (pp. 429–447). New York: Guilford Press.
Russell, J. A., Bachorowski, J., & Fernández-Dols, J. M. (2003). Facial and vocal expressions of emotion. *Annual Review of Psychology, 54*, 329–349.
Ryle, G. (2009). *The concept of mind*. New York: Routledge. (Original work published 1949)
Salmela, M. (2002). Intentionality and feeling. A sketch for a two-level account of emotional affectivity. *Sats: Nordic Journal of Philosophy, 3*(1), 56–75.
Salmela, M. (2006). True emotions. *Philosophical Quarterly, 56*, 382–405.
Salmela, M. (2011). Can emotion be modelled on perception? *Dialectica, 65*(1), 1–29.
Sartre, J. P., & Frechtman, B. (1948). *The emotions, outline of a theory*. New York: Philosophical Library.
Scarantino, A. (2009). Core affect and natural affective kinds. *Philosophy of Science, 76*, 940–957.
Scarantino, A. (2010). Insights and blindspots of the cognitivist theory of emotions. *British Journal for the Philosophy of Science, 61*(3), 729–768.
Scarantino, A. (2012a). Discrete emotions: From folk psychology to causal mechanisms. In P. Zachar & R. Ellis (Series Eds.), *Consciousness and Emotion Book Series. Categorical versus dimensional models of affect: A seminar on the theories of Panskepp and Russell* (pp. 135–154). Amsterdam: Benjamins.
Scarantino, A. (2012b). Functional specialization does not require a one-to-one mapping between brain regions and emotions. *Behavioral and Brain Sciences, 35*, 161–162.
Scarantino. A. (2012c). How to define emotions scientifically. *Emotion Review, 4*(4), 358–368.
Scarantino, A. (2014). The motivational theory of emotions. In D. Jacobson & J. D'Arms (Eds.), *Moral psychology and human agency* (pp. 156–185). Cambridge, UK: Cambridge University Press.
Scarantino, A. (2015). Basic emotions, psychological construction and the problem of variability. In J. Russell & L. Barrett (Eds.), *The psychological construction of emotion* (pp. 334–376). New York: Guilford Press.
Scarantino, A., & Griffiths, P. (2011). Don't give up on basic emotions. *Emotion Review, 3*(4), 444–454.
Scarantino, A., & Nielsen, M. (2015). Voodoo dolls and angry lions: How emotions explain rational actions. *Philosophical Studies, 172*(11), 2975–2998.
Schacter, D. L. (2004). Introduction. In M. S. Gazzaniga (Ed.), *The cognitive neurosciences* (Vol. 3, pp. 643–645). Cambridge, MA: MIT Press.
Scherer, K. R. (2001). Appraisal considered as a process of multilevel sequential checking. In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 92–120). New York: Oxford University Press.
Scherer, K. R. (2005). What are emotions?: And how can they be measured? *Social Science Information, 44*, 693–727.
Scherer, K. R. (2009). The dynamic architecture of emotion: Evidence for the component process model. *Cognition and Emotion, 23*(7), 1307–1351.
Searle, J. (1983). *Intentionality*. Cambridge, UK: Cambridge University Press .
Shand, A. F. (1920). *The foundations of character: Being a study of the tendencies of the emotions and sentiments*. London: Macmillan.
Shapiro, L. A. (Ed.). (2014). *The Routledge handbook of embodied cognition*. London: Routledge.
Skinner, B. F. (1953). *Science and human behavior*. New York: Macmillan.
Skinner, B. F. (1957). *Verbal behavior*. New York: Appleton-Century-Crofts.
Slaby, J. (2008). Affective intentionality and the feeling body. *Phenomenology and the Cognitive Sciences, 7*(4), 429–444.
Slaby, J., & Wüschner, P. (2014). Emotion and agency. In S. Roeser & C. Todd. (Eds.), *Emotion and value* (pp. 212–228). Oxford, UK: Oxford University Press.
Smith, C. A., & Ellsworth, P. C. (1985). Patterns of cognitive appraisal in emotion. *Journal of Personality and Social Psychology, 48*, 813–838.
Smith, C. A., & Lazarus, R. S. (1990). Emotion and adaptation. In L. A. Pervin (Ed.), *Handbook of personality: Theory and research* (pp. 609–637). New York: Guilford Press.
Smith, M. (1998). The possibility of philosophy of action. In J. Bransen & S E. Cuypers (Eds.), *Human action, deliberation and causation* (pp. 17–41). Netherlands: Springer.
Smith, M. (2010). Humeanism about motivation. In T. O'Connor & C. Sandis (Eds.), *A companion to the philosophy of action* (pp. 153–158). Oxford, UK: Wiley-Blackwell.
Solomon, R. (1976). *The passions*. New York: Doubleday.
Solomon, R. (1980). Emotions and choice. In A. Rorty (Ed.), *Explaining emotions* (pp. 251–282). Los Angeles: University of California Press.

Solomon, R. (2003). *Not passion's slave*. Oxford, UK: Oxford University Press.
Solomon, R. C. (2008). The philosophy of emotions. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (3rd ed., pp. 3–16). New York: Guilford Press.
Sorabji, R. (2000). *Emotion and peace of mind*. Oxford, UK: Oxford University Press.
Speisman, J. C., Lazarus, R. S., Mordkoff, A., & Davison, L. (1964). Experimental reduction of stress based on ego-defense theory. *Journal of Abnormal and Social Psychology, 68*, 367–380.
Spinoza, B. (1955). *The ethics*. New York: Dover.
Stephan, A., Walter, S., & Wilutzky, W. (2014). Emotions beyond brain and body. *Philosophical Psychology, 27*(1), 98–111.
Steuber, K. (2006). *Rediscovering empathy: Agency, folk psychology, and the human sciences*. Cambridge, MA: MIT Press.
Stout, G. F. (1899). *A manual of psychology*. New York: Hinds & Noble.
Stumpf, C. (1899). Über den Begriff der Gemüthsbewegung [On the concept of emotion]. *Zeitschrift für Psychologie und Physiologie der Sinnesorgane, 21*, 47–99.
Tappolet, C. (2000). *Emotions et valeurs*. Paris: Presses Universitaires de France.
Tappolet, C. (2010). Emotions, action, and motivation: The case of fear. In P. Goldie (Ed.), *Oxford handbook of philosophy of emotion* (pp. 325–345). Oxford, UK: Oxford University Press.
Teroni, F. (2007). Emotions and formal objects. *Dialectica, 61*(3), 395–415.
Thalberg, I. (1964). Emotion and thought. *American Philosophical Quarterly, 1*, 45–55.
Thompson, E. (2007). *Mind in life: Biology, phenomenology, and the sciences of mind*. Cambridge, MA: Harvard University Press.
Tomkins, S. S. (2008). *Affect imagery consciousness: The complete edition* (Vols. I–IV). New York: Springer. (Original work published 1962–1992)
Tooby, J., & Cosmides, L. (2008). The evolutionary psychology of the emotions and their relationship to internal regulatory variables. In M. Lewis, M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 114–137). New York: Guilford Press.
Van Kleef, G. A. (2009). How emotions regulate social life: The emotions as social information (EASI) model. *Current Directions in Psychological Science, 18*, 184–188.
Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. Cambridge, MA: MIT Press.
Velleman, J. (2001). The genesis of shame. *Philosophy and Public Affairs, 30*, 27–52.
von Scheve, C., & Salmela, M. (Eds.). (2014). *Collective emotions*. Oxford, UK: Oxford University Press.
Watson, J. B. (1913). Psychology as the behaviorist views it. *Psychological Review, 20*, 158–177.
Watson, J. B. (1919a). *Psychology from the standpoint of a behaviorist*. Philadelphia: Lippincott.
Watson, J. B. (1919b). A schematic outline of the emotions. *Psychological Review, 26*, 165–196.
Watson, J. B. (1925). *Behaviorism*. New York: Harpers.
Weiner, B. (1986). *An attributional theory of motivation and emotion*. New York: Springer-Verlag.
Whiting, D. (2011), The feeling theory of emotion and the object-directed emotions. *European Journal of Philosophy, 19*(2), 281–303.
Wierzbicka, A. (1999). *Emotions across languages and cultures: Diversity and universals*. Cambridge, UK: Cambridge University Press.
Winkielman, P. (2013). Unconscious emotions, psychological perspectives. In H. Pashler (Ed.), *Encyclopedia of the mind* (pp. 750–752). Thousand Oaks, CA: Sage Reference.
Winkielman, P., & Berridge, K. C. (2004). Unconscious emotion. *Current Directions in Psychological Science, 13*, 120–123.
Wittgenstein, L. (1953). *Philosophical investigations*. (Trans. G. E. M. Anscombe). Oxford, UK: Blackwell.
Worcester, W. L. (1893). Observations on some points in James's psychology: II. Emotion. *Monist, 3*, 285–298.
Young, P. T. (1943). *Emotion in man and animal: Its nature and relation to attitude and motive*. New York: Wiley.
Zachar, P. (2006). The classification of emotion and scientific realism. *Journal of Theoretical and Philosophical Psychology, 26*, 120–138.
Zagzebski, L. (2003). Emotion and moral judgment. *Philosophy and Phenomenological Research, 66*, 104–124.
Zajonc, R. B. (1984). On the primacy of affect. *American Psychologist, 39*(2), 117–123.

CHAPTER 2

The History of Emotions

Ute Frevert

The claim that emotions have a history might come as a surprise to those scholars who think of emotions predominantly as biological, chemical, neuronal, or cognitive phenomena. Those focused on such phenomena may assume that all feelings are innate and universal and can be encountered in any human being at any place and time. In recent years, historians have started to question this assumption. Alongside anthropologists and scholars of literature and art, they have identified a great variety of emotional concepts and expressions in different societies at different times. They have shed light on how language and culture set particular frames for experiencing emotions. Additionally, they have highlighted the fact that by tabooing certain emotions, societies render them invisible and, ultimately, obsolete. Conversely, emotions that are deemed positive and valued highly may become firsthand experiences for an increasing number of people.

This chapter introduces the reader to various aspects of how to deal with emotions in a historical perspective. It first provides an overview of the shifts that the concept of emotions underwent over time and in different regions of the world. It then examines how specific emotions have been defined, judged, and handled in different societies, offering a glimpse of the methodological problems faced by historians of emotions. Third and finally, it tackles the question of when and why historians became interested in the subject and what kind of stories they intend to tell.

What Are Emotions, Historically Speaking?

The term "emotion" is relatively recent. When English-speaking authors started using it after the mid-19th century, they parted from a semantic field that had been cultivated since antiquity. This field had been diverse in content as well as in regional scope, and it had included numerous words describing various bodily and mental states. In Sanskrit and Bengali, terms for emotions and thoughts, mind and heart were most frequently not differentiated. *Bhava*, for example, covered a wide range of emotional experiences, with connotations of perception, thought, and movement. Similarly, terms for cognition often implied feelings (McDaniel, 1995). In accordance to a perception of the world as fluid, the *rasa* theory, which was developed between 200 B.C.E. and 200 C.E., was based on the ayurvedic concept of the body as both physical and subtle. A *rasa*, which can be translated as juice or flavor, was thought to emerge in the subtle body as the outcome of a catalytic process. Aesthetic forms such as drama, dance, and poetry activated certain *bhava* (e.g., love, courage, disgust, anger, and pity) and transformed them into a purely aesthetic and transcendental *rasa*. Experiencing *rasa* thus served as "a preparation for, a sensibility to, and a cultivation of the emotional taste for divinity and supreme self-realization" (Lynch, 1990, p. 18; Pollock, 2012). Medieval devotional movements and social reformers later reinterpreted *rasa* as a mode of religious experience or *bhakti* (Reddy, 2012, pp. 223–289).

In China, Confucian philosophy was similarly uninterested in drawing a clear line of distinction between inner/outer, body/mind, and subjective/objective (Hansen, 1995). Living a harmonious life of *li* (ritual) and *jen* (goodness) entailed a set of social practices related to other people and one's ancestors. Emotions were thus "established, evaluated, and expressed in how we live" (Bockover, 1995, p. 174). They were not only thought to be motivationally indispensable, but considered to be important in themselves. A person who lacked the passions for the good clearly suffered from a deficiency in character. Since emotions were believed to be heavenly endowed, they were recognized as highly significant features of ethical life (Wang, 2008), although not quite as prominent as in Europe (Santangelo, 2003, 2007; Santangelo & Guida, 2006; Santangelo & Middendorf, 2006).

In the Western tradition, Greek philosophers used the term "pathos" when they examined emotional states such as pleasure and pain, fear and daring, and rage and hope. According to Plato, the human soul knew powerful *pathê* that energized the body and enabled it to expect pleasant or unpleasant feelings from a given object. Aristotle agreed with his teacher and stressed, as Plato had done, that human beings were to be educated from a very young age to feel pleasure and pain when appropriate (i.e., in relation to virtuous acts). Conceiving of the soul as the seat of passions, powers, and habits, he considered passions (e.g., "appetite, anger, fear, confidence, envy, joy, love, hatred, longing, emulation, pity") to be the primary movers of men. As such, they were virtue neutral. It was up to each person's powers and readiness to allow those passions to be felt, as much as it needed certain habits or virtues ("excellences") to deal with them in a praiseworthy and rightful manner (Aristotle, 1984, pp. 1744–1747).

An eminent philosopher and long-term tutor of Alexander the Great, Aristotle was not only concerned about individual ethics: Writing in the 4th-century B.C.E., he cared deeply about the political community and how it was governed. Public life in the *polis* depended on educated citizens who were not only able to lead a good life and engage in self-government but also well versed in the art of persuasive reasoning and discourse. In his *Treatise on Rhetoric*, he focused on how an orator's speech "stirs (their) emotions" and puts the audience "into a certain frame of mind." Pathos, like anger, pity, or fear, and their opposites, was thought to transform one's condition to an extent that judgment was affected (Aristotle, 1984, pp. 2155–2156; Gross, 2006. pp. 1–20).

Civic audiences in Ancient Greece, however, were not moved only by emotional persuasion: They also learned about pathos at the theater where they enjoyed plays, comedies, and tragedies alike. Here Aristotle strongly diverged from Plato's negative viewpoint. While Plato had cast a very critical eye on artistic mimesis since it allegedly drove people to indulge in orgies of passion, his student suggested that catharsis was a mechanism that generated the virtuous control of *pathê*. *Éleos* (sorrow, pity, compassion) and *phóbos* (fear, terror, scare) were not only evoked but brought into equilibrium. After experiencing those *pathê*, the audience was supposed to leave the theater in a purified and elevated state of mind, body, and soul (Aristotle, 1984, p. 2320).

Aristotle's writings on *pathê* offered philosophers a first glimpse of what might be called an ancient Western "theory of the emotions" (Cooper, 1996). Others have commented on how *pathê* figured in his moral psychology (Striker, 1996) and how he used them for "rational persuasion" (Nussbaum, 1996). For scholars of literature, his concept of poetic catharsis is particularly significant, especially since it had inspired early modern and modern theories and practices of theater (Belfiore, 1992; Munteanu, 2012). Yet historians have been reluctant to attribute excessive importance to a single author. Even though Aristotle is considered one of the giants on whose shoulders later generations of philosophers, theologians, and scientists could stand, it is far from clear to what extent his ideas and concepts provide adequate descriptions of what and how people in classical Greece actually felt (Chaniotis, 2012; Chaniotis & Ducrey, 2013). We return to this caveat in the section "What Kind of Emotions Matter When and for Whom?"

Aristotle was succeeded by another school of philosophical thought. The *Stoa* conceived of *pathê* as propositions and judgments that moved the soul in a certain way and direction. Whereas joy and pleasure elevated the soul, pain forced it to shrink and tighten. Fear caused it to recoil, while desire let it strive. Stoic philosophy was well aware that such *pathê* played an important role in people's lives, and they were not generally against them. Nevertheless, they urged their contemporaries to distinguish between good and bad *pathê*: indulge in joy but keep away from lust; be prudent instead of fearful; fight desire in favor of a sensible will. According to the Stoics, *pathê* should not be radically suppressed; instead they had to be well comprehended and processed. Wise men had to liberate themselves from the impulses of *pathê* in order to achieve *apatheia*, complete impassivity and peace of mind (Graver, 2007).

Stoic philosophy overall bore a great impact on Roman thought and literature. In his study on rage, Emperor Nero's teacher Seneca warned against the bad outcomes of an *adfectus* that reduced man's freedom of action and reasoning. He also advised his student to treat his future subjects with mild clemency rather than with haughty arrogance, and praised a conduct of life that sought serenity and harmony by tempering down passions and affections. As far as this last point was concerned, his teachings proved relatively ineffective as they did not prevent Nero from becoming one of the most voluptuous and violent statesmen in Ancient Rome (Braund & Gill, 1997; Sorabji, 2000).

What Seneca translated as *adfectus* from the Greek pathos and what Cicero called *perturbationes*, became of major concern for early Christian thinkers. As much as they criticized the notion of desire and associated it with carnal sin, they did not altogether condemn *passiones* and *affectiones*. The Stoic ideal of *apatheia* was not what human beings should pursue. Although *passiones* were thought to be signs of man's fallen state (and had thus been absent in paradise), they were considered God given. According to St. Augustine of Hippo, Christians had a right to *affectiones* of fear and desire, and grief and joy as long as their love of God was fairly ordered. But the human soul, as the seat of reason composed of intellect, will, and morality, could also become sinful and disordered and give root to evil passions such as jealousy, anger, envy, and licentiousness. This was seen as a willful process, depending on *voluntates* that turned away from God and focused on earthly desires (Dixon, 2003, pp. 29–35; Knuuttila, 2004).

Building on St. Augustine's writings but also taking into account Aristotle's work (that had been reintroduced to Europe, after long centuries of negligence or highly selective reception through Arabic translations) the work of the Franciscan monk Thomas Aquinas emerged during the 13th century as an impressive synthesis of former knowledge about affections and passions. Like St. Augustine, he chose *passiones* as a collective term defining them as active sensual appetites accompanied by a bodily transformation. Since *passiones* belonged to the sensitive part of the soul (*anima*), they occurred naturally and were neither good nor bad. Will did not have an original stake here, but was essential in order to mold, regulate, and channel the *passiones*. If reason held them in proper order, they were considered virtuous; if not, they led to sin (Dixon, 2003; Miner, 2009; Lombardo, 2011; Rosenwein, 2006).

Writing in Latin, Christian authors such as Augustine and Aquinas framed basic concepts of how to think about what people felt. Those concepts continued to be used by Europeans until the 18th century. When in the 17th century René Descartes took a fresh look at what he called *les passions de l'âme* (the passions of the soul), he claimed that they originated from so-called animal spirits (i.e., movements of the soul that reacted to outer impressions and, through the nerves, caused bodily organs to stir). Passions—defined as *des perceptions ou des sentiments ou des émotions*—thus had a somewhat exterior status in that they incited and predisposed the soul to desire certain things and keep away from others. By assuming a dynamic connection among the soul (located in the center of the brain), its spirits (fine matter of blood), and the body agitated by that matter, Descartes conceived of passions largely as "passive perceptions of bodily motions" (James, 1997, p. 94).

During the Age of Enlightenment, those bodily motions received increasing attention by medical doctors and scientists. While medieval thinkers considering passions as movements of the will had neglected the body and its physiology, French *médecins-philosophes* discovered the body as the seat of sensations and ennobled it as a mechanism of functional perfection (Vila, 1998; Williams, 1994). At the same time, the concept of the soul was widened so as to encompass passions and affections as a separate and independent faculty. While Christian thought believed the soul to comprise knowing/understanding and willing, 18th-century continental philosophy added a third faculty: feeling. According to Immanuel Kant, *Gefühl* was composed of affects and passions distinguished both temporally and morally. While affects were regarded as short-term eruptions of strong and immediate desires, passions appeared as long-term states of feeling that left room for evaluation and judgment. What mattered most, however, was that feelings were granted a proper foundational status and attributed independent causal power (Newmark, 2008).

This resonated well in an age of sensibility that had elevated feelings to the status of crucial tokens of humanity (Barker-Benfield, 1992). In 1765, the

French *encyclopédistes* held *la sensibilité* to be the mother of humanity. Without feelings, men would act like machines bereft of joy and sorrow, pleasure and pain. Although certain feelings might be more harmful than others, they all contributed to rendering human life exciting and worthwhile. Even passions that entirely consumed a person's heart and mind could eventually promote both his or her own happiness and the well-being of society at large (Frevert, Scheer, Schmidt, Eitler, Hitzer, et al., 2014, pp. 12–31).

Despite the fact that contemporaries still distinguished between various kinds of feelings and used different words for different states, such as "appetite," "sensation," "sentiment," "desire," "affect," and "passion," the 19th century gradually saw the vocabulary of feeling become more homogeneous. This was due to the triumph of science and its attempts to neatly classify and objectify empirical phenomena. In the Anglo-Saxon world, "emotion" turned out to be the overarching category, not without shedding most of the former vocabulary's diversity and subtleties (Dixon, 2003). When the American physiologist and philosopher William James posed the question "What is an emotion?" in 1884, he answered it by stressing the prevalent importance of the body. In his view, emotions were but perceptions of physiological disturbances. Those disturbances or changes occurred mainly on an involuntary and instinctive basis; they were processed through the sense organs that sent impulses to the brain, which then sent currents running down to muscles and viscera, and back again. Once those currents returned to the cortex, they were then perceived as emotions (i.e., they were felt rather than apprehended; Calhoun & Solomon, 1984, pp. 127–141).

In this sense, emotions were regarded as "a set of morally disengaged, bodily, non-cognitive and involuntary feelings" (Dixon, 2003, p. 3). And even though most 20th-century psychologists did not fully agree with all aspects of James's definition, they largely accepted the dichotomy between cognition and emotion. This was the price they paid for secularizing emotions and emancipating them from the Christian discourse on sinful vice and godly virtue. As much as this served the purpose of liberating them from moral judgment, it helped to establish a new distinction between cognitive reasoning and emotional feeling. Demoralization went hand in hand with somatization, and somatization signified universalization (Frevert, Scheer, et al., 2014). The notion that the body was an unchanging biological entity independent of culture implied that its movements and functions pertained to all human beings. Emotions thus acquired a universal character, as argued by Charles Darwin in 1872 and confirmed by Paul Ekman in 1998 (Darwin, 1998).

What was lost during this process of somatization and universalization was the idea that feelings comprised a wide range of different states, sensations, and perceptions. They not only varied in terms of temporality and intensity; they also differed in the way the body was affected or was thought to play a major or minor role. Furthermore, pre- and early modern concepts of passions and affections had emphasized social diversity. A person's feelings were supposed to depend on age, gender, social class, and ethnicity. Social contexts and religious beliefs were considered important framings of what could actually be experienced as passion, desire, appetite, or sentiment. The same held true for climatic conditions and physical habits as they were enshrined in certain professions and ways of life (Honegger, 1991). Unlike the climate, those habits could be altered *ad libitum* and were thus open to social intervention and education. In their wake, passions, affects, and sensations could change too.

Experimental psychology, as it developed and boomed from the late 19th century onward, tended to forget about the plasticity of emotions. Even when scientists acknowledged the "great varieties of human personalities and societies" and attributed them to the "innate plasticity of the affect mechanism, which permits the investment of any type of affect in any type of activity or object" (Tomkins, 1968, p. 219), they were far more interested in the mechanism itself than in its variability. Drawing heavily on evolutionary biology, mainstream psychologists disregarded differences in time and space and discarded both earlier concepts and non-Western traditions. There were but a few critics who questioned the hegemonic epistemology and alluded to "the possibility that the very objects of psychological discourse, and not just opinions about them, have changed radically in the course of history" (Danziger, 1990, p. 336).

As the short recapitulation of those opinions has shown, this possibility seems quite real. As much as reflections on, and perceptions of, the human body and soul have changed significantly throughout the last 2,000 or 3,000 years, so have concepts of feelings, passions, and affects. From the present standpoint this cannot be dismissed as false or "unscientific." Developmental psychologist Jerome Kagan (2007) recently reminded his colleagues that former emotion knowledge tended to be far more "robust" than what current experimental science had discovered (p. 1). Furthermore, this knowledge constructed its own reality by genuinely shaping what human beings could and would experience as emotional states and acts. If people, as the Confucian tradition held, did not distinguish between inner feelings and outer expressions, they were likely to take those expressions at face value. Conversely, modern West Europeans who grew up with a strong sense of the inner self might conceive of emotions as hidden states unreadable to anyone beyond the feeling person.

The claim that cultural diversity can shape concepts and experiences of "emotions" poses critical questions to the new discipline of affective neuroscience. Self-evidently, the discipline has little to say about the history of emotions since experimental analysis depends on living objects. But it might and should be open to a more nuanced and culturally informed inquiry into people's neuronal setup. If the brain is both biologically and culturally defined and possesses a high degree of plasticity, as neuroscience keeps reiterating, cultural traces might be identifiable on neuroimaging. Seeking help from anthropologists who have done extensive surveys on the social and cultural mapping of emotions in different parts of the world (Plamper, 2015), neuroscientists could develop new insights into how those mappings are reflected in the way that body and brain cells communicate.

What Kind of Emotions Matter When and for Whom?

Since the topic of emotions was first tackled in a systematic and explorative way, experts have come up with a wide range of different enumerations and taxonomies. Many present-day psychologists adhere to the concept of six or eight basic emotions that seem to be universally recognizable in people's facial expressions. The *rasa* theory applied in Indian drama, music, and theater knows eight to nine emotions that are rather distinctively expressed in facial gestures and less easily identifiable by non-Indian audiences. Descartes stressed the existence of six "primitive" passions of the soul (wonder, love, hatred, desire, joy, and sadness) from which all others derived their origin, while Spinoza recognized only three "primary emotions": pleasure, pain, and desire (Calhoun & Solomon, 1984, pp. 66–70, 79–85).

The manner in which emotions were classified and grouped together depended largely on the way in which they were explained and judged upon, as well as on the social practices and institutions to which they pertained. As a result, emotions were by no means distinct, stable, and finite entities. Whether and how they were experienced depended on their relative status in a given society. This status in turn was derived from the weight and impact of institutions that gave emotions meaning and credit. What love was and how it felt, for example, cannot be understood without knowing about the institution of marriage vis-à-vis nonmarital relations. What men felt when they invoked notions of pride and honor needs to be studied by examining, among others, institutions such as the military and their social ramifications. In a similar vein, pious emotions and practices of religious enthusiasm have to be contextualized as part of an emotional topography that reflects the relative importance of (organized) religion. Such investigations demand more than an interest in the history of philosophy or science: They need to be based on a thorough knowledge of social, economic, cultural, and political history in order to maintain a grasp of the complex compositions, meanings, and practices of emotions. To proceed on a comparative scale that includes different societies in time and space poses even more difficulties, and is still far beyond the means and linguistic abilities of most historians. Having said this, the following paragraphs focus on a small number of emotions that have already attracted a certain degree of historical attention and can thus be discussed with reference to their diachronic and synchronic plasticity.

Acedia/Melancholy/Depression

There is much talk concerning depression as the number one emotional disturbance in contemporary Western societies, with non-Western ones following at a fast pace. At the same time, conscious efforts are made to distinguish depression from other emotional states such as burnout, generally attributed to rising levels of stress and increased demands for overefficiency, self-optimization, and self-maximization in postmodern cultures. Yet there is no clear-cut definition of depression, either as an emotional state or as a biochemical description of a person's lack of self-confidence and initiative. Since the term entered the psychological lexicon in 1905, it has had a breathtaking and self-defining career. Over the years and decades, it has been recognized as a mental illness that affects up to one in five people at some point in their lifetime, at least in Western countries. Its symptoms include loss of interest or pleasure, sadness or barely any emotion, feelings of fatigue, guilt, helplessness, anxiety, and fear, often for little or no reason. The direct cause is nowadays attributed to neurobiological disorders with the level of neurotransmitters being either too high or too low (Lawlor, 2012).

Reading through the list of symptoms, one feels reminded of early modern descriptions concerning the state of melancholy. Melancholy used to be a favorite condition of mind and soul widely discussed by theologians, philosophers, and medical doctors. In antiquity it was thought to be caused by an excess of black bile, and was accompanied by sadness, low levels of enthusiasm, and no inclination to become actively involved. The German name was *Schwermut*, meaning that the *Gemüt* (which might be translated as soul) carried a heavy (*schwer*) load. Melancholy could express itself both through physical and mental symptoms, and was viewed as an internal state with ambiguity regarding its characteristics. In a famous engraving by Albrecht Dürer titled *Melencolia I*, dating from 1514, the female allegory was portrayed in a pensive mood. Instead of being overcome by anxiety, weakness, and inertia, she seemed to be immersed in a state of expectation, which in the 16th century was associated with creativity and ingenuity. During the early 17th century a cult of melancholy emerged in Britain; similar movements could be witnessed in late 18th-century Germany and during Romanticism (Clair, 2005; Radden, 2000; Schings, 1977).

While melancholy was thus supposed to be in close relation to an elevated state of self-reflection, *acedia* was not. In ancient Greek, acedia meant a kind of listlessness, of not caring or not being concerned with one's position or condition in the world. An English translation would be "sloth." In antiquity and during the Middle Ages, acedia was particularly noted as a problem among monks and other ascetics who led a solitary life. While religious passions ranked foremost in Christian, especially monastic life (Boquet, 2005; Nagy, 2000; Nagy & Boquet, 2009), "the sorrow of the world," in Thomas Aquinas's definition, was in sharp contrast to the kind of "spiritual joy" resulting from a person's close union with God. Acedia was thus perceived as a demonic intervention that could strike at any time, causing tedium or boredom. An overall laziness or refusal to work, a temptation that frequently befell the monastic at rest, was closely associated with tedium. Another characteristic of acedia was the lack of the desire to read or pray (Crislip, 2005; Irvine, 1999).

On the surface acedia, melancholy, and depression seem to share a number of characteristics. Yet there are also clear differences. First, the symptoms are not alike. Premodern sources talk about acedia's corporeal signs that range from mere sleepiness to general sickness or debility, alongside several more specific ailments: fever, pain in the limbs, and weakness in the knees. Second, and even more important, the interpretation of those signs was quite peculiar and would not fit into today's mental map. According to ancient beliefs the bodily signs did not just signal a certain state of mind: Instead, they demonstrated the presence of a demon, some external influence that invaded the body and transformed it for the worse. If the soul did not have the strength and willpower to cast off those influences and protect the body, one would fall prey to demonic illness. Somatic signs of the demon's activities thus meant that the spirit was too weak to fight and allowed the presence of sin and vice. Acedia ultimately placed guilt on the afflicted individual: his or her dedication to God was simply not strong enough. Consequently, acedia was considered a mortal sin, an affront to both God and the religious community.

This clearly affected the way in which people experienced and felt about it. For a 13th-century monk or nun, committing a mortal sin practically equaled a death sentence and was accompanied by profound soul-searching and painful feelings of personal guilt. By contrast, a 17th-century writer who felt his heart to be heavy had a completely different self-perception, which shaped his being affected by melancholy. Similarly, a person on antidepressants in the 21st century is equally far away from concepts of mortal sin and ideas about creative inspiration and apprehension. Knowing about neurotransmitters and synapses allows for an approach that differs from pondering over temperaments and fluids, demons, and sinning against God and community.

The general argument here is that the way in which a feeling state is labeled, framed, and contextualized deeply influences the way in which it is felt. Relating similar symptoms to diverse systems of reference (magic, religion, arts and sciences, neurobiology) affects the value attributed to them. This in turn has repercussions on the appraisal and experience of those states. What people feel and how they feel it is thus highly dependent on complex "emotional scripts" (Kaster, 2005) provided by social institutions. As these institutions undergo historical changes, their scripts and related emotional practices change too. Historians have only just started to investigate those changes—for instance, anger (Harris, 2001; Rosenwein, 1998; Stearns & Stearns, 1986) and fear (Bourke, 2005; Laffan & Weiss, 2012; Plamper & Lazier, 2012).

Pity and Compassion

An integral part of Aristotle's concept of tragedy and catharsis, pity might seem to be an "ancient" or "classical" emotion. But is the *éleos* that a 5th-century B.C.E. Athenian felt, identical or similar to the pity that a 20th-century Englishwoman might have experienced when watching a dramatic performance on stage (Wiles, 1997, p. 6)? Obviously, this question cannot be answered empirically. Historians, however, have cast serious doubt on the longevity of a general sense of pity by contextualizing literary and archaeological sources. As David Konstan (2001) writes, even in Greek and Roman antiquity, pity was not "a simple or uniform concept" but a complex emotion with numerous aspects. Moreover, it "underwent fundamental changes" over the course of a millennium (p. 1f). Pity was involved in the ancient practice of appealing to the judge or jury—something that is virtually unheard of in current judicial practice but was strongly endorsed by classical handbooks of rhetoric. Defendants asking for pity had to plead innocent, since pity depended on merit. Only those suffering from an undeserved misfortune could expect pity, which is why defendants in ancient systems of justice tended to affirm their innocence instead of expressing remorse or requesting pardon and forgiveness. Pity also relied on the distance between a suffering person and those who observed the suffering. While moral philosophers during the 18th century stressed that pity was a sentiment of sympathy toward a fellow human being, Aristotle claimed that "people pity just those things happening to others that they fear [may happen] to themselves" (pp. 73, 128–136). Furthermore, ancient pity was structurally connected to power: Only those who were in a position to show pity (and grant clemency) could afford it. In this vein, it was usually the fate of elders or women to beg for pity, and it was the powerful who either pitied or not.

Not each and every kind of suffering warranted pity. No one was supposed to feel pity for captured, tortured, and killed enemies. Neither slaves nor Christian martyrs deserved pity in ancient times. Later on, religious communities that preached the gospel of brotherly love and love of neighbor found no difficulty in denying it to those who did not belong and believe. This attitude only started to change during the 18th century. Playwrights reviving the Aristotelian concept of catharsis discovered pity as the most natural and most moral human faculty that should be cultivated by theater, literature, and music (Schings, 1988). Philosophers who sought a moral foundation for modern civil society praised pity and sympathy as counterforces of self-love and egoism. Novelists were eager to devise plots and stories that would elicit the readers' pity, inspiring them to become sensitive and sensible citizens. At the same time, hundreds of thousands of European and North American men and women campaigned for the abolition of slavery and the liberation of slaves. Spurred by an "imagined empathy" (Hunt, 2007, p. 32) and using a language of love for those "brothers" and "sisters" whose freedom and human dignity were trampled upon, they engaged in an unprecedented—and ultimately successful—struggle against the slave trade and the institution of slavery (Frevert, 2011, pp. 153–175).

Pity and compassion thus traveled across the Atlantic in both directions, connecting people from different regions, nations, and religions. This was enabled by a growing awareness of the world's integrative economy that delivered the products of slave labor (e.g., Caribbean sugar) to British tearooms. The spread and extension of compassion thus followed the increasing globalization of trade. Instead of being reserved for family members, close friends, neighbors, and fellow citizens, it began to encompass those whom one had never met and would never meet but whose fate could be imagined and felt as an all-human disaster. Geographical and social distance, however, had to be bridged by narratives. The media revolutions of the 19th and 20th centuries (with newspapers, radio, TV, Internet) generously provided those stories and, most important, added visual proofs of human suffering. "Distant suffering," as sociologist Luc Boltanski (1999) called it, thus became a prime object of global compassion yielding billions of dollars in human aid and donations (Wilson & Brown, 2009).

Tracing the history of pity/compassion as an ever more powerful and encompassing feeling thus cannot but acknowledge the deep impact of modern sensibilities that clearly departed from older and far more restricted notions of benevolence, charity, and neighborly love. Those sensibilities, however, were charged with cultural and political meaning. As much as they had to be taught, learned, and cultivated, they became part of a social capital that distinguished the haves from the have-nots. Colonial policies offer a glimpse as to how the social capital of compassion could be turned into a political asset. Emotional terms were often employed in order to justify the European urge to colonize non-European peoples: It was compassion for the misery suffered by Africans or Asians that rendered necessary the European presence among them (Rai, 2002). Even postcolonial humanitarianism frequently used this language of superiority, thereby stabilizing the close link between compassion and power and between suffering and powerlessness.

A global history of pity/compassion—which does not yet exist—would thus have to be aware of the structural asymmetry between those who pity and those who are pitied. Departing from the hitherto usual focus on new sensibilities toward suffering as they emerged and expanded during the 19th century, history should proceed further, concentrating on the men and women who were at the receiving end: How did they feel about the compassion they attracted, and how did they deal with it? Did gender make a difference? Could religion build bridges, or did it serve as a further obstacle? And what about those for whom this worldwide compassion affair was altogether irrelevant? We know a lot about European and North American humanitarian policies—state and nonstate—but we know far less about other parts of the world, other regional elites. Did they and do they share Western sensibilities and related practices, or did they and do they differ, and in what ways?

A Short Note on Methodology

Regarding emotions as practices is of the utmost importance to any history of emotions that aims to move beyond philosophical ideas about definitions and lists of emotions and their differentiation from allegedly nonemotional cognitive procedures. By this there is no intention of dismissing those ideas as mere thought material. In one way or another, they were indeed able to influence people's opinions, judgments, and behavior. The ancient Indian theory of *rasa*, for example, has had a long-lasting influence on Indian music, theater, and poetry, and even contemporary Bollywood movies. Aristotle's notions of pity as developed in his writings on aesthetics made a huge impact on 18th- and 19th-century European theater, as mentioned earlier. Similarly, his elaborations on emotional rhetoric continued to inspire modern orators and demagogues. In a similar vein, early Buddhist theories on empathy and compassion are still popular today and have been brought into a mutually fruitful dialogue with Western psychology (Dalai Lama & Ekman, 2008).

All these examples highlight a crucial point: The history of emotions is not so much a history of words and concepts, but of practices (Scheer, 2012). Words and concepts are interesting only to the extent that they inform, guide, and frame emotional practices, be it in art, prayer, and meditation, or in the diverse kinds of economic, political, and social communication. It is those practices that give emotion words their historically precise meaning. Without them, emotion words like "love," "hatred," "joy," "anger," "envy," "shame," and so on might claim an ahistorical presence thus confirming the conviction of many contemporary psychologists that emotions or affects are timeless as well as spaceless.

But how can historians discover and analyze emotional practices? Can they ever do without words? Do not words—printed on gravestones or monuments, written down in diaries and letters, transcribed in parliamentary minutes and legal documents—have to guide our search for practices? The answers are clear: Evidently, historians cannot conduct their research without relying on written sources, and so their work has to start with emotion words. As the literary critic Jean Starobinski (1966) commented: "For the historian, an emotion exists only beyond the point at which it attains a linguistic status. No facet of an emotion can be traced before it is named, before it is designated and expressed" (p. 81). This is correct. But what about Starobinski's next sentence: "It is not, then, the emotion itself which comes before us; only that part which has passed into a given form of expression can be of interest to the historian" (p. 81)?

There are two objections to this claim: First, what does the author mean by "the emotion itself"? He seems to imply that there is something beyond the expression, a kind of inner essence hidden and possibly unknown to the self. Such a distinction between a preconscious state of feeling and its defining expression is, however, highly dubious. On the one hand, it tends to overestimate the degree of consciousness that accompanies the expression of a feeling; on the other hand, it underestimates the constructive impact of that process. Expressing an emotion is a creative act: It bestows meaning on what is felt by labeling it and integrating it into a shared lexicon of understanding. To give an example: A person might feel a vague unease. But only after finding it a name (anger, shame, disgust etc.), is the person able to communicate it to him- or herself and others. Identifying the feeling means defining it, relating it to a cause, and acting on it. All this has a huge transformative effect on the initial feeling state by instantly giving it power and direction. Therefore, it seems futile as well as unnecessary to draw a clear line between "the emotion itself" and its expression. Such distinction tends to be counterfactual in that it overestimates the emotion at the expense of the expression. Instead, we should consider the expression as emotion *tout court* and not reduce it to the external part of something much greater that unfortunately does not "come before us" so that historians can never reach it.

A second objection to Starobinski (1966) concerns his implicit assumption that the "given form of expression" is always words. As argued earlier, words surely matter when it comes to labeling and thus defining an emotion. They set limits to what can be felt; at the same time, they offer opportunities to connect this feeling with other ones that are semantically related. But linguistic evidence does not reveal the whole story. The language of the body through mimics and gestures also contributes to that story, and so do spatial arrangements and material objects. Words are spoken in a particular context, and it is this very context that gives them meaning and communicative power. They are part of complex social practices, and even they themselves can be defined as practices. As the philosopher J. L. Austin (1962) famously explained in his theory of speech acts, we can "do things with words." To say "I love you" does not only define my feelings, but also makes suggestions about my current and future desires and related behavior. It might be an act of confession meant to initiate a chain of further communication. Or it might give confirmation to a relationship that has already been established but undergoes a period of doubt and crisis. In any event, it functions, in Austin's terms, as a "performative utterance"—or, in historian William Reddy's (2001) terms—as an "emotive," moving far beyond mere description and statement.

Furthermore, the word "love" implies promises and invites expectations of future practices that are firmly rooted in specific cultures and depend on historical circumstances. This is what renders emotional practices so important. If historians only focused on emotion words, as suggested by Starobinski (1966), they would miss the point. Emotion words lack a fixed meaning or status. They rather derive their meaning from the practices that they form part of. Those practices usually take place under particular social, cultural, political, or economic conditions that set limits to how emotion words can be understood and interpreted by those who speak, listen, and act. When present-day teenagers in the United States finish their phone calls to friends or family with the ubiquitous phrase "I love you," they say and mean different things than when they say it to the one they are attracted to. In other cultures, teenagers sometimes alter the phrase slightly in order to make space for different feelings labeled by the same word.

That love among friends might be different from love among lovers is not a new discovery. Since the late 18th century, when contemporaries praised both forms of love as the ultimate proof of upper- and middle-class sensibility, there have been numerous attempts to define each kind on its own terms. Although those emotional bonds have a lot in common, they were and still are linked to altogether different practices and aims. This shows once more that emotion words are not sufficient for historical research. Although the word "love" (or its equivalent in other languages) has been in use for a long time, we should not assume a stable, unchanging meaning (Orsini, 2006). The love that a medieval knight felt for his beloved was, presumably, quite different from the love that a 20th-century Indian stockbroker and his wife experienced for each other after their marriage had been arranged by their respective families. Since love was framed by different expectations and cultural scripts, it was similarly performed and acted upon through different practices and habits.

Shame and Humiliation

With regard to emotional practices, shame and shaming offer a highly instructive example. Shame is generally regarded as a social or moral emotion that is instigated by the awareness of having violated a social norm or moral law. In modern Western societies, shame tends to be private and individualized: A person feels ashamed once he or she realizes that he or she has done something of which others (whom the person cares about) would strongly disapprove if they knew about it. Shame can also occur when one fails to conform to one's own moral guidelines. One might even feel ashamed for someone else's embarrassing behavior.

Although shame depends on cognitive procedures—a moral law or social norm has to be known and remembered before it becomes violated—it is accompanied by certain physical signs that seem to be remarkably universal: People who are ashamed usually blush, and they lower their head and eyes. Describing their emotional state, they talk about wanting to disappear from the face of the earth. This again testifies to shame being a social emotion that involves others as witnesses, commentators, and guardians of moral/social standards.

But shame is not an automatic response to a certain kind of behavior. It is learned from early childhood, taught by adults, institutions, and the media. Parents demand children to feel ashamed if they have misbehaved. Teachers at school do the same and use shame sanctions as a way of punishing a student's deviance. Children's books published in increasing numbers from the 19th century onward describe how their young heroes experience shameful situations and suffer the consequences. Advice manuals and self-help literature inform adolescents and adults about how to avoid shaming others and how to react when they witness such behavior (Frevert, Eitler, et al., 2014). More recently, films and videos posted on the Internet provide ample evidence of shaming acts and their meaning for those who participate in them.

Shame thus is a feeling that needs education and cultivation. Before one can experience it, one has to learn the rules and their importance. Those rules are by no means universally valid. Societies differ greatly as to what they consider shameful behavior (in most Western societies spitting in public, or in India blowing one's nose in public—and not vice versa!). But they also differ internally, for instance, by setting different rules for men and women. Until the latter part of the 20th century, most European and North American girls grew up with a sense of bodily shame that their brothers never had to share. Girls were taught that it was shameful to expose certain body parts, and, later in their lives, to engage in premarital sex. An illegitimate child brought shame over the mother and the family (including the child); it often led to the "fallen woman" being cast out and having to move away. According to the official mantra, women's shamefulness served as a cornerstone of moral decency and social stability. Shameless women were women without honor and deserved public contempt.

This sheds light on deliberate acts of shaming, such as disdainful looks, derogative comments, and exclusion from "good society" that was reserved for women with children born out of wedlock. But shaming practices usually start much earlier. When mothers or fathers tell a child to be ashamed ("Shame on you") in a reproachful and authoritative voice, they can trigger a chain of reactions that eventually results in the very feeling to occur. For generations, school teachers developed elaborate practices of shaming those students whom they thought guilty of unruly behavior: They had them wear a donkey's hat, or, more mildly, had them stand in a corner of the classroom with their back to the other students. Exposing pupils in such a humiliating manner and making them the object of public attention and, possibly, *Schadenfreude*, was considered a more effective punishment than giving students a simple flogging or forcing them to stay behind after school.

Such shaming practices have only recently become obsolete. Under the battle cry "shame is over" (Meulenbelt, 1980; Millet, 1975), the second wave of feminism successfully fronted the shame verdict issued against women who had transgressed the strictly prescribed gender roles. Pedagogues warned that placing children and adolescents in a shameful position and making them the target of collective ridicule was not only counterproductive, but also reduced their sense of self-esteem and impinged upon human dignity. More often than not, those practices produced the opposite of what was intended: instead of feeling shame about what he or she had done, the shamed person harbored resentment against those who had inflicted shame on him or her, and openly rebelled against what the person perceived as humiliating.

However, criticism of shaming as a pedagogical tool was not universally accepted. As a recent BBC documentary showed, shaming practices continue to be used in Chinese elementary schools. In one incident, a little boy who had not taken good care of his eraser was reprimanded by his teacher in front of his classmates. As a shame sanction, he was made to wear a torn sweater. At the end of the day, he was allowed to take it off, and in turn promised to never be negligent about the eraser again. So the class welcomed him back, and the whole process was celebrated as a successful move to morally correct and reintegrate a trespasser (Chinese School, 2008).

The Chinese teacher obviously did not consider her sanctions as humiliating for the little boy. Rather, she intended to shame him in front of his peers in order to enforce the standard model of a good student's behavior: Take care of your study tools and chores, and be a competent and reliable member of the school community. Singling him out and ostracizing him for a day (while wearing the torn sweater) was supposed to make him feel lost and lonely, which was then succeeded by the heartwarming experience of returning to the community. The lesson for the boy was that he should feel ashamed about his misdemeanor, and that he should never repeat it or else he would suffer shameful exclusion.

Such tactics would no longer be endorsed in the Western hemisphere, where shaming has lost currency, both in schools and in the wider public. As explained earlier, shaming is generally held to be a violation of human dignity and the duty of respect. In highly individualistic societies that put personal autonomy first and community values second, public shaming seems no longer acceptable. Instead, it is judged as an act of humiliation, of degrading a person below the level of dignity that every human being deserves by right.

Europe's past cultural landscape, however, had been entirely different. For many centuries, public shaming had been a staple in local jurisdiction. Each town had stocks or a pillory where petty criminals were held for a few hours or even days. Placed in the marketplace or on crossroads, pillories were often elevated on a platform so that the gathered crowd would be able to watch the offender. The idea behind this was to publicly shame someone who had brought shame upon him- or herself by failing to comply with social norms and laws and thus insulting the community to which he or she belonged. The offender had to endure public contempt and ridicule, being exposed to the townsfolk in a demeaning, helpless, and uncomfortable position, without, though, being excluded from the community permanently. Meant to deter others from committing a similar transgression, the pillory served as a short-term punishment, which, unlike branding, did not leave any visible marks. Even if people remembered the incident, it did not match the exclusionary effect of the scarlet letter "A" (for adultery) in Nathaniel Hawthorne's 1850 novel (Nash & Kilday, 2010).

Shame sanctions thus particularly suited a society that spelled "community" with a capital "C" and placed individuals under its command. The more people emancipated themselves from that command claiming personal autonomy and independence, the more shame receded from the public interest. The new language of human rights and dignity that started to be spoken from the 18th century and, with ever greater force, after World War II, identified shaming as a practice of top-down humiliation. By linking humiliation to power and hierarchy, it was judged as incompatible with democratic practices and civic equality. Humiliation was the predicament of slaves at the hands of their masters who treated them in a disdainful manner. Humiliation was employed when state anti-Semitism as practiced by the National Socialist regime forced Jews to wear the yellow star or clean public toilets with their toothbrushes. Humiliation was involved in instances when the quest for equal and respectful treatment was denied. In this vein, women talk of the humiliating experience of being raped, and homosexuals have long stories to tell about humiliating homophobic slurs and assaults.

Humiliation is therefore closely associated with the concepts of human rights and individual dignity—concepts that were basically nonexistent in premodern societies and are still not popular in countries such as today's China. Shaming, by contrast, draws on the concept of a community or group whose norms and values have to be reinstated once a member of that group or community has violated them by offending his or her peers. Even though both practices might occasionally appear similar, sharing certain traits (e.g., ridicule), they follow a different logic and are structured by a different language. Consequently, they produce different emotions: Feeling humiliated is not the same as feeling (a)shamed. Feeling humiliated (as a slave, Jew, woman, homosexual, etc.) has different roots and calls for other actions compared with feeling shame (about one's own or someone else's offense).

Historicizing Emotions: A Political and Cultural History

Despite some initial attempts (Miller, 1993; Williams, 1993), the history of shame and humiliation has not been written yet—except, of course, for Norbert Elias's (2000) seminal study of *The Civilizing Process*. First published in the late 1930s, Elias's book presented a narrative of European history that deliberately linked sociogenetic and psychogenetic developments. He argued that state building in early modern Europe went hand in hand with installing stricter norms of self-control. Since the state monopolized physical violence, citizen subjects could form societies engaging in peaceful competition. Faced with increasing social differentiation and rising levels of interdependence, those societies were keen on coordinating and fine-tuning human behavior. In its wake, people's affective apparatus gradually changed so as to incorporate more restrained modes of conduct and interaction. Instead of giving in to spontaneous desires and strong affects, human beings learned to hold back, think twice, and reflect on the consequences of their actions. This is what Elias called "rationalization" and attributed it to the European nobility whose members transformed themselves from fierce warriors and knights into polite and polished courtiers from the 16th century onward.

During that transformation, shame thresholds were exponentially raised. Manners (concerning for instance, spitting, defecating, and cursing in public) that had been considered normal and acceptable in earlier times were now turned into something utterly despicable and shameful. As the fear of losing face, reputation, and honor in front of one's peers gained prominence, shame became a central regulator of human drives and appetites. It helped to internalize social demands by translating them into individual or psychic constraints. At the same time, the early modern period saw the boundaries of shame and embarrassment expanding, encompassing evermore modes of behavior and extending to evermore social strata (Elias, 2000).

Writing in the 1930s, Elias's intention was not to cast an overly positive and optimistic light on what he identified as a Europe-based process of civilization and rationalization. Although he criticized psychoanalysis for its lack of historical and social understanding, he still borrowed from Freud's language of "drives" and "superego." Behind the ever increasing thresholds of shame, he argued, lay the ubiquity of fear: man's fear of social degradation, of someone else's superiority, of his own vulnerability and defenselessness. Those fears were kept in check by the state and its stable monopoly of violence that allowed for the pacification of social interaction and communication. But, as Elias added, this particular arrangement was open to change, and the hitherto productive tension between fear and shame could be reversed in its wake. He remarked, toward the end of his book,

> At present, we are so accustomed to the existence of these more stable monopolies of force and the greater predictability of violence resulting from them, that we scarcely see their importance for the structure of our conduct and our personality. We scarcely realize how quickly what we call our "reason," this relatively farsighted and differentiated steering of our conduct, with its high degree of affect-control, would crumble or collapse if the anxiety-inducing tensions within and around us changed. (2000, p. 441)

Keeping in mind that Elias, who was born into a German–Jewish family, left his home country in 1933, wrote *The Civilizing Process* in British exile and published it in Switzerland in 1939, the year of Germany's attack on Poland and the beginning of World War II, those final sentences still seem to lack political acumen. Although the author had by then witnessed numerous instances of state-induced loss of affect control in German politics and society, he could obviously not imagine that "reason" would collapse altogether, giving way to an upsurge of anxieties and the breakdown of public decency. The narrative of progressive civilization and rationalization was too powerful and had too much to offer for it to be questioned and challenged. It took Elias another 20 years to acknowledge that civilization could and had indeed collapsed or regressed under the Nazi regime (1996, pp. 299–402).

The narrative of rationalization had not been invented by Elias. It can be traced back at least to Max Weber, who had published his complex analyses of modernity some 30 years earlier. Weber saw modern societies becoming increasingly rational and thus predictable. As members of market classes, people became accustomed to acting instrumentally, carefully relating means and ends. Instead of following culturally defined habits and moral duties, they organized their behavior so as to follow their own economic, political, or social interests. In order to achieve those goals, they learned to control their passions, hold back their immediate impulses, and channel their energy into promising fields of action. Rationalization thus was accompanied by an increasing level of self-reflection and self-evaluation that, at the same time, included awareness of other people's interests, strategies, and conduct. It was aided by institutionalizing rules and norms that rendered individual behavior uniform, regular, continuous, and, thus, transparent and predictable to others. According to Weber (1968), a major force and proponent of rationalization was capitalism, which by 1900 had pervaded all parts of modern life, with the exception, perhaps, of erotic life and art (pp. 340–483).

Although Weber, just like Elias some decades later, was not uncritical toward capitalist rationalization, he had a sound grasp of its overall advantages. Those advantages had already been spelled out by early modern authors who, in Albert Hirschman's words, sang capitalism's praise long "before its triumph." In their view, capitalism, *le doux commerce*, would eventually tame the wilder passions and turn them into far less disturbing interests that could be jointly realized in mutual harmony and peaceful cooperation. The calculating spirit of capitalism, as Weber, Joseph Schumpeter, and John Maynard Keynes perceived it later, did not lend itself to passionately heroic adventures or other tyrannical pursuits of self-aggrandizement (Hirschman, 1977).

Notwithstanding the fact that capitalism could be—and indeed was—conducive to no less violent pursuits of colonial exploitation and, as recent crises revealed, destructively short-term maximization of private profit, it seems noteworthy that even those intellectuals who had a clear and critical grasp of its pitfalls and dangers still praised its rationalization potential. They considered this a major achievement and contrasted it to a picture of precapitalist and prerational societies that was painted in very dark colors. The exuberant passions that medievalist Johan Huizinga (1919/1996) saw reigning in the late Middle Ages were frowned upon by the heirs of the Enlightenment heralding accountable bureaucratic rule and rational science. They despised both the risibility that had allegedly characterized the 14th and 15th centuries, as well as the grim hatred and the unrestrained violence that ensued.

The French historian Lucien Febvre shared this profound distrust of passions and emotions. As an expert on the 16th century, he was deeply troubled by what he observed in his own times: an overabundance of what he called "primitive feelings." Among his contemporaries, he witnessed "revivals of the cult of blood, red blood," of the "cult of Mother Earth" and the healing sun, a quest for "cruelty at the expense of love." He found emotions dominating over reason and hailing "animal behavior," and he warned that those emotions might soon turn the world into a "stinking pit of corpses" (Febvre, 1973, p. 26). Without presenting a stringent narrative of emotional development, as Elias did in 1939, Febvre obviously shared the general misgivings about excessive passions trumping reason and, in his view, erupting in bloody violence and the destruction of civilized society. This is why, in 1938, he strongly urged researchers to tackle emotions as a subject of historical inquiry. His first lectures in liberated Paris thus dealt, for obvious political reasons, with the topic of *honneur et patrie*, honor and fatherland—which both Vichy France and Charles de Gaulle's Free France had used as highly emotional catchphrases and mobilizing slogans during World War II (Febvre, 1996).

When Febvre turned his attention to the history of emotions—or sensibilities, as he preferred to call them—he did so with a sharp sense of cultural and political despair. His generation had witnessed what they perceived as the downfall of European civilization and the return of barbaric feelings and practices, a lack of reliable processes of continuous rationalization and refinement, and no progress toward greater freedom, equality, and solidarity. Rational insights and mutual respect could easily be brushed aside by "irrational" claims that drew on allegedly archaic drives and desires. Studying those in their precise historical settings and contexts, avoiding assumptions about unilinear and general trends, was meant as a project of radical self-enlightenment and disillusionment.

It is precisely this cautious attitude toward generalization and linearity that continues to prevail among scholars who have followed Febvre's lead. They include the historians of the Annales school, who focused on the history of mentalities and herewith increasingly included senses, sentiments, and sensibilities (Corbin, 1995; Flandrin, 1979). In his five-volume study of the "bourgeois experience from Victoria to Freud," American cultural historian Peter Gay (1984–1998) likewise focused on the "education of the senses." Covering the long 19th century and drawing on a wide range of primary sources from European and North American societies, he scrutinized sexual desire as much as the tender passions of love, the cultivation of hatred, aesthetic tastes, and the various attempts to discover the secret life of the self. While Gay was more interested in the emotional experience of individuals than in normative prescriptions and regulations, Carol and Peter Stearns embarked on an equally ambitious project of unraveling "emotionologies" (i.e., "the attitudes or standards that a society, or a definable group within a society, maintains toward basic emotions and their appropriate expression"; Stearns & Stearns, 1985, p. 813). Firmly placed in social and gender history, this approach materialized in multiple volumes of American emotional standards as they evolved during the modern period, ranging from jealousy to fear and anger, from parents' anxiety about child rearing to coolness as a distinct 20th-century emotional style (Stearns, 1989, 1994, 1999, 2004, 2006).

Interestingly, both Gay's and Stearns's projects largely remained individual enterprises that did not trigger a wider and broader disciplinary interest (with a few exceptions: Matt 2003, 2011; Matt & Stearns, 2013). At best, they were considered more or less useful additions to social and cultural history that flourished in consecutive order from the 1970s onward. It took the profound irritation of postcolonial theorizing and the radical suggestion of cultural relativism to have a new generation of historians take an interest in the history of emotions. Reading anthropological studies that, rightly or wrongly, asserted the nonconformity of emotional concepts and practices with those familiar from the Western tradition, historians felt encouraged to look at historical sources of emotions in a decidedly nonessentialist way. At the same time, the burgeoning field of neuroscience, assisted by newly available techniques of neuroimaging, suggested a novel take on emotions: Rather than confirming the older European tradition of strictly distinguishing between rational elaborations and irrational or emotional feeling, studies delineated the close connection and interaction between both processes. Held against the long devaluation of emotions to the benefit of reason, such findings served to "ennoble" emotions, investing them with strong cognitive meaning, and vice versa.

In order to make sense of the recent interest in the history of emotions, however, it is not enough to draw attention to developments in science and humanities proper. Historiography does not only receive incentives from various scientific fields; it is also influenced by, and takes account of, experiences that are part and parcel of historians' own contemporary culture. It seems that this culture entertains an intense love affair with emotions. Starting with the therapeutic wave of the 1970s and the vastly increased interest in the self, emotions have taken center stage, in self-help literature as well as in the numerous therapeutic cures of body and mind. They were discovered and highly valued by new social movements that used them as mobilizing forces, but also sought to emancipate them from "repressive" forces such as religion, social mores, or, *tout court*, rationalizing capitalism. This went hand in hand with the perception of emotions as basic, authentic, and non-negotiable. It did not take long for consumer societies and advertising industries to utilize this perception as a unique selling point. Products sold better if they were coated in positive emotions.

This is what cultural sociologist Eva Illouz (1997, 2007) called "emotional capitalism." Her studies have focused on how emotions like romantic love became commercialized and connected to a wide range of objects and goods. Trust can serve as another case in point: As much as trust talk has become ubiquitous in contemporary Western societies, more and more companies and businesses use it in order to market their services and appeal to customers' emotions (Frevert, 2014). Emotions have thus been pushed into the center of economic and political attention, with evermore penetrating efforts to read and understand the affective lives of citizen consumers.

While many sciences—from affective neuroscience and computing to behavioral economics—enthusiastically contribute to, and participate in, this surge of interest in emotions, historians are facing a different challenge. What they have to offer is critical distance and contextualization. Instead of focusing on short-term and fractioned phenomena, they situate them in a wider and broader context that includes cultural as well as social, economic, and political processes. They can thus provide a far more nuanced and complex perspective of contemporary developments by reading them against the background of preceding events, trends, and constellations. Theirs is both a genealogical and a critical endeavor: unearthing and unveiling the way in which people have thought, felt, expressed, and experienced emotions in history, while, at the same time, keeping in mind and emphasizing that emotions are themselves products of history, undergoing shifts both in content and shape. Those changes are not always easy to detect, and they do not proceed in a linear direction, neither within a given country or region, nor on a global scale.

References

Aristotle (1984). *The complete works of Aristotle. The revised Oxford translation* (J. Barnes, Ed.). Princeton, NJ: Princeton University Press.

Austin, J. L. (1962). *How to do things with words*. Oxford, UK: Clarendon.

Barker-Benfield, G. J. (1992). *The culture of sensibility: Sex and society in eighteenth-century Britain*. Chicago: Chicago University Press.

Belfiore, E. S. (1992). *Tragic pleasures: Aristotle on plot and emotion*. Princeton, NJ: Princeton University Press.

Bockover, M. I. (1995). The concept of emotion revisited: A critical synthesis of western and Confucian thought. In J. Marks & R. T. Ames (Eds.), *Emotions in Asian thought:*

A dialogue in comparative philosophy (pp. 161–180). Albany: State University of New York Press.

Boltanski, L. (1999). *Distant suffering: Morality, media and politics*. Cambridge, UK: Cambridge University Press.

Boquet, D. (2005). *L'ordre de l'affect au Moyen Âge: Autour de l'anthropologie affective d'Aelred de Rievaulx*. Caen, France: Publications du CRAHM.

Bourke, J. (2005). *Fear: A cultural history*. London: Virago.

Braund, S. M., & Gill, C. (Eds.). (1997). *The passions in Roman thought and literature*. Cambridge, UK: Cambridge University Press.

Calhoun, C., & Solomon, R. C. (Eds.). (1984). *What is an emotion?: Classic readings in philosophical psychology*. New York: Oxford University Press.

Chaniotis, A. (Ed.). (2012). *Unveiling emotions: Sources and methods for the study of emotions in the Greek world*. Stuttgart, Germany: Steiner Verlag.

Chaniotis, A., & Ducrey, P. (Eds.). (2013). *Unveiling emotions: II. Emotions in Greece and Rome: Texts, images, material culture*. Stuttgart, Germany: Steiner Verlag.

Chinese School. (2008). [Documentary originally broadcast on BBC4, 2 DVD]. Milton Keynes: Open University Worldwide.

Clair, J. (Ed.). (2005). *Mélancolie: Génie et folie en occident*. Paris: Gallimard.

Cooper, J. M. (1996). An Aristotelian theory of the emotions. In A. O. Rorty (Ed.), *Essays on Aristotle's rhetoric* (pp. 238–257). Berkeley: University of California Press.

Corbin, A. (1995). *Time, desire and horror: Towards a history of the senses*. Cambridge, UK: Polity.

Crislip, A. (2005). The sin of sloth or the illness of the demons?: The demon of acedia in early Christian monasticism. *Harvard Theological Review, 98*, 143–169.

Dalai Lama & Ekman, P. (2008). *Emotional awareness: Overcoming the obstacles to psychological balance and compassion*. New York: Holt.

Danziger, K. (1990). Generative metaphor and the history of psychological discourse. In D. Leary (Ed.), *Metaphors in the history of psychology* (pp. 331–356). Cambridge, UK: Cambridge University Press.

Darwin, C. (1998). *The expression of the emotions in man and animals* (3rd ed.). Oxford, UK: Oxford University Press. (Original work published 1872)

Dixon, T. (2003). *From passions to emotions: The creation of a secular psychological category*. Cambridge, UK: Cambridge University Press.

Elias, N. (1996). *The Germans: Power struggles and the development of habitus in the nineteenth and twentieth centuries*. New York: Columbia University Press.

Elias, N. (2000). *The civilizing process: Sociogenetic and psychogenetic investigations*. Oxford, UK: Blackwell. (Original work published 1939)

Febvre, L. (1973). Sensibility and history: How to reconstitute the emotional life of the past. In P. Burke (Ed.), *A new kind of history* (pp. 12–26). New York: Routledge.

Febvre, L. (1996). *Honneur et patrie*. Paris: Perrin.

Flandrin, J.-L. (1979). *Families in former times: Kinship, household and sexuality*. Cambridge, UK: Cambridge University Press.

Frevert, U. (2011). *Emotions in history: Lost and found*. Budapest, Hungary: Central European University Press.

Frevert, U. (2014). *The moral economy of trust: Modern trajectories (Annual Lecture/German Historical Institute 2013)*. London: German Historical Institute.

Frevert, U., Scheer, M., Schmidt, A., Eitler, P., Hitzer, B., Verheyen, N., et al. (2014). *Emotional lexicons: Continuity and change in the vocabulary of feeling, 1700–2000*. Oxford, UK: Oxford University Press.

Frevert, U., Eitler, P., Olsen, S., Jensen, U., Pernau, M., Brückenhaus, D., et al. (2014). *Learning how to feel: Children's literature and the history of emotional socialization, 1870–1970*. Oxford, UK: Oxford University Press.

Gay, P. (1984–1998). *The bourgeois experience: From Victoria to Freud*. New York: Oxford University Press.

Graver, M. R. (2007). *Stoicism and emotion*. Chicago: Chicago University Press.

Gross, D. M. (2006). *The secret history of emotion: From Aristotle's "Rhetoric" to modern brain science*. Chicago: University of Chicago Press.

Hansen, C. (1995). Qing (emotions) in pre-Buddhist Chinese thought. In J. Marks & R. T. Ames (Eds.), *Emotions in Asian thought: A dialogue in comparative philosophy* (pp. 181–211). Albany: State University of New York Press.

Harris, W. V. (2001). *Restraining rage: The ideology of anger control in classical antiquity*. Cambridge, MA: Harvard University Press.

Hirschman, A. O. (1977). *The passions and the interests: Political arguments for capitalism before its triumph*. Princeton, NJ: Princeton University Press.

Honegger, C. (1991). *Die Ordnung der Geschlechter: Die Wissenschaften vom Menschen und das Weib 1750–1850*. Frankfurt: Campus.

Huizinga, J. (1996). *The autumn of the Middle Ages*. Chicago: University of Chicago Press. (Original work published 1919)

Hunt, L. (2007). *Inventing human rights: A history*. New York: Norton.

Illouz, E. (1997). *Consuming the romantic utopia: Love and the cultural contradictions of capitalism*. Berkeley: University of California Press.

Illouz, E. (2007). *Cold intimacies: The making of emotional capitalism*. Cambridge, UK: Polity.

Irvine, I. (1999). Acedia, tristitia, and sloth: Early Christian forerunners to chronic ennui. *Humanitas, 12*, 89–103.

James, S. (1997). *Passion and action: The emotions in seventeenth-century philosophy*. Oxford, UK: Oxford University Press.

Kagan, J. (2007). *What is emotion?: History, measures, and meanings*. New Haven, CT: Yale University Press.

Kaster, R. A. (2005). *Emotion, restraint, and community in Ancient Rome*. New York: Oxford University Press.

Knuuttila, S. (2004). *Emotions in Ancient and Medieval philosophy*. Oxford, UK: Clarendon.

Konstan, D. (2001). *Pity transformed*. London: Duckworth.

Laffan, M., & Weiss, M. (Eds.). (2012). *Facing fear: The history of an emotion in global perspective*. Princeton, NJ: Princeton University Press.
Lawlor, C. (2012). *From melancholia to Prozac: A history of depression*. Oxford, UK: Oxford University Press.
Lombardo, N. E. (2011). *The logic of desire: Aquinas on emotion*. Washington, DC: Catholic University of America Press.
Lynch, O. M. (1990). The social construction of emotion in India. In O. M. Lynch (Ed.), *Divine passions: The social construction of emotion in India* (pp. 3–34). Berkeley: University of California Press.
Matt, S. J. (2003). *Keeping up with the Joneses: Envy in American consumer society, 1890–1930*. Philadelphia: University of Pennsylvania Press.
Matt, S. J. (2011). *Homesickness: An American history*. New York: Oxford University Press.
Matt, S. J., & Stearns, P. N. (Eds.). (2013). *Doing emotions history*. Bloomington: University of Illinois Press.
McDaniel, J. (1995). Emotion in Bengali religious thought: Substance and metaphor. In J. Marks & R. T. Ames (Eds.), *Emotions in Asian thought: A dialogue in comparative philosophy* (pp. 39–63). Albany: State University of New York Press.
Meulenbelt, A. (1980). *The shame is over*. London: Women's Press.
Miller, W. I. (1993). *Humiliation and other essays on honor, social discomfort, and violence*. Ithaca, NY: Cornell University Press.
Millet, K. (1975, January). The shame is over. *Ms*., pp. 26–29.
Miner, R. (2009). *Thomas Aquinas on the passions: A study of summa theologiae, 1a2ae 22–48*. Cambridge, UK: Cambridge University Press.
Munteanu, D. L. (2012). *Tragic pathos: Pity and fear in Greek philosophy and tragedy*. Cambridge, UK: Cambridge University Press.
Nagy, P. (2000). *Le don des larmes au Moyen Âge: Un instrument spirituel en quete d'institution (Ve-XIIIe siècles)*. Paris: Albin Michel.
Nagy, P., & Boquet, D. (Eds.). (2009). *Le sujet des émotions au Moyen Âge*. Paris: Beauchesne.
Nash, D., & Kilday, A.-M. (2010). *Cultures of shame: Exploring crime and morality in Britain 1600–1900*. Houndmills, UK: Palgrave Macmillan.
Newmark, C. (2008). *Passion—Affekt—Gefühl: Philosophische Theorien der Emotionen zwischen Aristoteles und Kant*. Hamburg, Germany: Meiner.
Nussbaum, M. C. (1996). Aristotle on emotions and rational persuasion. In A. O. Rorty (Ed.), *Essays on Aristotle's Rhetoric* (pp. 303–323). Berkeley: University of California Press.
Orsini, F. (Ed.). (2006). *Love in South Asia: A cultural history*. Cambridge, UK: Cambridge University Press.
Plamper, J. (2015). *The history of emotions: An introduction* (K. Tribe, Trans.). Oxford, UK: Oxford University Press.
Plamper, J., & Lazier, B. (Eds.). (2012). *Fear: Across the disciplines*. Pittsburgh, PA: Pittsburgh University Press.
Pollock, S. (2012). From rasa seen to rasa heard. In C. Guenzi & S. d'Intino (Eds.), *Aux abords de la clairière* (pp. 189–207). Paris: Brepols.
Radden, J. (Ed.). (2000). *The nature of melancholy: From Aristotle to Kristeva*. Oxford, UK: Oxford University Press.
Rai, A. S. (2002). *Rule of sympathy: Sentiment, race, and power, 1750–1850*. New York: Palgrave.
Reddy, W. M. (2001). *The navigation of feeling: A framework for the history of emotions*. Cambridge, UK: Cambridge University Press.
Reddy, W. M. (2012). *The making of romantic love: Longing and sexuality in Europe, South Asia and Japan, 900–1200 CE*. Chicago: University of Chicago Press.
Rosenwein, B. H. (Ed.). (1998). *Anger's past: The social uses of an emotion in the middle ages*. Ithaca, NY: Cornell University Press.
Rosenwein, B. H. (2006). *Emotional communities in the early Middle Ages*. Ithaca, NY: Cornell University Press.
Santangelo, P. (2003). *Sentimental education in Chinese history: An interdisciplinary textual research on Ming and Qing sources*. Leiden, The Netherlands: Brill.
Santangelo, P. (2007). Emotions and perception of inner reality: Chinese and European. *Journal of Chinese Philosophy, 34*, 289–308.
Santangelo, P., & Guida, D. (Eds.). (2006). *Love, hatred, and other passions: Questions and themes on emotions in Chinese civilization*. Leiden, The Netherlands: Brill.
Santangelo, P., & Middendorf, U. (Eds.). (2006). *From skin to heart: Perceptions of emotion and bodily sensations in traditional Chinese culture*. Wiesbaden, Germany: Harrassowitz.
Scheer, M. (2012). Are emotions a kind of practice (and is that what makes them have a history)?: A Bourdieuian approach to understanding emotion. *History and Theory, 51*, 193–220.
Schings, H.-J. (1977). *Melancholie und Aufklärung*. Stuttgart, Germany: Metzler.
Schings, H.-J. (1988). *Der mitleidigste Mensch ist der beste Mensch: Poetik des Mitleids von Lessing bis Büchner*. Munich, Germany: Beck.
Sorabji, R. (2000). *Emotion and peace of mind: From Stoic agitation to Christian temptation*. Oxford, UK: Oxford University Press.
Starobinski, J. (1966). The idea of nostalgia. *Diogenes, 54*, 81–103.
Stearns, C. Z., & Stearns, P. N. (1986). *Anger: The struggle for emotional control in America's history*. Chicago: University of Chicago Press.
Stearns, P. N. (1989). *Jealousy: The evolution of an emotion in American history*. New York: New York University Press.
Stearns, P. N. (1994). *American cool: Constructing a twentieth-century emotional style*. New York: New York University Press.
Stearns, P. N. (1999). *Battleground of desire: The struggle for self-control in modern America*. New York: New York University Press.

Stearns, P. N. (2004). *Anxious parents: A history of modern childrearing in America*. New York: New York University Press.

Stearns, P. N. (2006). *American fear: The causes and consequences of high anxiety*. New York: Routledge.

Stearns, P. N., & Stearns, C. Z. (1985). Emotionology: Clarifying the history of emotions and emotional standards. *American Historical Review, 90*, 813–836.

Striker, G. (1996). Emotions in context: Aristotle's treatment of the passions in the Rhetoric and his moral psychology. In A. O. Rorty (Ed.), *Essays on Aristotle's Rhetoric* (pp. 286–302). Berkeley: University of California Press.

Tomkins, S. S. (1968). Some varieties of psychological organization. In M. L. Simmel (Ed.), *The reach of mind: Essays in memory of Kurt Goldstein* (pp. 219–230). Berlin: Springer.

Vila, A. (1998). *Enlightenment and pathology: Sensibility in the literature and medicine in eighteenth-century France*. Baltimore, MD: Johns Hopkins University Press.

Wang, Y. (2008). Confucian ethics and emotions. *Frontiers of Philosophy in China, 3*, 352–365.

Weber, M. (1968). *Soziologie—weltgeschichtliche Analysen—Politik*. (J. Winckelmann, Ed.). Stuttgart, Germany: Kröner.

Wiles, D. (1997). *Tragedy in Athens: Performance space and theatrical meaning.* Cambridge, UK: Cambridge University Press.

Williams, B. (1993). *Shame and necessity*. Berkeley: University of California Press.

Williams, E. (1994): *The philosophical and the moral: Anthropology, physiology, and philosophical medicine in France, 1750–1850.* Cambridge, UK: Cambridge University Press.

Wilson, R. A., & Brown, R. D. (Eds.). (2009). *Humanitarianism and suffering: The mobilization of empathy*. Cambridge, UK: Cambridge University Press.

CHAPTER 3

The Sociology of Emotion

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Since its introduction nearly 40 years ago, sociological interest in the study of emotion has flourished. Today, it is no longer necessary to defend the role of emotion in social life. Indeed, emotions and their consequent processes are recognized as relevant and crucial, to many—if not all—aspects of society. In addition to drawing on numerous theoretical perspectives (see Stets & Turner, 2008; Stets, 2005, for recent reviews), sociological scholarship on emotion includes a variety of substantive topics. Nearly all this scholarship begins with a shared question: How do historically and culturally specific norms influence the experience and expression of emotion, and to what degree are emotions structured by one's position within groups, organizations, and social hierarchies?

Building on this common foundation, sociologists of emotion have turned their attention to a wide range of subjects, including the socialization of emotion in both children and adults; processes of intra- and interpersonal emotion management; emotional deviance; how emotion is sold for a wage and the consequences thereof; the role that emotion plays in the creation and maintenance of individual and group identities, small groups, and stratification hierarchies; the relationships among emotion, stress, and mental health; and the role emotion plays in the creation of social movements and social change. This chapter is not meant to be a comprehensive review of the field—such a task would be impossible. Instead, we present a sampling of the types of research that arise from a sociological perspective on emotion as well as opportunities for future research.

We begin by introducing sociological definitions of emotion as well as two broad theoretical paradigms used by sociologists studying emotion: the cultural perspective and the structural perspective. We then address a number of relatively well-studied substantive areas, before introducing new lines of inquiry in the field. In particular, we identify two areas where we see the greatest opportunities for interdisciplinary growth in the field of emotion: emotion regulation (Grandey, Diefendorff, & Rupp, 2013; Grandey, 2000) and affect control theory (Heise, 2006; Lively & Heise, 2014; Rogers, Schröder, & von Scheve, 2014).

Sociological Definitions of Emotion

Sociological definitions of emotion usually assume that emotions are inherently social. Hochschild (1983), for example, likens emotions to senses that signal what is personally relevant about surrounding social events. Similarly, Thoits (1984) posits a four-factor model of emotion, which suggests that emotional experience comprises four factors: physiology, cognition, emotional expressions, and emotion words. According to Thoits's model, the four factors of emotion—physiology, cognition, expression, and labeling—are interdependent, and most sociologists assume that a change in one may lead to a change in the others (Francis, 1997; Pollak & Thoits, 1989; Thoits, 1995).

Although recognizing the utility of Thoits's four-factor model, Lively and Heise (2014) have recently defined emotion as "responses to events that are linked with corporeal manifestations" (p. 68). Their streamlined conceptualization recognizes the possibility of "ineffable emotions," or emotions that are marked by particular physiological experiences and facial expressions, but are often not yet recognized or labeled as emotions, per se, and are detectable in both computer simulations and photographs, as well as lived experience.

Cultural and Structural Perspectives on Emotion

Sociological analyses presuppose that human behavior and interaction are constrained by individuals' locations in social structures, which are themselves influenced by culture (Stets & Turner, 2008). Most sociologists tend to view structure as one's position within a social network or as a set of status positions that grant access to various levels of prestige or other resources (Lawler & Thye, 1999; Ridgeway, 2011), whereas culture most often refers to a set of symbols and meaning that people create or use to regulate their behaviors, interactions, and emotions (Heise, 2006; Stets & Turner, 2008; Swidler, 1986).

From this perspective, individuals are seen as occupying roles (e.g., mother, teacher, surgeon) within sets of positions (e.g., an organization, an institution, a social structure) that are regulated by rights and obligations between role partners and systems of cultural symbols (e.g., words, expressions, norms). In keeping with this view of human behavior, the sociological approach to emotion also assumes that the emotional arousal, cognitive appraisals, expressions, and language that compose emotional experience are constrained by both culture and structure.

Although most sociological studies of emotion contain elements of both culture and structure, much of the existing empirical scholarship tends to privilege one over the other (Clark, 1997; Kemper, 1978; Simon & Nath, 2004), which can lead to complementary, if not incomplete, results (Lively & Powell, 2006).

The Cultural Perspective

The idea that emotions are socially patterned in large part by feeling rules—that is, culturally and historically variable norms defining what should be felt and expressed in various situations—was first introduced by Arlie Hochschild in 1975. Today it is well established that cultures differ in which emotional experiences are encouraged or discouraged (Wei, 2014; Smith & Francis, 2005). This leads to important differences in behavioral dispositions and expectations, which are historically specific (Lofland, 1985; Stearns & Stearns, 1989).

Candace Clark's (1997) seminal work on sympathy in everyday life exemplifies the cultural perspective. In this piece, she compares the emotion culture regarding sympathy in the United States to that of the Ik, a tribal community known for their marked lack of sympathy. With their tendency to laugh when older group members fall down or to simply watch when an unattended child walks toward an open fire, the Ik provide a stark contrast to most Western cultures, whose members tend to be sympathetic toward the elderly, children, and those whose misfortunes seem largely beyond their control.

Clark's (1997) corresponding analysis of the U.S. emotion culture, by contrast, details a sympathy economy governed by an elaborate set of rules, under which individuals are automatically granted certain amounts of sympathy (or "sympathy margins") as a function of their age, gender, social class, and so on. As individuals move through daily life, they draw upon and invest in sympathy "accounts" (much like a bank account) by asking for sympathy and providing it to others. Using a range of methodologies, including content analysis, vignette studies, observation, and interviews, Clark identifies four sympathy rules to which individuals are expected to adhere in order to avoid becoming overdrawn. These include not making undue claims to sympathy, not asking for too much sympathy, asking for some sympathy, and reciprocating once sympathy has been received (see also Charmaz, 1980; Lofland, 1985).

In addition to providing cross-cultural comparisons, the cultural perspective takes into account how feelings, and expectations regarding them, change over time (Stearns & Stearns, 1989; Stearns & Lewis, 1998). This perspective also reveals how emotion norms vary by actors' social status characteristics (Harlow, 2003; Lively & Heise, 2014; Pierce, 1995; Wingfield, 2010), their social and historical circumstances (Cancian & Gordon, 1988; Cancian, 1987; Hochschild, 1979; Lofland, 1985), and their participation in localized subcultures (Heise, 2007; Hunt, 2008; Ritchie & Barker, 2006; Smith-Lovin & Douglas, 1992).

As illustrated above, cultural approaches to the sociological study of emotion tend to focus on rules and cultural expectations that emerge over time and govern emotional experience and expression. Still, scholars who identify more with this paradigm do not ignore social structure entirely, as evidenced by their attention to how the emotional norms that guide emotional experience and expression are influenced by structural considerations, such as gender (Cancian, 1987; Hochschild, 1979; Pierce, 1995), race (Durr & Wingfield, 2011; Harlow, 2003), relative status (Clark, 1997), social role identities (Lively & Heise, 2014), access to tangible and intangible resources (Lofland, 1985), and, as we see below, occupational position (Hochschild, 1983; Lively, 2000; Sutton, 1991).

The Structural Perspective

In addition to the effects of culture, emotional experience and expression are likewise shaped by social structure. As noted previously, social structures can refer to status characteristics, one's position in a group or dyad, or one's membership in organizations.

Unlike the cultural perspective, which focuses on the more socially constructed aspects of emotion and the degree to which emotions are subject to acts of management, the structural perspective tends to focus more on the emotions that individuals experience as a result of their perceived, if not actual, structural conditions. An exemplar of this approach, Kemper's (1978) social interactional theory posits that most emotions can be determined by two fundamental dimensions governing social interactions: power and status (see also Kemper & Collins, 1990).

According to social interactional theory, when individuals experience the levels of status or power they expect during the course of a social interaction, they are predicted to feel content or happy. Experiences of excesses or deficits along these dimensions, however, produce certain distressful emotions depending on whether one attributes the cause to one's self or others. For instance, if an individual loses status as a result of his or her own incompetence, embarrassment is expected. However, if he or she loses status as a result of another's actions, anger is the expected response.

Consistent with the structural perspective, sociological stress researchers have argued that individuals who occupy disadvantaged positions within the larger social structure may also experience more negative emotions than those individuals who occupy more privileged positions (Simon & Nath, 2004; Simon, 2007; Simon & Lively, 2010). For instance, Simon and Lively (2010) suggest that women's higher levels of self-reported distress—a problem that has puzzled mental health scholars for decades—is likely a function of their structural position relative to men, which causes them to experience more intense and enduring anger (see also Collins, 2004). Notably, Ross and Mirowsky (2003) attribute the increased *positive* affect reported by the elderly to structural changes in living conditions, including elders' involvement with smaller networks, few mandatory roles, and the absence of children in the home (see also Evenson & Simon, 2005).

While stress research tends to be concerned with broader systems of seemingly enduring inequality, unlike the most interaction-based theories of emotion cited above (Kemper, 1978), both approaches generally assume that emotions arise more or less automatically as a result of structural arrangements. Thus, from the structural perspective, emotion is less something to be shaped, but is instead a rational response that signals an individual's standing within the context of a face-to-face interaction or acts as a sign of the perceived social and structural conditions in which he or she is embedded (see Hochschild & Machung, 1989; Hochschild, 1983).

Taking each of these perspectives as a backdrop, we now turn our attention to a number of substantive areas of interest within the sociology of emotion. We begin with the process of childhood socialization before turning our attention to the emotional lives and experiences of adults, organizations, and societies at large.

Emotional Socialization

Emotional socialization refers to the processes through which members of a society learn the expectations, rules, practices, and consequences of emotional experience and its display (Johnson, 1992). Young children are taught about emotions both explicitly and implicitly, most often by parents and teachers. For example, Pollak and Thoits (1989) found that children attending a therapeutic day care center for those with emotional difficulties were taught explicitly how to link emotion words ("sad" or "angry") to physiological experiences (an upset stomach) and events (being dropped off at school). The goal, rather than to teach students to manage their emotions in appropriate ways, was to get children to understand the causes of their emotions, to express them properly, and to understand their consequences. Notably, Leavitt (1994) documented analogous messages, as well as lessons involving emotion management, in her study of day care settings geared toward more general custodial care.

Although adults tend to be the primary agents of emotional socialization for young children (Johnson, 1992), by adolescence, teens are active in their own and others' socialization processes (Corsaro, 2005). Simon, Eder, and Evans (1992), for example, found that adolescent girls created new, and sometimes contradictory, norms about romance, while also mirroring norms from the dominant culture. Although the girls policed one another via gossip, name-calling, and, in some cases, shunning, some—especially those with high social status—successfully resisted these norms through the strategic use of humor (see also Thorne, 1993).

Emotional socialization, like other forms of socialization, occurs throughout the life course. Indeed, studies of black students attending predominantly white colleges (Jackson, 2012), medical students (Smith & Kleinman, 1989), and mortuary science students (Cahill, 1999) all reveal the hidden and sometimes not-so-hidden curriculum of emotion in higher education. Additionally, studies of occupations ranging from low-end service workers to high-end professionals document the processes of emotional selection, socialization, and—in the case of less professional or prestigious jobs—monitoring (see Lively, 2006, for a complete review of this literature).

Emotion Management

One of the most studied phenomena within the sociology of emotion is the act of emotion work, or as it is more widely known, emotion management (see Lively & Weed, 2014, for a recent review). Emotion management, generally speaking, refers to the strategies that individuals use to bring their feelings in line with existing emotion norms (Hochschild, 1979). Techniques used to manage emotions include surface acting, to mask or enhance the expression of emotion, and deep acting, wherein the actual emotion is changed (Hochschild, 1983).

Although Hochschild (1983) focused primarily on the cognitive strategies that flight attendants used in order to manage their negative feelings regarding unpleasant and unruly passengers, later studies revealed that each of the four factors of emotion identified by Thoits (1984) are potential points where emotion management can occur. Specifically, individuals can manage their emotions not only by reframing the meaning of a situation (i.e., reenvisioning a problematic passenger as a frightened child, or oneself as a gracious hostess, in order to cultivate positive emotions), but also by changing their emotional expression (Thoits, 1995), the labels they use to describe their feelings (Ritchie & Barker, 2006), and their physiological state (Simon & Nath, 2004).

Intrapersonal Emotion Management

One distinction that sociologists studying emotion make is the difference between intrapersonal and interpersonal emotion management. Whereas intrapersonal emotion management refers to the attempts that individuals make in order to bring their own emotions in line with existing feeling norms, and which may have an indirect effect on others, interpersonal emotion management refers to individuals' attempts to directly affect the emotions of others.

Here, empirical studies illustrate how emotion management specialists (e.g., therapists; Francis, 1997), psychodrama leaders (Thoits, 1995), and social movement activists (Britt & Heise, 2000) use interpersonal emotion strategies to manage the emotions of others directly. Such strategies tend to target one or more of the four factors in Thoits's model of emotion. For example, the therapists in Thoits's study of a psychodrama group helped participants relabel past traumas by inviting participants to take another's perspective or to exaggerate their emotional expression, all the while manipulating the elements of the physical space using lights or music. These interventions, when taken together, typically resulted in participants experiencing more positive emotions and an improved sense of well-being.

Notably, many interpersonal emotion management strategies involve moving subjects through numerous emotions, leading some scholars to conclude that making several moves between emotions that are experientially near, or similar in terms of one or more dimensions of affective meaning, is easier than making one big leap between two relatively distant or dissimilar emotions (Lively & Heise, 2004; Lively, 2008, 2013). Indeed, political leaders often move their constituents out of distress (a relatively weak and inactive emotion) and into pride (an emotion marked by higher levels of potency and activation) by first invoking fear and anger (Wasielewski, 1985; see also Britt & Heise, 2000).

Whereas most of these studies illustrate how therapists and group leaders target emotions directly, Francis's (1997) analysis of two support groups for individuals who had lost a spouse (either through divorce or death) highlights the relationship between emotion and identity (see also Britt & Heise, 2000). In much the same way that Hochschild's (1983) flight attendants were encouraged to see themselves as gracious hostesses and their belligerent passengers as frightened children, Francis illustrated how group leaders encourage their members to reframe themselves and their former or deceased spouses in ways that would allow them to experience more positive, powerful, and active emotions (Heise, 2007).

Finally, interpersonal emotion management also occurs in dyads and among peers. Staske (1996, 1998, 1999), for example, documents the collaborative emotion management that occurs among friends and lovers during intimate talk. Similarly, Lively (2000) illustrates how coworkers routinely engage in reciprocal emotion management in backstage areas, out of the earshot of troublesome employers or clients. Hochschild and Machung's (1989) account of dual-earner couples further reveals how husbands and wives cocreate family myths in order to manage individual and shared emotions. Notably, Lively's and Hochschild's analyses both reveal how interpersonal management, either through reciprocal exchanges of support over time or as collaborative "myths," has the capacity to manage individual or group feelings and to obscure or alleviate the negative effects of ongoing inequities (see also Jackson, 2012).

Emotional Labor

Another distinction made by sociologists is that between emotion management and emotional labor (Hochschild, 1983). Emotional labor, simply put, is the commercial exploitation of emotion management. Hochschild's flight attendants were paid to be nice regardless of insults, and paradoxically asked to be genuine in order to bring about ease and loyalty in passengers. Bill collectors, on the other hand, were taught to be angry, mean, and impatient in order to bring about fear and compliance in debtors (see also Sutton, 1991). Unlike emotion management, which typically occurs in individuals' private lives (such as trying to feel happy when one has adopted the role of bride) and has a "use value," emotional labor is sold for a wage and typically benefits the corporation by whom the actor is employed or the customers, clients, or patients on behalf of whom the actor is engaged (Hochschild, 1983).

Since its introduction, scholarly studies on emotional labor have multiplied. Although at first limited to middle- or low-end service workers (Hochschild, 1983), the literature on emotional labor now elucidates the experiences of employees all along the occupational continuum, from fast-food workers (Leidner, 1993), waitresses (Paules, 1991), home health care aids (Stacey, 2011), and exotic dancers (Barton, 2007) to registered nurses (Bolton, 2001), attorneys (Pierce, 1995), professors (Bellas, 1999; Harlow, 2003), and other professionals (Wingfield, 2010;.see also Erickson & Ritter, 2001; Sloan, 2004, 2007.) As part of the recent focus on emotional labor at the upper end of the occupational hierarchy, emotional labor is now seen as contributing not only to the passenger, client, and patient experience (Hochschild, 1983) but also to the workers' experience of themselves as being professional (Lively, 2001; Siemsen, 2004).

Because most service encounters and most workplace settings are hierarchical, studying emotional labor provides scholars with one way to better understand how the effects of culture and social structure intersect. Generally speaking, individuals at the lower end of the hierarchies within formal organizations have lower-status shields and, thus, less emotional leeway than those at the top (Hochschild, 1983). Not only are displaced negative emotions more likely to flow down status hierarchies (from those with higher status to those with lower status), those at the bottom are also expected, if not required, to transform those negative expressions into something substantially more positive (Hochschild, 1983).

In her study of attorneys and paralegals, for example, Pierce (1995) found that paralegals were expected to manage their own feelings of frustration, irritation, and being overwhelmed that arose from their troublesome encounters with adversarial litigators, and also transform the attorneys' combative and, on occasion, insecure feelings into feelings of confidence and powerfulness. Because most litigators in Pierce's study were male and most of the paralegals were female, these organizational expectations regarding emotional labor matched the cultural expectations that men are more aggressive and women are more nurturing (Simon & Nath, 2004; see also Ridgeway, Li, Erickson, Backor, & Tinkler, 2009). As a result of the confluence of these cultural and structural expectations, many female attorneys (and to a lesser degree male paralegals) were faced with a double bind when it came to expressing powerful and or negative emotions in the workplace.

Although Hochschild (1983), herself, did not discuss race explicitly in her discussion of status shields, racial and ethnic minorities face different emotional expectations and have different emotional experiences compared with their white counterparts. These differences are structurally similar to—though culturally distinct from—those between men and women. In the United States, African American professors employed in predominantly white colleges and universities, for example, routinely face challenges to their knowledge base, as well as their authority (if not their ability) to assess students' work, often resulting in feelings of frustration and irritation, which, in turn, require additional emotion management above and beyond that of their white colleagues (Harlow, 2003). Black professionals, especially males, also feel pressure to avoid expressing anger in order to avoid cultural stereotypes, such as being just another "angry black man," a prohibition not experienced by their white colleagues, who routinely express minor frustrations, irritations, and even anger (see also Wingfield, 2010). Perhaps somewhat surprisingly, black female professionals seem to be more likely than their male counterparts to embrace cultural stereotypes surrounding black women and anger—and their white colleagues' subsequent fear and discomfort—in order to express themselves outside of the norms governing predominantly white social spaces (Durr & Wingfield, 2011).

Consequences of Emotion Labor

In addition to the plethora of studies documenting emotion management and emotional labor in the workplace, scholars have also attempted to understand its consequences. While some have documented the social consequences—that is, the reification of social status hierarchies (Lively, 2000) or other systems of inequality (Harlow, 2003; Pierce, 1995; Wingfield, 2010)—the bulk of scholarship assessing the consequences of emotional labor has focused on Hochschild's intuitive, but largely anecdotal, claims that emotional labor has deleterious effects on the individual (Hochschild, 1983). Based on a range of methodologies, including ethnography and survey methods, these inquiries have produced mixed results regarding her initial concerns about the cost of emotional labor to individual well-being (see Wharton & Erickson, 1995; see also Lively, 2006; Wharton, 2009, for recent reviews of this literature).

Controlling for a variety of individual and job-related characteristics, Wharton (1993), reported that workers in jobs requiring emotional labor were no more likely than other workers to experience job-related burnout (see also Wharton & Erickson, 1995). Instead, burnout was better explained by more general job characteristics (e.g., autonomy and number of hours worked) than by emotional labor. Moreover, workers who performed emotional labor were significantly more satisfied with their jobs than those who did not (Wharton, 1993).

Similarly, Erickson and Wharton (1997) examined the relationship between inauthentic feelings and emotional labor by comparing the experiences of workers who engaged in emotional labor and those who did not. Distinguishing among client–contact, the amount of time spent working with people on the job, and the degree to which "handling people well" is an important aspect of the job, they found that the latter was the only dimension of emotional labor positively related to feelings of inauthenticity (see also Wharton, 1999).

Finally, Erickson and Ritter (2001) teased apart the more potentially damaging dimensions of emotional labor and the degree to which these differed for women and men. Controlling for different types of emotional experiences and different forms of emotional labor, they found that managing feelings of agitation (e.g., hiding feelings of anger) is the only form of emotional labor related to feelings of burnout and inauthenticity. Furthermore, they found that the severity of one's feelings of inauthenticity corresponds with one's level of agitation, and that the negative effects were similar for both women and men (see also Sloan, 2007).

Emotional Deviance

Sociologists are also interested in the ways in which individuals—and their emotions—deviate from cultural and structural expectations. Although questions of emotional deviance originally grew out of an attempt to better understand the relationship between emotion and mental health (Thoits, 1985), the concept has, in recent years, been applied to individuals who are not viewed as mentally ill, per se, but who are simply unwilling or unable to adhere to traditional emotional scripts.

Drawing on Becker's (1963) labeling theory of deviance in order to better understand individuals' increasing willingness to seek professional help for emotional problems, Thoits (1985) suggests that individuals who are unable to bring their emotions in line with existing feeling norms, may be labeled—by both self and others—as emotionally deviant. With this background in place, Thoits takes a role perspective, and argues that discrepant (or deviant) feelings may arise from having multiple roles, role transitions, and unrealistic role demands. In accordance with this view, individuals who self-label as emotionally deviant are increasingly likely to seek professional help today, in large part because of the deinstitutionalization of mental health care and the corresponding destigmatization of seeking professional help for emotional problems. In this regard, Thoits's analysis draws attention to the more micro processes of coping behaviors and social support, as well as the more macro structural and cultural processes associated with structural and cultural change.

Since its introduction in the late 1980s, the concept of emotional deviance has been applied to numerous populations, though most often to mothers (Lois, 2013; Taylor, 1996). Notably, these recent studies suggest that individuals do not always simply accept the label of being "emotionally deviant," and may instead resist it (see Simon et al., 1992). Such resistance can occur in face-to-face interactions or in small groups (Lois, 2013), as well as within the contexts of institutions (e.g., families) and social movement organizations (Taylor, 1996).

Most of the scholarship on emotion management, emotional labor, and emotional deviance has relied disproportionately on qualitative methods, including in-depth interviews and ethnography (but see Lively & Powell, 2006). The exceptions are largely a handful of studies detailing the consequences of emotional labor in the workplace. This reliance on qualitative methods is partly due to a strong affiliation with the cultural perspective on emotions. In the next section, we shift our attention to more structural considerations, and a number of midrange social psychological theories, all of which have been expanded to address emotion more centrally, most often as an outcome of social interaction. In keeping with the structural perspective, this body of work is more likely to rely on experimental and survey methods to investigate the relationships among social structure, perception, and emotion.

Identity, Emotion, and Social Structure

According to sociologists, our sense of self, or our identity, is connected to social structures and institutions (MacKinnon & Heise, 2010; Stryker & Serpe, 1982, 1994; see also Burke, 1991). This is in part because identities are embedded in social roles. Obviously, the roles that we see as available to us are guided, in large part, by culture, and emotions influence role performance (e.g., confidence may propel us forward, whereas fear may cause us to choke). Emotions also arise from role performances (e.g., pride when things go well or shame when they do not), and may shape future performances.

The emotional aspects of identity work are, in effect, commitments to role performances. When actors conform to the emotional and behavioral expectations of social roles, they are managing their sense of self, as well as reifying the institutions, the organizations, and the cultures in which these roles are embedded. For example, when doctors enact the emotional and behavioral expectations of a physician, they reify the institution of medicine. They also perpetuate the relative status positions of physicians, patients, and other health care providers, as well as the common cultural understandings of what it means to be a physician.

Affect Control Theory

According to *affect control theory*, individuals create events that confirm their fundamental affective sentiments regarding themselves, others, and settings (Heise, 2007). Fundamental sentiments capture *evaluation* (how good or bad something is), *potency* (how powerful or weak something is), and *activation* (how lively or quiescent something is); these dimensions of affective meaning have been documented across numerous cultures and, within a single culture, represent shared meaning regarding identities, behaviors, settings, attributes, and emotion (Heise, 2007).

When individuals find themselves in transient situations that disconfirm their fundamental sentiments, they feel a form of affective dissonance, typically referred to as deflection, which is experienced as discrete emotion. The actual emotion that is experienced is a function of the direction and the magnitude of the disconfirmation. For example, someone whose fundamental sentiments regarding him- or herself are disconfirmed in a positive way, is likely to experience joy, surprise, or pride. On the other hand, someone whose fundamental sentiments regarding his or her identity are disconfirmed in a negative way is more likely to experience embarrassment, shame, or guilt. Drawing on a cybernetic model, affect control theory predicts that when transient sentiments contradict fundamental sentiments, individuals are motivated to alter their behavior in order to minimize deflection and reduce the likelihood of reidentification of self, other, or both.

Much of the theoretical work within the sociology of emotion has been based on qualitative methods, such as ethnography and in-depth interviews. In contrast, affect control theory incorporates a unique computer program, Interact, that uses mathematical models to make probabilistic predictions regarding behaviors, emotions, and labeling, many of which have been replicated using ethnography, survey data, and experiments (Francis, 1997; Lively & Powell, 2006; Robinson, Smith-Lovin, & Tsoudis, 1994). This more quantitative approach to identity and affect illustrates clearly that emotion and emotion norms are not entirely emergent, as many early sociological accounts seemed to suggest, but rather inextricably linked to culturally shared affective sentiments regarding social role identities, social settings, behaviors, and attributes. In fact, Lively and Heise (2014) argue that the static emotion norms cited by many cultural sociologists, such as feeling sad at a funeral or feeling joyous at a wedding, are simply the characteristic emotions of a mourner or a bride, respectively, whose fundamental identities have been confirmed perfectly. Notably, when you model the interaction between two mourners at a funeral, their emotions, while starting with sad, will rapidly become more pleasant and active, which may shed insight as to why it is not that uncommon to find people smiling and laughing at a funeral or acting boisterously at a wake.

Although affect control theory was initially developed as a theory of identity, where emotions were essentially a signal of the degree to which one's identity was being confirmed or disconfirmed during the course of daily interaction, emotions have become increasingly more central (Smith-Lovin & Heise, 1988). Lively and Heise (2014) recently summarized the contributions of affect control theory to the sociological literature on emotion and have suggested a number of new applications for the theory, including how the emotional experiences and expressions seem to have differential consequences for those with positively and negatively valued identities. Additionally, Rogers et al. (2014) has nominated affect control theory as a long-overdue launching point for cross-disciplinary collaboration on emotion because of its empirically grounded conceptualization of social mechanisms operating at multiple levels—including individual interactions, groups, and culture—and its mathematical specification of the actual processes that link social and individual aspects of emotion (a point to which we return below).

Identity Theory

Identity theory, as articulated by Burke (1991) and Stets (2005), also illustrates the emotional effects of disconfirming individual identities. Unlike affect control theory, which calculates deflection using culturally shared affective meanings of social roles, behaviors, and settings, identity theory is focused primarily on the correspondence between individuals' self-conceptions and others' reactions to their identity performances. For example, several early studies in this tradition examine intimate relationships, where spouses were asked to compare their own individual self-conceptions with the specific reflected appraisals of their partners (Burke & Harrod, 2005; Cast & Cantwell, 2007). When there was a discrepancy between their partner's reflected appraisals and their own self-conceptions, distress ensued, even in cases where they were viewed more positively than they anticipated. Notably, Burke and Harrod's (2005) analysis of identity processes among intimate couples takes temporal components into consideration as well. Their findings reveal that individuals within committed relationships are more content when their partner's evaluations of them match their own, compared with individuals at the beginning stages of relationships, who would rather their partners see them as slightly better than they see themselves.

Since its introduction, identity theory has been applied not only to relationship satisfaction, but also to individuals' attempts to engage in purposeful self-change. In her study of weight loss, for example, Granberg (2006) found that individuals were more satisfied with, and more committed to, their weight-loss endeavors when the reactions of those around them—both real and imagined—were consistent with their own conceptions and expectations. Recently, Stets and Carter (2011) have extended identity theory to the discussion of moral identities and emotions. Their results reveal that the disconfirmation of moral identities also results in negative feelings.

Emotion and Justice, Equity, Expectation States, and Exchange

Other social psychological theories—including justice theory (Hegtvedt & Parris, 2014), equity theory (Walster et al., 1978), expectation states theory (Ridgeway, 2006), and exchange theory (Lawler & Thye, 1999; Lawler, 2001)—also detail the co-constitutive relationship between emotion and social structure. Importantly, equity theory, justice theory, and exchange theory all rely on the assumption that it is the perception of equity, fairness, or net gains over the course of a single, or ongoing, interaction that affects emotions, not the actual, obdurate conditions in which the individual is embedded.

Justice Theory

Justice theory generally considers two processes: procedural and distributive justice, and has grown to include the study of emotion (Guillermina, 2006; Hegtvedt & Parris, 2014). Whereas procedural justice is focused on the means by which outcomes are distributed, distributive justice is more concerned with the actual allocation of outcomes, often taking into account such issues as need, equity, and equality (Hegtvedt, 2006). Generally speaking, people are happy when they feel that procedural decisions are just and the outcomes fair. By contrast, when people believe the procedures to be unfair and the outcomes unjust, they experience negative emotions. This is true whether the individual is a target of the procedure, a recipient of the outcome, or simply a third-party perceiver of the process. However, even when individuals receive less than they expected, if they believe that the procedure governing the decision is fair (Hegtvedt & Killian, 1999), or that the decision maker is legitimate (Clay-Warner, 2006), their negative feelings are somewhat alleviated.

At first justice theory focused primarily on distributive justice or fair outcomes, such as pay; recent work has focused more on procedural justice and fair methods of distribution (Hegtvedt, 2006). Although most people assume that fair procedures will lead to fair outcomes, this is not always the case. As a result, justice research today is often situated at the intersection of procedural and distributive justice. Organizational justice combines these categories and adds one of its own: interactional justice. Interactional justice refers to the way individuals are treated in the decision-making process (Greenberg, 1990). For example, an organization that treats its employees with respect and keeps them abreast of the decisions being made within the company would be viewed as more interactionally just. Studies in organizational justice also draw particular attention to the individual consequences of organizational practice by elucidating the effects of status characteristics and investigating how individuals feel about the organization to which they belong (e.g., satisfied, disappointed, uncommitted) as well as their role in that organization (Clay-Warner, Hegtvedt, & Roman, 2005; Foschi, 2000).

Equity Theory

Consistent with the justice framework, *equity theory* predicts that individuals are likely to experience negative emotion when they perceive an inequity in their interactions with others, and are motivated to maintain equity in their relationships. Notably, equity does not mean that partners contribute or benefit equally, but rather that partners have an equal ratio of contributions to benefits, subject to individual perception. Originally, the theory predicted that individuals would experience generalized distress, whether they under- or overbenefited (Adams, 1965). However, later scholars specified that anger was more likely in the former case, whereas shame was more likely experienced in the latter (Walster, Berscheid, & Walster, 1975).

Most of the early scholarship on equity and discrete everyday emotion utilized experiments using college student samples and were limited to undifferentiated emotions such as generalized distress (Adams, 1965). Later survey-based studies of married and cohabiting adults, however, found that a broad range of emotions—including positive ones—are affected by perceptions of inequity within the context of long-term romantic relationships (Lively, Powell, Geist, & Steelman, 2008). They also found that emotional responses were affected by perceptions of under- and overbenefiting, as well as by biological sex (Lively, Steelman, & Powell, 2010)

Expectation States Theory

Expectation states theory, with its focus on status hierarchies, provides predictions for socioemotional behavior, particularly within task-oriented groups, such as those commonly found in the workplace. Recent studies of small groups—either based on experiments or computer simulations—illustrate how status hierarchies structure emotion (Heise, 2013; Ridgeway, 2006). Research has shown that low-status individuals are expected to constrain their negative emotions when interacting with high-status individuals in ways that high-status individuals are not (Ridgeway & Johnson, 1990). Further, people have a general understanding of certain emotions as being more or less acceptable for low- or high-status individuals (Tiedens, Ellsworth, & Mesquita, 2000). Correspondingly, when people interact with a group, they are able to use these types of emotion cues to ascertain the relative status of different group members (Tiedens et al., 2000). For instance, in a group of undifferentiated actors, the one who expresses the most anger is often viewed as having the highest status.

Importantly, these predictions are problematized with the consideration of status characteristics, such as gender or race (Ridgeway, 2006; see also Wingfield, 2010; Pierce, 1995). So, it would be normal for a high-status businessman to feel and express more anger if his idea is rejected than his lower-status colleagues; however, it is less normal or permissible for a businesswoman to feel and express anger in the same way. Instead, she is expected to feel guilty or depressed. This example, like the one of the male and female attorneys, cited earlier, illustrates how cultural understandings regarding gender have the ability to undermine institutional power when it comes to the experience and expression of emotion. In his study of juror participation, Heise (2013) argues that any marked identity—that is, any social role identity that is marked by the gender category of female or by race—is automatically viewed as less powerful than those identities that are not marked, therefore signifying maleness and whiteness.

Exchange Theory

Finally, *exchange theory* has also been expanded to include the role of emotions in exchange interactions (see Stets, 2005, for a short review). Exchange theory is a framework for a number of more specific theories—for example, the theory of social commitments (Lawler, Thye, & Yoon, 2009), relational cohesion theory (Lawler & Yoon, 1996), and the affect theory of social exchange (Lawler, 2001). Exchange theory, at its most basic, suggests that individuals who perceive equity in their social arrangements, who see these arrangements as inherently just, and who believe that their contributions are successful, are happier with their outcomes, experience more group cohesion, and are more affectively committed to participating in ongoing exchanges. Conversely, individuals who feel that their costs outstrip their rewards, their contributions are not valued, or the exchange is not successful are likely to exit the exchange—whether within the context of a friendship, a marriage, a job, or a small task-focused group.

Taken together, these perspectives—be they rooted in identity or affective processes, justice, equity, or social exchange—reveal that emotions are shaped by existing social and structural arrangements. They also illustrate emotions' ability to contribute to and disrupt the very conditions that gave rise to them initially, an insight seen most clearly in the scholarship on emotion and social change.

Emotions and Social Change

Whereas the bulk of sociological analysis of emotion has focused on the ways in which emotion is shaped by culture and social structure, emotions have always been recognized as an important part of social movements and, thus, social change (Goodwin, Jasper, & Polletta, 2001). That said, prior to the 1970s, emotions were often viewed pejoratively by movement scholars, who perceived them as something that transformed protestors into angry, irrational mobs (Jasper, 2014). Then, from the 1970s to the 1990s, scholars routinely overlooked the emotions of protesters, mainly out of fear that documenting strong emotions (e.g., pride or righteous anger) would paint the protestors as irrational—as opposed to rational—actors. As such, it was not until the 1990s, bolstered by the rise of cognitive-appraisal theories and the influence of a cultural paradigm sympathetic to protestors' points of view, that emotion began to reappear as a normal part of political action (see Jasper, 2014).

Since making emotions more central, social movement scholars have identified several emotional dynamics that help explain social and political protest. These include acts of motivation (Collins, 2001; van Stekelenburg & Klandermans, 2013), group solidarity (McGarry & Jasper, 2014; van Zomeren, Spears, Fischer, & Leach, 2004), the impact of morality on political action (Jasper & Poulsen, 1995; Jasper, 1997; see also Gould, 2009; Nepstad & Smith, 2001; Risley, 2011; Warren, 2010; Young, 2001) and the gendered division of labor—which tends to assign emotional labor and other devalued emotional tasks to women—in social movement organizations (Taylor, 1996).

In addition to the role that emotions play in social movements, scholars have also turned their attention to the role that emotion management, particularly interpersonal emotion management, plays in motivating social movement participation. Identity-based social movements, for example, face a unique challenge in motivating potential constituents to participate in collective action (Britt & Heise, 2000). Because identity-based movements often involve overcoming stigma, and thus shame, constituents who fear further stigmatization may wish to limit their involvement. As such, inspiring individuals to take action can be difficult. According to Britt and Heise (2000), movement activists use identity-based emotion management strategies that maneuver constituents through fear and anger in order to get them from an affective space largely characterized by shame into one of pride. When potential constituents feel pride (a relatively positive, powerful, and active emotion), they are more likely to participate in positive, powerful, and active behaviors, such as social protest, marching, and chanting (see also Taylor, 1996).

Gould's (2009) analysis of the rise, success, and eventual decline of ACT UP organizations during the beginning of the U.S. AIDS epidemic documents the role of both emotion and emotion management in creating and sustaining social change. According to Gould, the gay and lesbian community actively encouraged members to feel and express anger toward the federal government following a Supreme Court decision that upheld a state ruling deeming homosexual sodomy in the privacy of one's own home illegal. The successful transformation of the groups' collective shock and grief, which had arisen during the early years of the AIDS epidemic into anger and rage after the Supreme Court decision, resulted in the proliferation of ACT UP organizations across the country, and this led to both short-term upheaval and long-term social change. Gould's analysis suggests that in order for emotions and, subsequently, protest, to ignite, a certain emotional habitus, a template for what and how to feel, is necessary. Prior to the Supreme Court decision, the gay and lesbian community was lacking such a template that would not only allow, but also *encourage*, its constituents to feel anger and engage in sustainable protest.

Conclusions

This review drew attention to two of the guiding perspectives within this particular subfield of sociology—that is, the cultural and structural perspectives—to highlight a few of the founding and enduring questions that have come to characterize much of the work within the sociology of emotion. Sociological analysis of emotion uniquely illuminates the interdependent relationship between emotions and the cultural and structural arrangements in which they occur. Just as emotions are shaped by these arrangements, they also have the ability to reify existing structural and cultural arrangements, and to facilitate large-scale cultural and social change.

Although certainly not exhaustive, we seek in this review to outline the current state of the field as we see it and to introduce some of the emerging lines of sociological research on emotion, as scholars continue to venture into increasingly specialized organizations and subcultures (Hunt, 2013; Kolb, 2014; Lois, 2003; Newmahr, 2014; Vaccaro, Schrock, & McCabe, 2011), create evermore detailed datasets (Erickson & Ritter, 2001; Sloan, Evenson Newhouse, & Thompson, 2013), and adopt increasingly complicated and nuanced models of emotional experience, many of which are rooted deeply within identity processes (Dippong, 2013; Hoey, Schröder, & Alhothali, 2013) . To this end, we would like to conclude by drawing attention to what we hope is a trend in the general study of emotion—a trend that sociologists are involved in and, in some cases, leading.

Over the last 10 years, we have seen the introduction of broad theoretical frames large enough to invite, promote, and incorporate interdisciplinary inquiry in the study of emotion. One of the most recent examples comes from Rogers et al. (2014), who propose affect control theory (Heise, 2007) as a useful medium for cross-disciplinary collaborative studies of emotion. Their argument is grounded in the fact that affect control theory rests on an empirical base, links individual and social aspects of emotion, and describes how emotion is affected by social mechanisms operating at the interaction, relationship, and cultural levels. The authors illustrate how affect control theory's emotion model corresponds with other major theories of emotion construction at four different levels of analysis—cultural, interactional, individual, and neural—and extend an invitation to scholars in a range of disciplines to participate in their multidisciplinary vision that is already being answered (see Rogers et al., 2014; Lindquist & MacCormack, 2014; Salmela, 2014; Pornpattananangkul & Chiao, 2014; Robinson, 2014).

While the creation of interdisciplinary bridges is not unheard of, such endeavors do remain relatively rare within academia. This no doubt stems in part from the increasing specialization within social sciences, as well as the ongoing organizational specialization perpetuated in most academic settings (House, 1981; Mills, 1956). Despite such barriers, however, the interdisciplinary research that does exist has been extremely fruitful, as psychologist Grandey's decade-long study of emotion regulation in the workplace has revealed (Grandey et al., 2013; Grandey, 2000).

In a series of papers and projects, including an edited volume drawing from a range of academic disciplines, Grandey and colleagues (2013) have successfully unified many of the discipline-specific perspectives on emotion management and emotional labor in the workplace under the umbrella of emotion regulation. Such an approach embraces insights from Grandey's home discipline as well as from sociology and organizational behavior, among others. This model, like that of Rogers et al. (2014) introduced above, invites and encourages analysis of emotional labor in the workplace using a wide range of methods, from lab experiments to field observations, and provides a useful frame under which those studying emotion can engage in meaningful dialogue around commonly held interests and concerns.

Nearly 40 years have passed since sociologists turned their attention to the social and cultural influences of emotion, as well as the ways in which emotion has the ability to reify or alter existing cultural and structural frames. While these analyses bring important sociological insight to a topic that has been historically dominated by psychology, and more recently, neurology, many—if not most—have been less attuned to the intrapersonal, or even neurological, processes associated with emotionality, in much the same way that psychologists and neurologists have been less attuned to the social aspects for which sociology is best known. To the degree that these disciplinary boundaries are beginning to recede, through the introduction of multilevel, interdisciplinary frames, scholars will undoubtedly be increasingly able to develop more nuanced understandings of emotion as it occurs within, between, and outside of the individuals through which it is experienced.

References

Adams, J. S. (1965). Inequity in social exchange. *Advances in Experimental Social Psychology, 2*, 267–299.

Barton, B. (2007). Managing the toll of stripping: Boundary setting among exotic dancers. *Journal of Contemporary Ethnography, 36*(5), 571–596.

Becker, H. S. (1963). *Outsiders: Studies in the sociology of deviance*. New York: Free Press.

Bellas, M. L. (1999). Emotional labor in academia: The case of professors. *Annals of the American Academy of Political and Social Science, 561*, 96–110.

Bolton, S. C. (2001). Changing faces: Nurses as emotional jugglers. *Sociology of Health and Illness, 23*(1), 85–100.

Britt, L., & Heise, D. R. (2000). From shame to pride in identity politics. In S. Stryker, T. J. Owens, & R. W. White (Eds.), *Self, identity, and social movements* (pp. 252–268). Minneapolis: University of Minnesota Press.

Burke, P. J. (1991). Identity processes and social stress. *American Sociological Review, 56*(6), 836–849.

Burke, P. J., & Harrod, M. M. (2005). Too much of a good thing? *Social Psychology Quarterly, 68*(4), 359–374.

Cahill, S. E. (1999). Emotional capital and professional socialization: The case of mortuary science students (and me). *Social Psychology Quarterly, 62*(2), 101–116.

Cancian, F. M. (1987). *Love in America: Gender and self-development*. New York: Cambridge University Press.

Cancian, F. M., & Gordon, S. L. (1988). Changing emotion norms in marriage: Love and anger in U.S. women's magazines since 1900. *Gender and Society, 2*(3), 308–342.

Cast, A. D., & Cantwell, A. M. (2007). Identity change in newly married couples: Effects of positive and negative feedback. *Social Psychology Quarterly, 70*(2), 172–185.

Charmaz, K. (1980). The social construction of self-pity in the chronically ill. *Studies in Symbolic Interaction, 3*, 123–145.

Clark, C. (1997). *Misery and company: Sympathy in everyday life*. Chicago: University of Chicago Press.

Clay-Warner, J. (2006). Procedural justice and legitimacy: Predicting negative emotional reactions to workplace injustice. In S. R. Thye & E. J. Lawler (Eds.), *Advances in group processes* (Vol. 23, pp. 207–227). Bingley, UK: Emerald Books.

Clay-Warner, J., Hegtvedt, K. A., & Roman, P. (2005). Procedural justice, distributive justice: How experiences with downsizing condition their impact on organizational commitment. *Social Psychology Quarterly, 68*(1), 89–102.

Collins, R. (2001). Social movements and the focus of emotional attention. In J. Goodwin, J. M. Jasper, & F. Polletta (Eds.), *Passionate politics: Emotions and social movements* (pp. 27–44). Chicago: University of Chicago Press.

Collins, R. (2004). *Interaction ritual chains*. Princeton, NJ: Princeton University Press.
Corsaro, W. A. (2005). *The sociology of childhood* (2nd ed.). Thousand Oaks, CA: Pine Forge Press.
Dippong, J. (2013). Using simulated interactions to explore emotional processes and status organizing processes: A joint application of expectation states theory and affect control theory. *Advances in Group Processes, 30*, 195–229.
Durr, M., & Wingfield, A. H. (2011). "Keep your 'N' in check!": African American women and the interactive effects of etiquette and emotional labor. *Critical Sociology, 37*(5), 557–571.
Erickson, R. J., & Ritter, C. (2001). Emotional labor, burnout, and inauthenticity: Does gender matter? *Social Psychology Quarterly, 64*(2), 146–163.
Erickson, R. J., & Wharton, A. S. (1997). Inauthenticity and depression: Assessing the consequences of interactive service work. *Work and Occupations, 24*(2), 188–213.
Evenson, R. J., & Simon, R. W. (2005). Clarifying the relationship between parenthood and depression. *Journal of Health and Social Behavior, 46*(4), 341–358.
Foschi, M. (2000). Double standards for competence: Theory and research. *Annual Review of Sociology, 26*, 21–42.
Francis, L. E. (1997). Ideology and interpersonal emotion management: Redefining identity in two support groups. *Social Psychology Quarterly, 60*(2), 153–171.
Goodwin, J., Jasper, J. M., & Polletta, F. (Eds.). (2001). *Passionate politics: Emotions and social movements*. Chicago: University of Chicago Press.
Gould, D. B. (2009). *Moving politics: Emotion and ACT UP's fight against AIDS*. Chicago: University of Chicago Press.
Granberg, E. (2006). "Is that all there is?": Possible selves, self-change, and weight loss. *Social Psychology Quarterly, 69*(2), 109–126.
Grandey, A. A. (2000). Emotion regulation in the workplace: A new way to conceptualize emotional labor. *Journal of Occupational Health Psychology, 5*(1), 95–110.
Grandey, A. A., Diefendorff, J., & Rupp, D. E. (2013). *Emotional labor in the 21st century: Diverse perspectives on emotion regulation at work*. New York: Routledge.
Greenberg, J. (1990). Organizational justice: Yesterday, today, and tomorrow. *Journal of Management, 16*(2), 399–432.
Guillermina, J. (2006). Emotion in justice processes. In J. E. Stets & J. H. Turner (Eds.), *Handbook of the sociology of emotions* (pp. 321–346). New York: Springer.
Harlow, R. (2003). "Race doesn't matter, but . . .: The effect of race on professors' experiences and emotion management in the undergraduate college classroom. *Social Psychology Quarterly, 66*(4), 348–363.
Hegtvedt, K. A. (2006). Justice frameworks. In P. J. Burke (Ed.), *Contemporary social psychological theories* (pp. 46–69). Stanford, CA: Stanford University Press.
Hegtvedt, K. A., & Killian, C. (1999). Fairness and emotions: Reactions to the process and outcomes of negotiations. *Social Forces, 78*(1), 269–302.
Hegtvedt, K. A., & Parris, C. L. (2014). Justice theory and emotions. In J. E. Stets & J. H. Turner (Eds.), *Handbook of the sociology of emotions* (Vol. 2, pp. 103–126). New York: Springer.
Heise, D. R. (2006). Sentiment formation in social interaction. In K. A. McClelland & T. J. Fararo (Eds.), *Purpose, meaning and action: Control systems theories in sociology* (pp. 189–211). London: Palgrave Macmillan.
Heise, D. R. (2007). *Expressive order: Confirming sentiments in social actions*. New York: Springer.
Heise, D. R. (2013). Modeling interactions in small groups. *Social Psychology Quarterly, 76*(1), 52–72.
Hochschild, A. R. (1975). The sociology of feeling and emotion: Selected possibilities. *Sociological Inquiry, 2*(3), 280–307.
Hochschild, A. R. (1979). Emotion work, feeling rules, and social structure. *American Journal of Sociology, 85*(3), 551–575.
Hochschild, A. R. (1983). *The managed heart: Commercialization of human feeling*. Berkeley: University of California Press.
Hochschild, A. R., & Machung, A. (1989). *The second shift: Working parents and the revolution at home*. New York: Viking.
Hoey, J., Schröder, T., & Alhothali, A. (2013). Bayesian affect control theory. *Proceedings of the 5th biannual Humaine Association Conference on Affective Computing and Intelligent Interaction (ACII-2013)*, 166–172.
House, J. S. (1981). Social structure and personality. In M. Rosenberg & R. H. Turner (Eds.), *Social psychology* (pp. 525–561). New York: Basic Books.
Hunt, P. M. (2008). From festies to tourrats: Examining the relationship between jamband subculture involvement and role meanings. *Social Psychology Quarterly, 71*(4), 356–378.
Hunt, P. M. (2013). *Where the music takes you: The social psychology of music subcultures*. San Diego, CA: Cognella.
Jackson, B. A. (2012). Bonds of brotherhood: Emotional and social support among college black men. *Annals of the American Academy of Political and Social Science, 642*(1), 61–71.
Jasper, J. M. (1997). *The art of moral protest*. Chicago: University of Chicago Press.
Jasper, J. M. (2014). Constructing indignation: Anger dynamics in protest movements. *Emotion Review,* 6(3), 208–213.
Jasper, J. M., & Poulsen, J. D. (1995). Recruiting strangers and friends: Moral shocks and social networks in animal rights and anti-nuclear protests. *Social Problems, 42*(4), 493–512.
Johnson, C. (1992). The emergence of the emotional self: A developmental theory. *Symbolic Interaction, 15*(2), 183–202.
Kemper, T. D. (1978). *A social interactional theory of emotions*. New York: Wiley.
Kemper, T. D., & Collins, R. (1990). Dimensions of microinteraction. *American Journal of Sociology, 96*(1), 32–68.
Kolb, K. H. (2014). *Moral wages: The emotional dilemmas of*

victim advocacy and counseling. Oakland, CA: University of California Press.

Lawler, E. J. (2001). An affect theory of social exchange. *American Journal of Sociology, 107*(2), 321–352.

Lawler, E. J., & Thye, S. R. (1999). Bringing emotions into social exchange theory. *Annual Review of Sociology, 25,* 217–244.

Lawler, E. J., Thye, S. R., & Yoon, J. (2009). *Social commitments in a depersonalized world.* New York: Russell Sage Foundation.

Lawler, E. J., & Yoon, J. (1996). Commitment in exchange relations: Test of a theory of relational cohesion. *American Sociological Review, 61*(1), 89–108.

Leavitt, R. L. (1994). *Power and emotion in infant–toddler day care.* Albany: State University of New York Press.

Leidner, R. (1993). *Fast food, fast talk: Service work and the routinization of everyday life.* Berkeley: University of California Press.

Lindquist, K. A., & MacCormack, J. K. (2014). Comment: Constructionism is a multilevel framework for affective science. *Emotion Review,* 6(2), 134–135.

Lively, K. J. (2000). Reciprocal emotion management: Working together to maintain stratification in private law firms. *Work and Occupations, 27,* 32–63.

Lively, K. J. (2001). Occupational claims to professionalism: The case of paralegals. *Symbolic Interaction, 24*(3), 343–366.

Lively, K. J. (2006). Emotions in the workplace. In J. H. Turner & J. E. Stets (Eds.), *Handbook of the sociology of emotions* (pp. 569–590). New York: Springer.

Lively, K. J. (2008). Emotional segues and the management of emotion by women and men. *Social Forces, 87*(2), 911–936.

Lively, K. J. (2013). Age and the experience and management of emotion. In S. R. Thye, E. J. Lawler (Eds.), *Advances in group processes* (Vol. 30, pp. 231–265). Bradford, UK: Emerald Group.

Lively, K. J., & Heise, D. R. (2004). Sociological realms of emotional experience. *American Journal of Sociology, 109*(5), 1109–1136.

Lively, K. J., & Heise, D. R. (2014). Emotions in affect control theory. In J. E. Stets & J. H. Turner (Eds.), *Handbook of the sociology of emotions* (Vol. 2, pp. 51–76). New York: Springer.

Lively, K. J., & Powell, B. (2006). Emotional expression at work and at home: Domain, status, or individual characteristics? *Social Psychology Quarterly,* 69(1), 17–38.

Lively, K. J., Powell, B., Geist, C., & Steelman, L. C. (2008). Equity among intimates. In K. A. Hegtvedt & J. Clay-Warner (Eds.), *Advances in group processes* (Vol. 25, pp. 87–115). Bingley, UK: Emerald Books.

Lively, K. J., Steelman, L. C., & Powell, B. (2010). Equity, emotion, and household division of labor. *Social Psychology Quarterly, 73*(4), 358–379.

Lively, K. J., & Weed, E. A. (2014). Emotion management: Sociological insight into what, how, why, and to what end? *Emotion Review, 7*(6), 187–188.

Lofland, L. H. (1985). The social shaping of emotion: The case of grief. *Symbolic Interaction,* 8(2), 171–190.

Lois, J. (2003). *Heroic efforts: The emotional culture of search and rescue volunteers.* New York: New York University Press.

Lois, J. (2013). *Home is where the school is: The logic of homeschooling and the emotional labor of mothering.* New York: New York University Press.

MacKinnon, N. J., & Heise, D. R. (2010). *Self, identity, and social institutions.* New York: Palgrave.

McGarry, A., & Jasper, J. M. (2014). *The identity dilemma.* New York: Temple Press.

Mills, C. W. (1956). *The power elite.* Oxford, UK: Oxford University Press.

Nepstad, S. E., & Smith, C. (2001). The social structure of moral outrage in recruitment to the U.S. Central America peace movement. In J. Goodwin, J. M. Jasper, & F. Polletta (Eds.), *Passionate politics: Emotions and social movements* (pp. 158–174). Chicago: University of Chicago Press.

Newmahr, S. (2014). Eroticism as embodied emotion: The erotics of the Renaissance Faire. *Symbolic Interaction, 37*(2), 209–225.

Paules, G. F. (1991). *Dishing it out: Power and resistance among waitresses in a New Jersey restaurant.* Philadelphia: Temple University Press.

Pierce, J. L. (1995). *Gender trials: Emotional lives in contemporary law firms.* Berkeley: University of California Press.

Pollak, L. H., & Thoits, P. A. (1989). Processes in emotional socialization. *Social Psychology Quarterly, 52*(1), 22–34.

Pornpattananangkul, N., & Chiao, J. Y. (2014). Comment: Affect control theory and cultural priming: A perspective from cultural neuroscience. *Emotion Review,* 6(2), 136–137.

Ridgeway, C. L. (2006). Expectation states theory and emotion. In J. E. Stets & J. H. Turner (Eds.), *Handbook of the sociology of emotions* (pp. 347–367). New York: Springer.

Ridgeway, C. L. (2011). *Framed by gender: How gender inequality persists in the modern world.* Oxford, UK: Oxford University Press.

Ridgeway, C. L., & Johnson, C. (1990). What is the relationship between socioemotional behavior and status in task groups? *American Journal of Sociology,* 95(5), 1189–1212.

Ridgeway, C. L., Li, Y. E., Erickson, K. G., Backor, K., & Tinkler, J. E. (2009). How easily does a social difference become a status distinction?: Gender matters. *American Sociological Review, 74*(1), 44–62.

Risley, A. (2011). Rejoinder. In J. Goodwin & J. Jasper (Eds.), *Contention in context: Political opportunities and the emergence of protest* (pp. 108–113). Stanford, CA: Stanford University Press.

Ritchie, A., & Barker, M. (2006). "There aren't words for what we do or how we feel so we have to make them up": Constructing polyamorous languages in a culture of compulsory monogamy. *Sexualities,* 9(5), 584–601.

Robinson, D. T. (2014). Comment: Growing a multilevel science of emotion. *Emotion Review,* 6(2), 137–138.

Robinson, D. T., Smith-Lovin, L., & Tsoudis, O. (1994). Heinous crime or unfortunate accident?: The effects of remorse on responses to mock criminal confessions. *Social Forces, 73*(1), 175–190.

Rogers, K. B., Schröder, T., & von Scheve, C. (2014). Dissecting the sociality of emotion: A multi-level approach. *Emotion Review, 6*(2), 124–133.

Ross, C. E., & Mirowsky, J. (2003). *Social causes of psychological distress* (2nd ed.). New York: Aldine de Gruyter.

Salmela, M. (2014). Comment: Critical questions for affect control theory. *Emotion Review, 6*(2), 138–139.

Siemsen, C. (2004). *Emotional trials: The moral dilemmas of women criminal defense attorneys*. Boston: Northeastern University Press.

Simon, R. W. (2007). Contributions of the sociology of mental health for understanding the social antecedents, social regulation, and social distribution of emotion. In W. Avison, J. McLeod, & B. Pescosilido (Eds.), *Mental health, social mirror* (pp. 239–274). New York: Springer.

Simon, R. W., Eder, D., & Evans, C. (1992). The development of feeling norms underlying romantic love among adolescent females. *Social Psychology Quarterly, 55*(1), 29–46.

Simon, R. W., & Lively, K. J. (2010). Sex, anger and depression. *Social Forces, 88*(4), 1543–1568.

Simon, R. W., & Nath, L. E. (2004). Gender and emotion in the U.S.: Do men and women differ in self-reports of feelings and expressive behavior? *American Journal of Sociology, 109*, 1137–1176.

Sloan, M. M. (2004). The effects of occupational characteristics on the experience and expression of anger in the workplace. *Work and Occupations, 31*(1), 38–72.

Sloan, M. M. (2007). The "real self" and inauthenticity: The importance of self-concept anchorage for emotional experiences in the workplace. *Social Psychology Quarterly, 70*(3), 305–318.

Sloan, M. M., Evenson Newhouse, R. J., & Thompson, A. B. (2013). Counting on coworkers: Race, social support, and emotional experiences on the job. *Social Psychology Quarterly, 76*(4), 343–372.

Smith, A. C. I., & Kleinman, S. (1989). Managing emotions in medical school: Students' contacts with the living and the dead. *Social Psychology Quarterly, 52*(1), 56–59.

Smith, H., & Francis, L. (2005). Social vs. self-directed events among Japanese and Americans. *Social Forces, 84*(2), 821–830.

Smith-Lovin, L., & Douglas, W. T. (1992). An affect control analysis of two religious subcultures. In D. D. Franks & V. Gecas (Eds.), *Social perspectives on emotion* (pp. 217–247). New York: JAI Press.

Smith-Lovin, L., & Heise, D. R. (Eds.). (1988). *Analyzing social interaction: Advances in affect control theory*. New York: Gordon and Breach Science.

Stacey, C. L. (2011). *The caring self: The work experiences of home care aides*. Ithaca, NY: ILR Press.

Staske, S. A. (1996). Talking feelings: The collaborative construction of emotion in talk between close relational partners. *Symbolic Interaction, 19*(2), 111–142.

Staske, S. A. (1998). The normalization of problematic emotion in conversations between close relational partners: lnterpersonal emotion work. *Symbolic Interaction, 21*(1), 59–86.

Staske, S. A. (1999). Creating relational ties in talk: The collaborative construction of relational jealousy. *Symbolic Interaction, 22*(3), 213–246.

Stearns, C. Z., & Stearns, P. N. (1989). *Anger: The struggle for emotional control in America's history*. Chicago: University of Chicago Press.

Stearns, P. N., & Lewis, J. (Eds.). (1998). *An emotional history of the United States*. New York: New York University Press.

Stets, J. E. (2005). Examining emotions in identity theory. *Social Psychology Quarterly, 68*(1), 39–56.

Stets, J. E., & Carter, M. J. (2011). The moral self: Applying identity theory. *Social Psychology Quarterly, 74*(2), 192–215.

Stets, J. E., & Turner, J. H. (2008). The sociology of emotions. In M. Lewis, J. M. Haviland-Jones, & L. F. Barret (Eds.), *Handbook of emotions* (3rd ed., pp. 32–46). New York: Guilford Press.

Stryker, S., & Serpe, R. T. (1982). Commitment, identity salience and role behavior: Theory and research example. In W. Ickes & E. S. Knowles (Eds.), *Personality, roles and social behavior* (pp. 192–216). New York: Springer-Verlag.

Stryker, S., & Serpe, R. T. (1994). Identity salience and psychological centrality: Equivalent, overlapping, or complementary concepts? *Social Psychology Quarterly, 57*(1), 16–35.

Sutton, R. I. (1991). Maintaining norms about expressed emotions: The case of bill collectors. *Administrative Science Quarterly, 36*(2), 245–268.

Swidler, A. (1986). Culture in action: Symbols and strategies. *American Sociological Review, 51*(2), 273–286.

Taylor, V. A. (1996). *Rock-a-bye baby: Feminism, self-help and postpartum depression*. New York: Routledge.

Thoits, P. A. (1984). Coping, social support, and psychological outcomes: The central role of emotion. *Review of Personality and Social Psychology, 5*, 219–238.

Thoits, P. A. (1985). Self-labeling processes in mental illness: The role of emotional deviance. *American Journal of Sociology, 91*(2), 221–249.

Thoits, P. A. (1995). Stress, coping, and social support processes: Where are we? What next? *Journal of Health and Social Behavior, 35*(Extra issue), 53–79.

Thorne, B. (1993). *Gender play: Girls and boys in school*. New Brunswick, NJ: Rutgers University Press.

Tiedens, L. Z., Ellsworth, P. C., & Mesquita, B. (2000). Sentimental stereotypes: Emotional expectations for high- and low-status group members. *Personality and Social Psychology Bulletin, 26*(5), 560–575.

Vaccaro, C. A., Schrock, D. P., & McCabe, J. M. (2011). Managing emotional manhood: Fighting and fostering fear in mixed martial arts. *Social Psychology Quarterly, 74*(4), 414–437.

van Stekelenburg, J., & Klandermans, B. (2013). Fitting demand and supply: How identification brings appeals and motives together. *Social Movement Studies: Journal of Social, Cultural and Political Protest, 13*(2), 179–203.

van Zomeren, M., Spears, R., H., Fischer, A. H., & Leach, C. W. (2004). Put your money where your mouth is!: Explaining collective action tendencies through group-based anger and group efficacy. *Journal of Personality and Social Psychology, 87*, 649–664.

Walster, E. H., Berscheid, E., & Walster, G. W. (1975). New directions in equity research. In L. Berkowitz & E. Walster (Eds.), *Advances in experimental social psychology* (Vol. 9, pp. 1–42). New York: Academic Press.

Walster, E. H., Walster, G. W., & Berscheid, E. (1978). *Equity: Theory and research*. New York: Allyn & Bacon.

Warren, M. R. (2010). *Fire in the heart: How white activists embrace racial justice*. New York: Oxford University Press.

Wasielewski, P. L. (1985). The emotional basis of charisma. *Symbolic Interaction, 8*(2), 207–222.

Wei, J. (2014). Mass media and the localization of emotional display: The case of China's next top model. *American Journal of Cultural Sociology, 2*(2), 197–220.

Wharton, A. S. (1993). The affective consequences of service work: Managing emotions on the job. *Work and Occupations, 20*(2), 205–232.

Wharton, A. S. (1999). The psychosocial consequences of emotional labor. *Annals of the American Academy of Political and Social Science, 561*, 158–176.

Wharton, A. S. (2009). The sociology of emotional labor. *Annual Review of Sociology, 35*, 147–165.

Wharton, A. S., & Erickson, R. J. (1995). The consequences of caring: Exploring the links between women's job and family emotion work. *Sociological Quarterly, 36*(2), 273–296.

Wingfield, A. H. (2010). Are some emotions marked "whites only"?: Racialized feeling rules in professional workplaces. *Social Problems, 57*(2), 251–268.

Young, M. P. (2001). A revolution of the soul: Transformative experiences and immediate abolition. In J. Goodwin, J. M. Jasper, & F. Polletta (Eds.), *Passionate politics: Emotions and social movements* (pp. 99–114). Chicago: University of Chicago Press.

CHAPTER 4

Emotions in Music, Literature, and Film

P. N. Johnson-Laird and Keith Oatley

Emotions appear to be common to all social mammals. Human emotions, however, are unique in their connection to music and literature—the arts. People can experience an emotion not because of a real event, but because they are reading a poem or a novel, watching a play or a movie, looking at a picture or a sculpture, or listening to music. People probably go out of their way to have these experiences. They spend much of their time seeking emotions, because to be bereft of them is hardly to be alive. Psychologists need to study these phenomena, because they mutually inform their understandings of both the arts and emotions.

The artistic side of the equation reduces to words, images, and music, which may be singular or combined in what the composer Richard Wagner referred to as *Gesamtkunstwerk*—a total work of art. For him it was opera; for us nowadays it is cinema. The most striking effects from a psychological standpoint, however, are that emotions can arise from music and from words.

> Oooooooooooooooooooooooo,
> dll rrrrr beeeee bö
> dll rrrrr beeeee bö fümms bö,
>   rrrrr beeeee bö fümms bö wö,
>   beeeee bö fümms bö wö tää

This is an extract from Kurt Schwitters's poem "Ursonate." You probably noticed that it is not written in German, Schwitters's native tongue. It is not in any natural language. It is a "sound poem," written in a sequence of speech sounds that don't mean anything. You can listen to Schwitters's dramatic reading of his poem at *www.costis.org/x/schwitters/ursonate.htm*. If you do, you may be slightly amused at first, but it grows tiresome. The sounds don't refer to anything, and it lacks emotional impact.

Pure music is a sequence of sounds that don't refer to anything. Yet pure music can move you. So, why the difference? One clue comes from another sort of poem, such as W. H. Auden's poem "Night Mail," which he wrote for the final minutes of a film about the express train that took the mail from London to Scotland. You can watch the movie and hear the poem on *www.youtube.com/watch?v=JPLH00tlcnM*. The images its rhyming couplets evoke—the jug gently shaking, and so forth—are so powerful that the movie's directors felt no need to accompany them with matching pictures.

Poetry stands midway between fiction and music. It communicates *propositions* that can summon up a world (i.e., a mental model), much as novels can. Propositional content often suffices to create emotions. But, poetry can also embody rhythm and meter, much as music can. Poetry may move readers even if they don't quite understand it, as, say, in the symbolist works of Valéry. Likewise, a novel such as Joyce's *Finnegans Wake* with its torrent of neologisms, is almost beyond comprehension, and yet for dedicated readers it is a source of joy; and at least one of them discerns within it a musical structure (Kitcher, 2007). Speech sounds, however, cry out for referents, and when they have none, as in "Ursonate," the result is tedium.

This chapter focuses on music, literature, and film. Since our last review (Johnson-Laird & Oatley, 2008), the field has continued to burgeon. For example, the topic of music and emotion now has its own handbook (Juslin & Sloboda, 2010). This chapter's goal is to bring readers up to date. It begins with a cognitive theory of emotions—the one that underlies our research. It addresses the mystery of how music creates emotions even though it has no propositional content. It then considers literature, drama, and film, to explain the emotional effects of narratives.

A Communicative Theory of Emotions

Mammals need to solve problems. Some problems, such as the quest for a mate or the care of offspring, arise from their social environment. Thinking, as a means to solve these problems, takes time and memory, and almost all problems that fall within the purview of logic, probability, or decision theory, are computationally intractable (Johnson-Laird, 2006). Emotions are a way around this impasse. Many situations trigger emotions that direct attention, coordinate plans, prepare appropriate behaviors, and signal to conspecifics. Emotions are communications both within and between individuals (Oatley & Johnson-Laird, 1987, 1996, 2011). Within individuals, they can combine a subjective feeling, a physiological response, and behavior. Between individuals, they can spread emotions to others.

A system of emotions is common to all social mammals. It handles innate *basic* emotions that have evolved to cope with their principal problems. To generate such emotions, very simple computations, which do not require any working memory for intermediate results, appraise the current situation and transmit signals within the brain. These signals do not require working memory for their interpretation because, unlike propositions, they do not depend on computations that construct their meanings from the meanings of their parts and the grammatical relations among these parts.

The distinction between signals that do and do not have propositional content is critical to our argument in this chapter. In humans, nonpropositional signals underlie facial expressions, tone of voice, postures, and behaviors that communicate basic emotions such as happiness, sadness, anger, and fear (see Russell, Bachorowski, & Ferndandez-Dols, 2003; Keltner, Oatley, & Jenkins, 2013). In all cultures, a smile is a signal of happiness, and weeping is a signal of sadness. These and other expressions of basic emotions are human universals, and their creation and interpretation is carried out in specialized regions of the brain (see, e.g., Panksepp, 1998, 2005; Keltner, Ekman, Gonzaga, & Beer, 2003).

An emotional signal begins with an appraisal. If a piece of music lifts your spirits, you can be aware both of your emotion and of the music as its cause. But if the music is in the background, you may not realize that your feelings are attributable to it, and you may fail to notice a change in them. Hence, contrary to Freud (1915/1971), your emotions can be unconscious. Likewise, you may not be aware of the exact features of the music responsible for your feelings or of the transition from appraisal to emotion. You cannot choose to switch an emotion on or off: you feel anger or fear without choice (Aristotle, 1984, *Nichomachean Ethics*, line 1106a3). Basic emotions arise as a result of rudimentary appraisals, and they can be experienced for no known reason (Oatley & Johnson-Laird, 1996). Psychological illnesses appear to arise from pathology in these basic emotions (Johnson-Laird, Mancini, & Gangemi, 2006).

Consider these events:

A couple's two sons stabbed them and left them to bleed to death in order to inherit their money.

You are likely to feel revulsion and to judge the sons as wicked. This scenario and many others elicit emotions prior to moral evaluations. The order of events, however, is different in other scenarios, because moral judgments can precede emotions (Bucciarelli, Khemlani, & Johnson-Laird, 2008). In either case, you are aware of the propositional content and the emotion it triggers. *Complex* emotions, as we define them, can be experienced only by means of the propositional content of the appraisals that give rise to them. Such emotions include remorse, jealousy, and sympathy. Their propositional content may vary depending on culture (Johnson-Laird & Oatley, 2000). Yet, even so, you cannot control the unconscious transition from an appraisal to an emotion.

In sum, humans have basic and complex emotions. Basic emotions depend on evolutionarily older subcortical regions of the brain, such as the limbic system. They can be experienced in the absence of propositional content. Complex emotions occur when a conscious appraisal with propositional content evokes a basic emotion (Keltner et al., 2013), and they depend on the evolutionarily newer prefrontal lobes of the brain. If these regions are damaged, individuals suffer impairments in these emotions, and cease to be able to plan their lives or to make sensible decisions (Damasio, 1994). Propositions can be mapped into, or from, language. And their creation and interpretation depend on working memory, because their structures are often recursive (Fitch, Hauser, & Chomsky, 2005), and call for people to determine the referents of expressions. The human emotional system handles both simple signals and complex messages, as internal and external communications.

Music and Emotions

Most people enjoy music; and, as far as we know, every culture makes music, often as a social activity. Its universality implies that, like basic emotions, it has an innate basis. This basis includes the fundamental properties of mammalian hearing:

- Logarithmic steps in frequency yield equal steps in perceived pitch.
- Natural sounds, which contain a fundamental frequency and overtones of higher frequencies with small amplitudes, are perceived as individual events.
- A pair of notes that have harmonic overtones and that are an octave apart sound very similar, where the higher note in an octave has a fundamental frequency twice that of the lower note, and harmonic overtones are those with frequencies that are integral multiples of the frequency of the fundamental; for example, a fundamental frequency of 20 cycles per second has integral multiples of 40, 60, 80, . . . , cycles per second. String and wind instruments produce notes with harmonic overtones.
- Overtones that are close in frequency create rapid beating, because they stimulate adjacent regions of the basilar membrane within the cochlea. The result is a roughness in sound (Helmholtz, 1877/1912).

The processing capacity of human working memory both constrains scales—the notes from which most music is constructed—to contain 7 ± 2 notes (Miller, 1956), and leads to temporal groupings of musical events, a principle that underlies meter (Longuet-Higgins & Lee, 1984).

Most Western music consists of a melody and an accompaniment, where the accompaniment consists of sets of pitches in chords. And, from around 1600 C.E. to the present day, most Western music is *tonal*, including popular songs and jazz (Johnson-Laird, 2002). Tonality, despite the claims of composers from Hindemith to Bernstein, is not innate, and it cannot be derived from the series of harmonic overtones. It depends on a division of the octave into 12 separate notes—nowadays into 12 *equal* logarithmic intervals of frequency, and the use of major and minor scales. These choices are cultural. Other cultures make other choices (e.g., Indian classical music originally divided the octave into 22 notes, and used other scales). Western musicians also prefer string and wind instruments, which produce harmonic overtones. Other musicians differ. Indonesians, for example, favor instruments made from metal, which produce notes with inharmonic overtones, and their gamelan orchestras are tuned individually to no common standard (Sethares, 2005).

Granted its innate basis, the question of whether music conferred evolutionary advantages is unresolved (see, e.g., Darwin, 1872/1965; Pinker, 1997; Miller, 2000; Huron, 2003; Patel, 2008, chap. 7). Our aim is to try to answer three more tractable questions. First, does music create emotions? Listeners can tell that a piece of music conveys happiness, but can listening to it make them happy? The evidence shows that it can. The second question is, accordingly: What emotions can music create? The third question is How does music evoke these emotions?

Music Creates Emotions

Many, if not most, listeners can grasp that different pieces of music communicate different emotions. For instance, they know that the tune of the Beatles' "Yellow Submarine" communicates happiness, whereas Thelonious Monk's theme "Round Midnight" communicates sadness. Yet they themselves may be bored or irritated by these pieces. Indeed, many people feel happy listening to sad music (Kawakami, Kiyoshi, Katahira, Kamiyama, & Okanoya, 2013). This distinction between recognizing an emotion that is communicated and feeling the emotion also occurs with literature. The demise of Little Nell in Dickens's *The Old Curiosity Shop* is a poignant moment in literature, but Oscar Wilde remarked, "One would have to have a heart of stone to read the death of Little Nell without laughing." Granted this distinction, studies of whether participants have real feelings from listening to music are essentially over once experimenters have selected the musical extracts, because at least some individuals—the experimenters themselves—are affected by the music. Since the 1890s, experiments have examined what participants report about their experiences, and they say that music creates real feelings (see e.g., Gilman, 1891, 1892; Downey, 1897; Gabrielsson & Lindström, 2001; and Eerola & Vuoskoski, 2013, for a review), and that it is a way to induce moods (Västfjäll, 2001–2002; see Juslin & Sloboda, 2010).

Of course there are skeptics. The most famous was the composer Igor Stravinsky. He wrote, "I consider that music is, by its very nature, powerless to express anything at all, whether a feeling, an attitude of mind, a psychological mood, etc." (1936, p. 91). Likewise, some philosophers argue that emotions are *about* something, but pure music is not about anything, and so it can't create emotions (see, e.g., Nussbaum, 2001; cf. Sloboda & Juslin, 2001). Such arguments are baseless according to our communicative theory, because basic emotions can be experienced without being about anything or having any propositional content. An empirical rebuttal to the skeptics is the evidence of brain activity when individuals report emotional responses to music; such activity occurs in regions of the brain that mediate emotions (e.g., Blood & Zatorre, 2001; Trainor & Schmidt, 2003). Another rebuttal comes from medicine. Music has calming effects on physiological indices of stress in premature babies (Loewy, Steward, Dassler, Telsey, & Homel, 2013), and it induces relaxation and a rise in oxytocin levels after open-heart surgery (Nilsson, 2009). In summary, individuals report that a piece of music stirs them, they tend to concur about the emotion, and it is mediated by regions known to be active concurrently with the emotion. People report that they listen to music to reinforce their current emotion or to change it, especially as a form of psychotherapy in order to relieve stress. The evidence is overwhelming: Music can create emotions in human listeners.

It does not follow that the popularity of music depends on its emotional appeal. The 19th-century Viennese critic Eduard Hanslick accepted that music evokes emotions, but he argued they were not crucial to its appreciation. He wrote, "An art aims, above all, at producing something beautiful which affects not our feelings but the organ of pure contemplation, our *imagination*" (1854/1957, p. 11). The notion that listeners respond to beauty without an emotional reaction seems at odds with aesthetic experience (Scherer, 2004). People often have a feeling of awe—a complex emotion based on fear. Beauty creates it, not just in music, but also in many other human activities from science (Farmelo, 2003) to sports (Richards, 2010). In music, it can elicit gooseflesh and other physiological reactions (Panksepp, 1995), and their correlates are evident in the brain (Trost, Ethofer, Zentner, & Vuilleumier, 2012). Later, we consider the literary evocation of aesthetic emotions.

Emotions That Pure Music Can Create

Music is a Rorschach test. It is easy to project interpretations onto it (see, e.g., Downey, 1897). Consider what three distinguished commentators wrote about the same musical moment:

> A flame of incandescent terror. (Lam, 1966, p. 161)
>
> The sky . . . blazing from horizon to horizon. (Simpson, 1970, p. 60)
>
> One of the most horrifying moments in music, as the carefully prepared cadence is frustrated, damming up energy which finally explodes in the throttling murderous rage of a rapist, incapable of attaining release. (McClary, 1987)

They are all referring to the start of the recapitulation (measure 301) in the first movement of Beethoven's Ninth Symphony. It *is* an extraordinary moment. But, no piece of pure music can refer to flame, sky, or rapists. Whatever music may convey, its meaning is not composed from the meanings of its parts, and its parts do not refer to entities, their properties, or relations among them. They do not refer at all. At best they can mimic a sound, as in Olivier Messaien's *Catalogue of Birds*, or Arthur Honegger's simulation of a steam train in *Pacific 231*. When listeners indulge in interpretation, they are exercising their imagination, perhaps creating a sequence of events—a program—for which the music offers an accompaniment. This interpretative propensity leads commentators to ascribe complex emotions to music, such as love, morality, and spirituality (e.g., Ives, 1962, p. 36). They less often describe it as conveying hatred, immorality, and the mundane.

If you hear the John Philip Sousa march "The Liberty Bell," you are unlikely to think of that iconic symbol of American liberty. Instead, you may think of *Monty Python*, because it was the show's theme music. If you play it in your mind's ear, you may hear the flatulent squelch with which it ended in *Python*. Such associations often occur in songs: the music takes on the lyric's emotions. If you listen to Schubert's "The Erl-King," and are unfamiliar with Johann Wolfgang von Goethe's poem, then you will hear that the music conveys fear. But if you understand its German lyrics, then it communicates fear of a greater intensity. Associations can intensify the emotional impact of music. But, as moviemakers know, causation can work in the opposite direction: Music can intensify, and even create, the emotion that a scene conveys (Cohen, 2001). In *Psycho*, the director Alfred Hitchcock shocked viewers: less than half way through the movie he had his leading lady, Janet Leigh, stabbed to death in the shower. Hitchcock's original idea was to have no music during the scene, just screams and the sound of the shower. When the film's composer Bernard Herrmann heard of this plan, he was furious, because he'd already written music for the scene. He persuaded Hitchcock to view the sequence with, and without, his music—high-pitched shrieks on the violins—which anyone who has seen the movie is likely to recall. Hitchcock agreed that the montage was more frightening with the music.

If one discounts associations and the propensity for propositional interpretations, what emotions does pure music prompt? The communicative theory implies that it can elicit only basic emotions, that is, those that are not necessarily *about* anything. As Hanslick (1854/1957, p. 24) wrote: "'Music] cannot reproduce the feeling of love but only the element of motion. . . ." The emotions that music elicits are, accordingly: happiness, sadness, anxiety, anger, and their cognates and mixtures. Music can create surprise, it can be exciting, it can even be shocking—as it was to the audience a century ago at the premiere of Stravinsky's "The Rite of Spring." They rioted. Surprise is a surprising emotion; it can make you happy, sad, fearful, or angry. Excitement, or arousal, may also differ in its affective tone. Meyer (1956) argued that emotions derive from musical expectations, delayed in fulfillment. The longer their resolution is postponed, the greater the emotion. This account can explain how music creates tension, but not how it evokes different emotions, such as happiness or sadness (Budd, 1985).

On the whole, evidence bears out the occurrence of basic emotions to music, but just about every logically possible view about the emotions that music elicits has a defender (see, e.g., Juslin & Västfjäll, 2008). One complication is that some music communicates little or no emotion; another complication is that not everyone experiences the same, or any, emotion to a given piece of music. A recent study, however, sampled 32 students, at random intervals during the day. If they were listening to music, they had to describe their emotions in their own words (Juslin, Liljeström, Västfjäll, Barradas, & Silva, 2008). In their reports, the six most frequent emotions were in rank order: calm–contentment, happiness–elation, interest–expectancy, nostalgia–longing, pleasure–enjoyment, sadness–melancholy. Other studies have obtained similar results using different procedures, such as a large-scale questionnaire (Juslin, Liljeström, Laukka, Västfjäll, & Lundqvist, 2011). These studies show that music–perhaps on television or in a social setting–elicited these emotions, which for the most part are basic. The one exception is nostalgia–longing; you have nostalgia for a past situation or experience, and you long for someone or something. It is feasible that some extra-musical aspect of the listeners' situations elicited this emotion. But what the communicative theory rules out is that music alone can create object-oriented emotions such as love or hate, or complex emotions such as jealousy or remorse. Evidence corroborates this account. Children ages 4 to 6 years are able to discriminate music that expresses basic emotions (Cunningham & Sterling, 1988). Adults can recognize basic emotions in music (Krumhansl, 1997; Kreutz, Ott, Teichmann, Osawa, & Vaitl, 2008). Musicians and music therapists can improvise music to convey these emotions to others (Bunt & Pavlicevic, 2001; Juslin & Timmers, 2010). But perhaps the best evidence is that a people who had never heard Western music, the Mafa in Cameroon, recognized it as happy, sad, or fearful (Fritz et al., 2009).

How Music Evokes Emotions

Granted that music that you have never heard before can stir you, music itself must contain cues that engage the unconscious appraisals creating basic emotions. The process occurs rapidly, with minimal computational power, and without working memory. One corroboration is the speed with which music conveys emotions. Individuals need less than a quarter of a second—a chord or a few notes of melody—to identify whether a musical excerpt is happy or sad (Peretz, Gagnon, & Bouchard, 1998). The question, then, is What cues in music signal emotions?

The answer, following Aristotle (*Politics*, 1984, 1340a11 et seq.), is a mimetic one. Music can signal characteristics of emotional behavior, speech, and thought (Scherer, 1986; Davies, 1994; Juslin &

Laukka, 2003, 2004; Pronin, 2013). When people are happy, they move and think quickly, and speak loudly with an intonation contour that can leap upward for emphasis. But when they are sad, they move and think slowly, and speak softly with a low intonation contour that has only small changes in pitch. Music imitates these features with its "global parameters" (i.e., settings that can vary but that tend to remain constant for some time, such as tempo, volume, pitch, timbre, the range of pitches in a melody, key, and consonance or dissonance). In tonal music, the notes in melodies and chords tend to be from a major scale or a minor scale, which have a psychological reality (Krumhansl, 1990). The C major scale contains the notes C D E F G A B—the white notes on the piano—and the C minor scale replaces the note E with E flat. Settings for the main basic emotions are roughly as follows (see, e.g., Bunt & Pavlicevic, 2001; Juslin, 2001; Johnson-Laird & Oatley, 2008):

- Happiness: medium tempo, loud, wide range of pitches in melody, major scale, consonant.
- Sadness: slow tempo, soft, low pitch, small range of pitches, minor scale, mildly dissonant.
- Anxiety: rapid tempo, moderate volume, low pitch, minor scale, dissonant.
- Anger: rapid tempo, loud, high pitch, minor scale, dissonant.

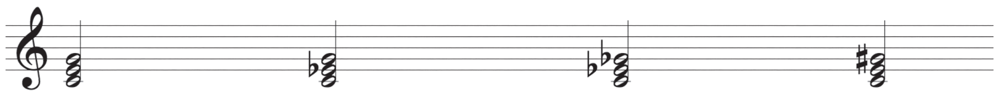
Settings of single parameters affect the ratings of emotions (Juslin & Laukka, 2004). Music in a major scale tends to elicit happiness, whereas in minor or less familiar scales it tends to elicit negative emotions (Gagnon & Peretz, 2003; Temperley & Tan, 2013; Trochidis & Bigand, 2013). The contrast between fast tempo and slow tempo has the same effect (Rigg, 1940; Fritz et al., 2009). When several parameters in music cue a particular emotion, they have an enhanced effect (Webster & Weir, 2005).

A striking phenomenon occurs when music embodies conflicting cues to emotions, such as a major key but a slow tempo. Listeners experience mixed emotions. One study investigated happiness and sadness with actual recordings (Hunter, Schellenberg, & Schimmack, 2008). And an unpublished study due to Olivia Kang exploited a computer program that created music. The program (written by J-L) builds up a matrix of transitions from one note to the next from a corpus of melodies. The transitions embodied both pitch and rhythm. With an input of a chord sequence, the program uses the matrix to generate new melodies. With matrices based on corpora of music eliciting different basic emotions, and with appropriate settings of global parameters, the resulting output is a novel piece of music expressing the relevant emotion. Kang's study confirmed the effect with music based on three corpora of melodies (happy, sad, and anxious). But when the global parameters were set to conflicting values, the listeners were less certain about what emotion the music conveyed, and their choice of terms to characterize it referred to mixed emotions.

Harmony, as the parameter settings above show, communicates emotions. Consonant chords convey positive emotions; dissonant chords convey negative emotions. But what causes consonance or dissonance? The question is one of the oldest in cognitive psychology, probably going back to Pythagoras, though he lived a century before the invention of academia, and published nothing. He is reputed to have argued that consonant musical intervals depend on simple arithmetical ratios between the fundamental frequencies. Galileo and Euler speculated about consonance in a similar way. In contrast, Helmholtz (1877/1912) argued that the roughness caused by fundamentals or overtones creates dissonance, and this view has recent defenders (e.g., Parncutt, 1989).

Figure 4.1 epitomizes the problem. It presents ratings of the dissonance of the four main "triads" in tonal music (i.e., chords of three notes). As the figure shows, roughness fails to explain why the augmented triad is the most dissonant of triads. A modern version of the Pythagorean idea uses the numerical ratio of the fundamental frequency of the lowest note in a chord to the repeating period of the complex waveform of the fundamentals of all the notes in the chord (Stolzenburg, 2010). Figure 4.1 shows these ratios, and they account for the dissonance of triads, but they cannot explain the effects of either timbre or tonal context on dissonance. An alternative theory explains these phenomena, and it combines the innate component of roughness with the cultural component of tonality (Johnson-Laird, Kang, & Leong, 2012). On this account, the augmented triad is the most dissonant because, unlike the other triads, it cannot be constructed from the notes in a major scale. It requires a minor scale. Within the two scales, roughness predicts relative dissonance.

Consonant chords in a tonal sequence convey happiness, whereas dissonant chords create sadness, anxiety, or anger, depending on other parameters, such as tempo. Roughness may explain the observation that 2-month-old infants prefer consonance to dissonance (Trainor, Tsang, & Cheung, 2002). Infants appear to be born sensitive to an



Chord	Major	Minor	Diminished	Augmented
Dissonance	1.67	2.41	3.89	5.26
Roughness	7.27	9.72	22.14	16.07
Periodicity	4.00	10.00	17.00	20.03

FIGURE 4.1. The four main triads of tonal music, their rated dissonance (Johnson-Laird, Kang, & Leong, 2012), roughness following Parncutt's algorithm (multiplied by 100), and periodicity (Stolzenburg, 2010).

emotional component of music as shown in a study of 2-day-old hearing infants of congenitally deaf parents. These neonates prefer singing intended for infants, which is more emotional than singing intended for adults (Masataka, 1999). Likewise, the hemispherical differences in the processing of music are evident even in newborn infants (Perani et al., 2010).

Musical works can have a large-scale structure, made possible by notation, which is a substitute for working memory, and which allows greater computational power in musical composition. No one, for example, is likely to be able to improvise a crab canon, such as the one in Bach's Musical Offering (BMV 1079), in which a melody is accompanied by the same melody played backward. Structure, as Hanslick (1854/1957) intimated, can be beautiful, and this beauty may elicit an aesthetic emotion (Scherer, 2004). What happens more often is that music expresses basic emotions. It does so by *mimesis*. Unconscious cognitions of minimal computational power transmute melody and harmony, and the settings of global parameters, into emotions. As another theorist remarked:

> It becomes possible for motion in music to imitate the peculiar characteristics of motive forces in space, that is, to form an image of the various impulses and forces which lie at the root of motion. And on this . . . essentially depends the power of music to picture emotion. (Helmholtz, 1877/1912, p. 370)

Emotions in Literature and Film

In this section we move from music, which has no propositional content, to forms of art that depend on such content: novels, plays, and films. For such genres, we can use the term "narrative." There is, of course, a distinct psychology of film and its related visual genres (Oatley, 2013a), but text and film versions of a story have been found to have similar emotional effects (Green et al., 2008), which suggest that cognitive processes for narratives in different genres are comparable. We therefore treat together hearing, reading, and watching narratives. For music, a principal question is whether it can elicit emotions, but it is hardly controversial that narratives can do so. The present section accordingly addresses three new questions. The first is What emotions do people want to experience from narratives? The second is How do narratives create emotions? The third is What psychological effects do these emotions have?

Emotions and the Choice of Narratives

People choose pieces of narrative fiction depending on their current emotional state, on their anticipation of the emotions that they will experience from the narrative, and on their personal goals, which are often of an emotional nature (Mar, Oatley, Djikic, & Mullin, 2011). According to a theory of mood management (Zillmann, 1988), people try to promote positive moods and to reduce negative moods, where moods are based on what we refer to as *basic* emotions, because they need not have any propositional content. But Zillmann's theory doesn't explain why people choose narratives that induce negative emotions, such as sadness in tragedy, or anxiety in suspense stories. The same problem arises in listening to music that elicits these emotions. Zillmann (1998) has countered this criticism by arguing that anxiety is acceptable in stories because it magnifies the relief that will be felt on its resolution. This argument leaves unanswered why people enjoy tragedy or sad music.

Oliver (2008) has proposed that people are interested in what she calls tender emotions, which arise from situations in which humans are vulnerable or show compassion. In an experimental test of this idea, participants watched one of three versions of an excerpt from a sad film—Mimi

Leder's *Pay It Forward*—in which the protagonist is stabbed to death as he tries to defend someone (Schramm & Wirth, 2010). One extract was the original version in which the music becomes increasingly upbeat; a second version replaced the original music with a sad piece from Beethoven's Moonlight Sonata; and a third version cut the scene of the protagonist's death, replacing it with a scene underscoring the notion of paying forward good deeds. This third version transformed viewers' sadness into enjoyment, perhaps because it encouraged them to explore deeper meanings of the film, and its underlying social implications. Emotional considerations of this kind influence what people choose to read and to watch.

How Narratives Prompt Emotion

Emotions are at the center of most narrative fiction. In a review of stories worldwide, the two most common genres are the love story and the story of an angry conflict (Hogan, 2003). The emotions that such stories prompt are of several sorts (Oatley, 1994, 2004). One sort, as in the case of music, is aesthetic. It depends on holding the work at a certain psychical distance and considering it as a cultural artifact (see Cupchik, 2002). In this way, individuals might enjoy it as innovative, as possessing a distinctive style, or as having historical significance. Emotions of the second sort are basic: People report about movies that comedies make them happy, thrillers make them anxious, and tragedies make them sad (Oliver & Bartsch, 2010). But this study also showed that movies could be thought provoking and lead to emotions of a third sort: complex emotions. They occur when, like Alice through the looking glass, you enter through a story's surface into its interior, and engage with its characters.

If you enter a narrative, you experience complex emotions such as empathy and sympathy with the characters (Miall & Kuiken, 2002; Oatley, 2002). The so-called paradox of fiction is that to feel emotions of this kind for fictional characters such as Anna Karenina or Mrs. Dalloway, who do not exist, is irrational (e.g., Radford, 1975). Walton's (1990) version of the paradox is to say that emotions elicited by narratives—for instance, in movie thrillers, are make-believe—they are only quasi-emotions. In our view, it is the paradox that is not real. If music evokes real emotions without referring to the real world, it is hardly surprising that imaginary individuals can evoke them too.

To explain how narratives have this effect, we propose three main mechanisms. The first is empathy, which is a complex emotion in which one shares and understands the same emotion as someone else, as a result of identifying with that person (Johnson-Laird & Oatley, 1989; de Vignemont & Singer, 2006). The second is sympathy, which is a complex emotion in which one can feel for people because of their predicament. The third is the triggering of remembered emotions. We discuss each of them in turn.

Empathetic Identification

Although flint tools fashioned for practical reasons have been found from several million years ago, the appearance of art objects in the archaeological record is more recent: a flute from 43,000 years ago (Huron, 2003), burial mounds from 40,000 years ago (Bowler et al., 2003), cave paintings from 31,000 years ago (Chauvet, Deschamps, & Hillaire, 1996). Mithen (1996) has proposed that these signal the appearance into human mentality of metaphor, in which one thing can also be something else: sounds can be music, someone dead can be alive again in a different world, marks on a cave wall can be a rhinoceros. Another metaphorical step can occur in narrative: you can be yourself and someone else (Oatley, 2013b). For instance, you can be yourself and also Anna Karenina (see also Miall & Kuiken, 2002). Empathy is at the heart of this process. The emotion is fundamental to everyday life, because it enables you to feel what others feel. Kaufman and Libby (2012) have shown that people who are less self-conscious, either chronically or as result of instructions, are more able to identify with a character in a short story. These authors also showed that a story in the first-person singular in comparison with one in the third person, or one that delayed the identification of the protagonist as a member of an outgroup, increased participants' spontaneous identification with the protagonist.

Narratives typically concern human intentions and their vicissitudes (Bruner, 1986). Authors offer cues that enable you to construct a kinematic mental model that simulates a world, its characters, and their interactions (Johnson-Laird, 1983; Bower & Morrow, 1990; Oatley, 1999; Mar & Oatley, 2008). A study using functional magnetic resonance imaging (fMRI) corroborated Bower and Morrow's behavioral studies: When a protagonist put down an object he was holding, the region of the reader's brain concerned with grasping and letting go of objects was active. When a story location changed, the region of the reader's brain concerned with visual analysis of a scene was active (Speer, Reynolds, Swallow, & Zacks, 2009). Hence, the simulation that you run when you read a story depends on the brain regions that underlie comparable actions and perceptions in real life (see also Mar, 2011).

When you simulate a story, you tend to identify with the story's protagonist (see also Freud, 1905–1906/1985). You put aside your own goals and plans, and run the protagonist's plans on your own planning processor, which you use to organize your own plans in daily life. When the intentions of the protagonist in the story meet vicissitudes, you experience emotions from your simulation. Although these emotions relate to those of the protagonist's situation, they are not the protagonist's emotions. They are your own. They derive from empathy: you have emotions similar to those of the character. Any emotion can be based on imagination, and so you can empathize with fictional characters. In a crucial experiment, Trabasso and Chung (2004) asked 20 viewers to watch the films *Blade Runner* and *Vertigo*. They rated their liking for the protagonist and the antagonist soon after the beginning and at the end of each film. As participants watched each of these films, the film was stopped at 12 points. At each point one group of 10 viewers rated how well or badly things were going for the protagonist and for the antagonist. The other group of 10 viewers named their own emotions and rated their intensity. When the first group thought that things were going well for the liked protagonist or badly for the disliked antagonist, the second group felt positive emotions, such as happiness, satisfaction, and relief. But, when the first group thought that things were going badly for the protagonist or well for the antagonist, the second group felt negative emotions, such as anxiety, anger, and sadness. As Trabasso and Chung pointed out, the second group's feelings were based on empathy for the protagonist and antipathy for the antagonist, who is in conflict with the protagonist, or interferes with the protagonist's goals. The triggering of empathy may be unconscious, and it occurs in many other activities, such as watching sports.

Although empathy in fiction may be familiar, it remains surprising. As Hamlet says, after seeing an actor affected by emotion as he plays the part of Hecuba: "What's Hecuba to him, or he to Hecuba?" (Shakespeare, 1623/1997). It may be that actors during rehearsal, though not necessarily during performance (Konijn, 2000), use Stanislavski's (1936) method of drawing on events in their own lives in order to feel certain emotions. In everyday life, your intentions often run into obstacles. In fiction, sometimes as a kind of trope, such obstacles are embodied in a personal antagonist, and this embodiment seems to help you to engage in the story.

Sympathy

A second kind of narrative emotion is sympathy. T. S. Eliot (1919/1953) wrote, "The only way of expressing emotion in the form of art is by finding an 'objective correlative'; in other words a set of objects, a situation, a chain of events which shall be the formula for that particular emotion" (pp. 107–108).

In psychology, a similar idea is appraisal of such situations or events (Tan, 1996, 2008; Tan & Frijda, 1999). Readers and viewers infer how events would strike a character, and then they can feel sympathy for that character. Theories of emotions in fiction as deriving from empathy or from sympathy were first put forward as alternatives, but it now seems clear that most narratives invite both sorts of emotion. Authors use them in different ways and with different effects. For instance, when Dorothea, the protagonist of George Eliot's (1871–1872/1965) *Middlemarch*, agrees to marry the aged scholar Casaubon, she is full of enthusiasm to help him with his work. You identify with her empathetically, and share some of her enthusiasm, but at the same time your heart sinks because Eliot has conveyed Casaubon's character to you in a way that goes beyond Dorothea's understanding of him. You realize, as she does not, that she has married a desiccated scholar, and so you feel sorry for her. One of the skills of great writers is to enable you to feel the emotions of a character with whom you empathize, but also to feel sympathy toward the same character.

The distinction between empathy and sympathy, as we pointed out in our last review (Johnson-Laird & Oatley, 2008), was important for Indian literary theorists a millennium ago, such as Abhinavagupta (see Ingalls, Masson, & Patwardhan, 1990). They described the emotions depicted by an actor in a play, using facial expressions, gestures, tone of voice, and the content of utterances, and the corresponding emotions—*rasas* in Sanskrit—that occur in audiences (see Keltner et al., 2013, p. 111). For example, when an actor depicts amusement or anger, the audience identifies empathetically and feels amusement or anger, and when an actor depicts something disgusting, the audience feels loathing, which puts that character into the role of antagonist. But when an actor depicts sorrow, the audience feels sympathy for that character. According to these theorists, *rasas* were literary emotions and subtly distinct from the emotions of daily life. Each well-constructed work should be based on a single *rasa*, which is the basis for a genre (e.g., a love story, a comedy, a tragedy). Within a story, other *rasas* would also occur, but in a supporting and often transient way.

Remembered Emotions

Narratives tend to evoke memories (Larsen & Seilman, 1988). An event in a simulation can prompt a memory of an emotion but the remembered event itself may remain unconscious. Earlier, we described the concept of aesthetic distance, and according to Scheff (1979), narratives enable individuals to experience emotions at a better distance than the one at which they originally experienced them. In daily life, people may cut themselves off from emotions that would be too painful: they experience them at too great a distance. Other emotions may overwhelm them: they experience them at too small a distance. Fiction, Scheff argued, enables people to relive such emotions at a more optimal distance, so that they can cope with them properly. If they find themselves in tears at Shakespeare's (1623/1997) *Romeo and Juliet*, they may be remembering and reliving their own experience of a loss, with which they had not come to terms. They can feel sad even if they do not explicitly remember that loss. They are not just reliving a remembered experience (Miall & Kuiken, 2002); the fictional context modifies the emotion and enables them to understand it and to assimilate it. The *rasa* theorists made the same point. People can recognize their own emotions as universal, and as shared with others. When they experience a new narrative, they therefore do so with a wide variety of remembered emotions, and it can evoke them in a new context.

A Western literary parallel occurs in *À la recherche du temps perdu*. In the first book of Proust's masterpiece, the narrator, Marcel, sits with his mother drinking herbal tea. He moistens a madeleine cake in the tea, and no sooner has he tasted it than he feels exquisite pleasure. He wonders what evoked it and what it means. Proust continues:

> And suddenly the memory revealed itself. The taste was that of the little piece of madeleine which on Sunday mornings at Combray (because on those mornings I did not go out before mass), when I went to say good morning to her in her bedroom, my aunt Léonie used to give me, dipping it first in her own cup of tea or tisane. The sight of the little madeleine had recalled nothing to my mind before I tasted it. (p. 48 et seq.)

Marcel's joy, as he eventually realizes, was in being able to recall the panorama of events in his childhood, but now in a way that he could begin to understand. In day-to-day life, meanings of events very often pass one by. For Proust, one of the profound kinds of significance of literary art was that it enabled readers to experience emotions and at the same time to understand their meanings.

Remembered emotions contrast with the immediate emotions that empathy and sympathy elicit in reading a literary text. The difference has been corroborated experimentally (Cupchik, Oatley, & Vorderer, 1998). The participants read four excerpts from James Joyce's *Dubliners*. Two excerpts described the emotional sequence of an event, and two were static and descriptive. In one condition, the participants were told to sympathize with the protagonist, and in another condition they were told to imagine being the protagonist. Participants reported fewer remembered emotions than immediate emotions, but the remembered emotions were more pleasant and more intense. Overall, empathy helped readers to experience immediate emotions in response to static descriptions, whereas sympathy for a protagonist elicited remembered emotions.

Certain cues in narratives prompt personal reactions as a result of empathy, sympathy, and remembered emotions. These cues—in what Oatley (2002) calls the "suggestion structure" of a narrative—include tropes such as metaphor and metonymy. Western poetics has tended to neglect the role of suggestion. In contrast, as Hogan (2003) points out, it is central in Indian poetics: The Sanskrit word is *dhvani* (Ingalls et al., 1990). Hogan offers an illustration from the final scene in Shakespeare's (1623/1997) *Hamlet*. As Hamlet dies, Horatio says:

> Now cracks a noble heart. Good night, sweet prince;
> And flights of angels sing thee to thy rest!

"Good night, sweet prince" suggests a theme of attachment and perhaps of memories of your parents saying "good night" during your childhood—a suggestion that makes the lines deeply moving.

The role of personal suggestion has been corroborated in experiments. Readers of a narrative had more emotions that were personal as compared with generic than readers of an explanatory piece of the same length, content, and ease of comprehension (Mar, Oatley, & Eng, 2003). Likewise, Nundy (1996) demonstrated a variety of responses to suggestion. Her participants read a short story by Russell Banks in which a man cruelly severs his relationship with a woman. The participants experienced strong emotions as a result, but their nature differed from one reader to another: Some were angry, others were sad, and a few were disgusted. Suggestion lies at heart of narrative.

Effects of Emotional Narratives

Just as people who learn to fly planes improve their skills in a flight simulator, so readers of fiction—simulations of the social world—can improve their social skills. Mar, Oatley, Hirsh, dela Paz, and Peterson (2006) found that the amount people had read during their lifetime correlated with empathy and with their scores on the Reading Mind in the Eyes Test (i.e., their ability to infer the mental state of persons from photographs of their eyes; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). It also correlated to a lesser extent with a test of interpersonal perception (i.e., their ability to infer what was going on in videos of people interacting). However, individuals who read more nonfiction were no better at social skills. Even when differences in ability to empathize were controlled for, those who read a lot of fiction were more socially skilled (Mar, Oatley, & Peterson, 2009). Likewise, the more stories that children listened to, and the more films they watched, the greater was their ability to infer the mental states of others in five tests (Mar, Tackett, & Moore, 2010). In contrast, no correlation occurred between the amount of television that the children watched and these measures. Fong, Mullin, and Mar (2013) compared effects on people's scores on the Reading Mind in the Eyes Test with the amount of their reading of various sorts of fiction, controlling for age, gender, and personality of the readers. They found significant positive correlations of empathy and of the Reading Mind in the Eyes Test with the amount of reading of romances and thrillers, a positive but less strong correlation with domestic fiction, and a negative correlation with science fiction. The difference, presumably, is that romances and thrillers elicit empathy with protagonists, and inferences about what other characters are up to in the story. As a result, readers get better at recognizing other people's emotions. In science fiction, these matters are usually less important than those of a different kind, such as alien invasion, robots, and space travel.

Experiments have confirmed that the relation between reading literature and empathy is a causal one. In one such study, participants read either a short story selected from a set of eight or else an essay selected from a set of eight—the literary authors of both sorts of piece were well-known (Djikic, Oatley, & Moldoveanu, 2013). People who were low in the personality trait of openness to experience, and who read a story, subsequently rated themselves higher in empathy than those who read an essay. Kidd and Castano (2013) showed that reading a fictional story, but not a factual essay, increased participants' levels of empathy and their scores on the Reading Mind in the Eyes Test (Baron-Cohen et al., 2001), and that literary stories produced bigger effects than popular stories. In a different kind of experiment, which used a specially written story, Johnson (2012) found that the more that participants were transported by the story, the more empathy they reported with its protagonist, and the more likely they were to be helpful later, in picking up some pens that the experimenter had "accidentally" dropped.

Narratives elicit emotions, which can affect personality, as measured by the Big Five personality traits of neuroticism, extraversion, openness to experience, conscientiousness, and agreeableness (Djikic, Oatley, Zoeterman, & Peterson, 2009b). In the study, half of the participants read Anton Chekhov's story *The Lady with the Dog*, and the other half of the participants read a control story that described the same characters and events but in a documentary style. Readers rated it just as interesting, though not as artistic as Chekhov's story. Before and after they read the text, the participants rated the intensity of their current emotions and a test of the Big Five personality traits. Those who read Chekhov's story showed small but reliable changes in their personality in comparison with those who read the documentary text. The amount of emotion they experienced while they read the story mediated these changes. As another analysis of these results showed, narratives may be able to circumvent psychological defenses. People who tended to suppress their emotions, and to avoid contact with others, experienced significantly more emotion in reading the original Chekhov story than in reading its documentary version (Djikic, Oatley, Zoeterman, & Peterson, 2009a).

Conclusions

The communicative theory of emotion (Oatley & Johnson-Laird, 1987) helps to solve the mystery of how works of art create emotions. Music doesn't refer to anything, but simple mimesis can elicit a small set of basic emotions: happiness, sadness, fear, and anger. It can trigger emotions quickly, and the same emotions can be triggered in different cultures. In contrast, narratives in literature or film concern characters and their plans. People put aside their own goals and plans and, following the narrative's suggestions, take on the goals and plans of the protagonist. Metaphorically, they become models of the protagonist. Narratives, even if they don't refer to real individuals, can accordingly create in people complex emotions that depend on propositional content. As we showed earlier, the emotions that music elicits are real, and so doubtless are the emotions that narratives elicit.

Consider this vignette:

"Someone must have been telling lies about Joseph K., for without having done anything wrong he was arrested one fine morning."

If you read this sentence in a newspaper, you are likely to feel a pang of sympathy for the protagonist. But, you are also likely to do so if you read it at the beginning of Franz Kafka's novel *The Trial* (in Willa & Edwin Muir's translation), or if you watch the scene in Orson Welles's film based on the novel. A picture is said to be worth a thousand words, but a sentence can be worth more than a thousand pictures. As the need for subtitles in silent movies demonstrates, words can do things that are beyond pictures. Words can convey abstractions, such as the immorality of telling lies, and words in metaphors and other tropes also transcend depiction (Glucksberg, 2001). They can elicit our empathy and sympathy with characters in fiction, and our antipathy toward them—even toward characters that could not exist—such as the talking pig Napoleon, who is an allegory of Stalin in George Orwell's *Animal Farm*. Empathy, sympathy, and remembered emotions from suggestions in narratives are the ways in which you can enter into stories. As a result, you extend your understanding of yourself and of others.

Emotions can be so excessive in intensity that they cause psychological illnesses (Johnson-Laird et al., 2006). But music can modulate emotions, and, as a result, it can play a role in restoring mental and physical health (e.g., Davis, Gfeller, & Thaut, 2008; Loewy et al., 2013). Literature too has comparable effects (e.g., Davis, 2009). And, as Pennebaker (1997) has shown, if you write for as little as 20 minutes a day for 4 days, it can improve both your mental and physical health provided that you write about emotionally significant events in your life (see Frattaroli, 2006, for a meta-analysis).

What do you learn from listening to music? Despite many claims for improved intelligence or executive ability, the evidence is not decisive. Less controversial is that you learn to enjoy and to experience aesthetic feelings for works of art. The evidence is clearer for narratives. Beyond aesthetics and matters of fact embodied in a story, such as how to harpoon a whale, you can learn how to feel toward other people, how to cope with personal relationships, and even how to understand your own emotions (Oatley, 2003). These emotions are a foundation for altruism (Batson, 2011). They prompt moral intuitions, though sensible moral judgments depend on reasoning, too (Bucciarelli et al., 2008).

We have postponed the most difficult question. There is no doubt that human beings enjoy vicarious emotions from music, narratives, and other activities. But why? Aristotle (1984, *Poetics*, 1449b28) wrote that it was for *catharsis*. Some translators take him to be referring to the purging of emotions—in the sense that you might say to someone, "Go on, have a good cry, you'll feel better for it." But another interpretation is that Aristotle was referring to the "clarification" of experiences of a pitiable and fearful kind (Nussbaum, 1986). You can reflect on your emotions, and gain insight into them, from a wider set of circumstances than you would encounter in everyday life (Oatley, 1999). Such an account makes sense for fiction, but why do you enjoy the emotions that music inspires? Aristotle (1984, *Politics*, 1341b37) refers to catharsis in a passage concerning the different "modes" of music, which correspond in part to modern scales. He writes that musicians should learn them all. One reason is for catharsis, which again he does not explain. It is enjoyable to listen to sad music; it is enjoyable to mourn the death of Hamlet. But it is not enjoyable to mourn the death of a person one loves. Perhaps, as Cova and Deonna (2014) have suggested, being moved is a distinct emotional state. But, as far as we know, no one has a good testable explanation of why sad emotions from music and narrative are enjoyable.

References

Aristotle. (1984). *The complete works of Aristotle* (Vols. 1 and 2). (J. Barnes, Ed.). Princeton, NJ: Princeton University Press.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "Reading the Mind in the Eyes" test revised: A study with normal adults, and adults with

Asperger's syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry, 42*, 241–251.

Batson, C. D. (2011). *Altruism in humans*. New York: Oxford University Press.

Blood, A. J., & Zatorre, R. J. (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proceedings of the National Academy of Sciences*, 98(20), 11818–11823.

Bower, G. H., & Morrow, D. G. (1990). Mental models in narrative comprehension. *Science, 247*, 44–48.

Bowler, J. M., Johnston, H., Olley, J. M., Prescott, J. R., Roberts, R. G., Shawcross, W., et al. (2003). New ages for human occupation and climatic change at Lake Mungo, Australia. *Nature, 421*, 837–840.

Bruner, J. (1986). *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.

Bucciarelli, M., Khemlani, S., & Johnson-Laird, P. N. (2008). The psychology of moral reasoning. *Judgment and Decision Making, 3*, 121–139.

Budd, M. (1985). *Music and the emotions: The philosophical theories*. London: Routledge.

Bunt, L., & Pavlicevic, M. (2001). Music and emotion: Perspectives from music therapy. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 181–201). Oxford, UK: Oxford University Press.

Chauvet, J.-M., Deschamps, E. B., & Hillaire, C. (1996). *Dawn of art: The Chauvet cave*. New York: Abrams.

Cohen, A. J. (2001). Music as a source of emotion in film. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 249–272). Oxford, UK: Oxford University Press.

Cova, F., & Deonna, J. A. (2014). Being moved. *Philosophical Studies, 16*(3), 447–466.

Cunningham, J. G., & Sterling, R. S. (1988). Developmental change in the understanding of affective meaning in music. *Motivation and Emotion, 12*, 399–413.

Cupchik, G. C. (2002). The evolution of psychical distance as an aesthetic concept. *Culture and Psychology*, 8, 155–187.

Cupchik, G. C., Oatley, K., & Vorderer, P. (1998). Emotional effects of reading excerpts from short stories by James Joyce. *Poetics, 25*, 363–377.

Damasio, A. R. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York: Grosset/Putnam.

Darwin, C. (1965). *The expression of the emotions in man and animals*. Chicago: University of Chicago Press. (Original work published 1872)

Davies, S. (1994). *Musical meaning and expression*. Ithaca, NY: Cornell University Press.

Davis, J. (2009). Enjoying and enduring: Groups reading aloud for wellbeing. *Lancet, 373*, 714–715.

Davis, W. B., Gfeller, K. E., & Thaut, M. H. (2008). *An introduction to music therapy* (3rd ed.). Silver Spring, MD: American Music Therapy Association.

de Vignemont, F., & Singer, T. (2006). The empathic brain: How, when and why? *Trends in Cognitive Sciences, 10*, 435–441.

Djikic, M., Oatley, K., & Moldoveanu, M. (2013). Reading other minds: Effects of literature on empathy. *Scientific Study of Literature, 3*, 28–47.

Djikic, M., Oatley, K., Zoeterman, S., & Peterson, J. B. (2009a). Defenseless against art?: Impact of reading fiction on emotion in avoidantly attached individuals. *Journal of Research in Personality, 43*, 14–17.

Djikic, M., Oatley, K., Zoeterman, S., & Peterson, J. B. (2009b). On being moved by art: How reading fiction transforms the self. *Creativity Research Journal, 21*, 24–29.

Downey, J. E. (1897). A musical experiment. *American Journal of Psychology, 9*, 63–69.

Eerola, T., & Vuoskoski, J. K. (2013). A review of music and emotion studies: Approaches, emotion models, and stimuli. *Music Perception, 30*, 307–340.

Eliot, G. (1965). *Middlemarch: A study of provincial life*. New York: Penguin. (Original work published 1871–1872)

Eliot, T. S. (1953). Hamlet. In J. Hayward (Ed.), *T. S. Eliot: Selected prose* (pp. 104–110). Harmondsworth, UK: Penguin. (Original work published 1919)

Farmelo, G. (Ed.). (2003). *It must be beautiful: Great equations of modern science*. New York: Granta Books.

Fitch, W. T., Hauser, M., & Chomsky, N. (2005). The evolution of the language faculty: Clarifications and implications. *Cognition, 97*, 179–210.

Fong, K., Mullin, J., & Mar, R. (2013). What you read matters: The role of fiction genres in predicting interpersonal sensitivity. *Psychology of Aesthetics, Creativity, and the Arts, 7*(4), 370–376.

Frattaroli, J. (2006). Experimental disclosure and its moderators: A meta-analysis. *Psychological Bulletin, 132*, 823–865.

Freud, S. (1971). The unconscious. In J. Strachey (Ed. & Trans.), *The standard edition of the complete works of Sigmund Freud* (Vol. 14, pp. 161–215). London: Hogarth Press and the Institute of Psychoanalysis. (Original work published 1915)

Freud, S. (1985). Psychopathic characters on the stage. In A. Dickson (Ed.), *Pelican Freud library, 14: Art and literature* (pp. 119–127). London: Penguin. (Original work published 1905–1906)

Fritz, T., Jentschke, S., Gosselin, N., Sammler, D., Peretz, I., Turner, R., et al. (2009). Universal recognition of three basic emotions in music. *Current Biology, 19*(7), 573–576.

Gabrielsson, A., & Lindström, E. (2001). The influence of musical structure on emotional expression. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 223–248). Oxford, UK: Oxford University Press.

Gagnon, L., & Peretz, I. (2003). Mode and tempo relative contributions to "happy–sad" judgments in equitone melodies. *Cognition and Emotion, 17*, 25–40.

Gilman, B. I. (1891). Report on an experimental test of musical expressiveness. *American Journal of Psychology, 4*, 558–576.

Gilman, B. I. (1892). Report on an experimental test of musical expressiveness (continued). *American Journal of Psychology, 5*, 42–73.

Glucksberg, S. (2001).*Understanding figurative language: From metaphors to idioms*. New York: Oxford University Press.

Green, M. C., Kass, S., Carrey, J., Herzig, B., Feeney, R., & Sabini, J. (2008). Transportation across media: Repeated exposure to text and film. *Media Psychology, 11*, 512–539.

Hanslick, E. (1957). *The beautiful in music* (7th ed., G. Cohen, Trans.). New York: Liberal Arts Press. (Original work published 1854)

Helmholtz, H. (1912). *On the sensations of tone* (4th ed.). New York: Longmans, Green. (Original work published 1877)

Hogan, P. C. (2003). *The mind and its stories: Narrative universals and human emotion*. Cambridge, UK: Cambridge University Press.

Hunter, P. G., Schellenberg, E. G., & Schimmack, U. (2008). Mixed affective responses to music with conflicting cues. *Cognition and Emotion, 22*, 327–352.

Huron, D. (2003). Is music an evolutionary adaptation? In I. Peretz & R. Zatorre (Eds.), *The cognitive neuroscience of music* (pp. 57–75). Oxford, UK: Oxford University Press.

Ingalls, D. H., Masson, J. M. & Patwardhan, M. V. (1990). *The Dhvanyaloka of Anandavardana with the Locana of Abhinavagupta*. Cambridge, MA: Harvard University Press.

Ives, C. (1962). *Essays before a sonata and other writings*. New York: Norton.

Johnson, D. R. (2012). Transportation into a story increases empathy, prosocial behavior, and perceptual bias toward fearful expressions.*Personality and Individual Differences, 52*, 150–155.

Johnson-Laird, P. N. (1983). *Mental models*. Cambridge, MA: Harvard University Press.

Johnson-Laird, P. N. (2002). How jazz musicians improvise. *Music Perception, 19*, 415–442.

Johnson-Laird, P. N. (2006). *How we reason*. New York: Oxford University Press.

Johnson-Laird, P. N., Kang, O. E., & Leong, Y. C. (2012). On musical dissonance. *Music Perception, 30*, 19–35.

Johnson-Laird, P. N., Mancini, F., & Gangemi, A. (2006). A hyper-emotion theory of psychological illnesses. *Psychological Review, 113*, 822–841.

Johnson-Laird, P. N., & Oatley, K. (1989). The language of emotions: An analysis of a semantic field. *Cognition and Emotion, 3*, 81–123.

Johnson-Laird, P. N., & Oatley, K. (2000). The cognitive and social construction of emotions. In M. Lewis & J. Haviland (Eds.), *Handbook of emotions* (2nd ed., pp. 458–475). New York: Guilford Press.

Johnson-Laird, P. N., & Oatley, K. J. (2008). Emotions, music, and literature. In M. Lewis, J. Haviland-Jones, & L. F. Feldman-Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 102–113). New York: Guilford Press.

Juslin, P. N. (2001). Communicating emotion in music performance: A review and theoretical framework. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 309–337). Oxford, UK: Oxford University Press.

Juslin, P. N., & Laukka, P. (2003). Communication of emotions in vocal expression and music performance: Different channels, same code? *Psychological Bulletin, 129*, 770–814.

Juslin, P. N., & Laukka, P. (2004). Expression, perception, and induction of musical emotions: A review and a questionnaire study of everyday listening. *Journal of New Music Research, 33*, 217–238.

Juslin, P. N., Liljeström, S., Laukka, P., Västfjäll, D., & Lundqvist, L.-O. (2011). Emotional reactions to music in a nationally representative sample of Swedish adults: Prevalence and causal influences. *Musicae Scientiae, 15*, 174–207.

Juslin, P. N., Liljeström, S., Västfjäll, D., Barradas, G., & Silva, A. (2008). An experience sampling study of emotional reactions to music: Listener, music, and situation. *Emotion, 8*, 668–683.

Juslin, P. N., & Sloboda, J. A. (2010). *Handbook of music and emotion: Theory, research, applications*. New York: Oxford University Press.

Juslin, P. N., & Timmers, R. (2010). Expression and communication of emotion in music performance. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, applications* (pp. 453–489). New York: Oxford University Press.

Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. *Behavioral and Brain Sciences, 31*, 559–621.

Kaufman, G. F., & Libby, L. K. (2012). Changing beliefs and behavior through experience-taking. *Journal of Personality and Social Psychology, 103*, 1–19.

Kawakami, A., Kiyoshi, F., Katahira, K., Kamiyama, K., & Okanoya, K. (2013). Relations between musical structures and perceived and felt emotions. *Music Perception, 30*, 407–417.

Keltner, D., Ekman, P., Gonzaga, G. C., & Beer, J. (2003). Facial expression of emotion. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 415–432). New York: Oxford University Press.

Keltner, D., Oatley, K., & Jenkins, J. M. (2013). *Understanding emotions* (3rd ed.). Hoboken, NJ: Wiley-Blackwell.

Kidd, D. C., & Castano, E. (2013). Reading literary fiction improves theory of mind. *Science, 342*, 377–380.

Kitcher, P. (2007). *Joyce's kaleidoscope: An invitation to Finnegans Wake*. Oxford, UK: Oxford University Press.

Konijn, E. (2000). *Acting emotions: Shaping emotions on stage*. Amsterdam, The Netherlands: Amsterdam University Press.

Kreutz, G., Ott, U., Teichmann, D., Osawa, P., & Vaitl, D. (2008). Using music to induce emotions: Influences of musical preference and absorption. *Psychology of Music, 36*, 101–126.

Krumhansl, C. L. (1990). *Cognitive foundations of musical pitch*. New York: Oxford University Press.

Krumhansl, C. L. (1997). An exploratory study of musical emotions and psychophysiology. *Canadian Journal of Experimental Psychology, 51*, 336–352.

Lam, B. (1966). Ludwig van Beethoven. In R. Simpson (Ed.), *The symphony* (Vol. 1, pp. 104–174). Harmondsworth, UK: Penguin.

Larsen, S. F., & Seilman, U. (1988). Personal meanings while reading literature. *Text, 8*, 411–429.

Loewy, J., Steward, K., Dassler, A.-M., Telsey A., & Homel,

P. (2013). The effects of music therapy on vital signs, feeding, and sleep in premature infants. *Pediatrics, 131*(5), 901–918.

Longuet-Higgins, H. C., & Lee, C. S. (1984). The rhythmic interpretation of monophonic music. *Music Perception, 1*, 424–441.

Mar, R. (2011). The neural bases of social cognition and story comprehension. *Annual Review of Psychology, 62*, 103–134.

Mar, R. A., & Oatley, K. (2008). The function of fiction is the abstraction and simulation of social experience. *Perspectives on Psychological Science, 3*, 173–192.

Mar, R. A., Oatley, K., Djikic, M., & Mullin, J. (2011). Emotion and narrative fiction: Interactive influences before, during, and after reading. *Cognition and Emotion, 25*, 818–833.

Mar, R. A., Oatley, K., & Eng, A. (2003, August 7–10). *Abstraction and the vividness of details in fiction*. Paper presented at the Annual Convention of the American Psychological Association, Toronto, Ontario, Canada.

Mar, R. A., Oatley, K., Hirsh, J., dela Paz, J., & Peterson, J. B. (2006). Bookworms versus nerds: Exposure to fiction versus non-fiction, divergent associations with social ability, and the simulation of fictional social worlds. *Journal of Research in Personality, 40*, 694–712.

Mar, R. A., Oatley, K., & Peterson, J. B. (2009). Exploring the link between reading fiction and empathy: Ruling out individual differences and examining outcomes. *European Journal of Communication, 34*, 407–428.

Mar, R. A., Tackett, J. L., & Moore, C. (2010). Exposure to media and theory-of-mind development in preschoolers. *Cognitive Development, 25*, 69–78.

Masataka, N. (1999). Preference for infant-directed singing in 2-day-old hearing infants of deaf parents. *Developmental Psychology, 35*, 1001–1005.

McClary, S. (1987). Getting down off the beanstalk. *Minnesota Composers Forum Newsletter, 1*, 7.

Meyer, L. B. (1956). *Emotion and meaning in music*. Chicago: University of Chicago Press.

Miall, D. S., & Kuiken, D. (2002). A feeling for fiction: Becoming what we behold. *Poetics, 30*, 221–241.

Miller, G. (2000). Evolution of human music through sexual selection. In N. L. Wallis, B. Merker, & S. Brown (Eds.), *The origins of music* (pp. 319–360). Cambridge, MA: MIT Press.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63*, 81–97.

Mithen, S. (1996). *The prehistory of the mind: The cognitive origins of art and science*. London: Thames and Hudson.

Nilsson, U. (2009). Soothing music can increase oxytocin levels during bed rest after open-heart surgery: A randomised control trial. *Journal of Clinical Nursing, 18*, 2153–2161.

Nundy, S. (1996). *The effects of emotion on human inference: Towards a computational model*. Unpublished doctoral dissertation, University of Toronto, Ontario, Canada.

Nussbaum, M. C. (1986). *The fragility of goodness: Luck and ethics in Greek tragedy and philosophy*. Cambridge, UK: Cambridge University Press.

Nussbaum, M. C. (2001). *Upheavals of thought: The intelligence of emotions*. Cambridge, UK: Cambridge University Press.

Oatley, K. (1994). A taxonomy of the emotions of literary response and a theory of identification in fictional narrative. *Poetics, 23*, 53–74.

Oatley, K. (1999). Why fiction may be twice as true as fact: Fiction as cognitive and emotional simulation. *Review of General Psychology, 3*, 101–117.

Oatley, K. (2002). Emotions and the story worlds of fiction. In M. C. Green, J. J. Strange, & T. C. Brock (Eds.), *Narrative impact: Social and cognitive foundations* (pp. 39–69). Mahwah, NJ: Erlbaum.

Oatley, K. (2003). Creative expression and communication of emotion in the visual and narrative arts. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 481–502). New York: Oxford University Press.

Oatley, K. (2004). Scripts, transformations, and suggestiveness of emotions in Shakespeare and Chekhov. *Review of General Psychology, 8*, 323–340.

Oatley, K. (2013a). How cues on the screen prompt emotions in the mind. In A. P. Shimamura (Ed.), *Psychocinematics* (pp. 269–284). New York: Oxford University Press.

Oatley, K. (2013b). Worlds of the possible: Abstraction, imagination, consciousness. *Pragmatics and Cognition, 21*(3), 448–468.

Oatley, K., & Johnson-Laird, P. N. (1987). Towards a cognitive theory of emotion. *Cognition and Emotion, 1*, 29–50.

Oatley, K., & Johnson-Laird, P. N. (1996). The communicative theory of emotions: Empirical tests, mental models, and implications for social interaction. In L. L. Martin & A. Tesser (Eds.), *Striving and feeling: Interactions among goals, affect, and self-regulation* (pp. 363–393). Mahwah, NJ: Erlbaum.

Oatley, K., & Johnson-Laird, P. N. (2011). Basic emotions in social relationships, reasoning, and psychological illnesses. *Emotion Review, 3*, 424–433.

Oliver, M. B. (2008). Tender affective states as predictors of entertainment preference. *Journal of Communication, 58*, 40–61.

Oliver, M. B., & Bartsch, A. (2010). Appreciation as audience response: Exploring entertainment gratifications beyond hedonism. *Human Communication Research, 36*, 53–81.

Panksepp, J. (1995). The emotional sources of "chills" in music. *Music Perception, 13*, 171–207.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions*. Oxford, UK: Oxford University Press.

Panksepp, J. (2005). Affective consciousness: Core emotional feelings in animals and humans. *Consciousness and Cognition, 14*, 30–80.

Parncutt, R. (1989). *Harmony: A psychoacoustical approach*. Berlin: Springer.

Patel, A. D. (2008). *Music, language, and the brain*. Oxford, UK: Oxford University Press.

Pennebaker, J. W. (1997). Writing about emotional experiences as a therapeutic process. *Psychological Science, 8*, 162–166.

Perani, D., Saccuman, M. C., Scifo, P., Spada, D., Andreoli, G., Rovelli, R., et al. (2010). Functional specializations for music processing in the human newborn brain. *Proceedings of the National Academy of Sciences, 107*, 4758–4763.

Peretz, I., Gagnon, L., & Bouchard, B. (1998). Music and emotion: Perceptual determinants, immediacy, and isolation after brain damage. *Cognition, 68*, 111–141.

Pinker, S. (1997). *How the mind works*. New York: Norton.

Pronin, E. (2013). When the mind races: Effects of thought speed on feeling and action. *Current Directions in Psychological Science, 22*(4), 283–288.

Proust, M. (1982). *Remembrance of things past: Vol. 1. Swann's way: Within a budding grove* (C. K. Scott Moncrieff & T. Kilmartin, Trans.). New York: Vintage.

Radford, C. (1975). How can we be moved by the fate of Anna Karenina? *Proceedings of the Aristotelian Society, Supplementary Volumes, 49*, 67–80.

Richards, T. (Ed.). (2010). *Soccer and philosophy: Beautiful thoughts on the beautiful game*. Chicago: Open Court.

Rigg, M. G. (1940). Speed as a determiner of musical mood. *Journal of Experimental Psychology, 27*, 566–571.

Russell, J. A., Bachorowski, J. A., & Fernandez-Dols, J. M. (2003). Facial and vocal expression of emotion. *Annual Review of Psychology, 54*, 329–349.

Scheff, T. J. (1979). *Catharsis in healing, ritual, and drama*. Berkeley: University of California Press.

Scherer, K. R. (1986). Vocal affect expression: A review and a model for future research. *Psychological Bulletin, 99*, 143–165.

Scherer, K. R. (2004). Which emotions can be induced by music?: What are the underlying mechanisms? And how can we measure them? *Journal of New Music Research, 33*, 239–251.

Schramm, H., & Wirth, W. (2010). Exploring the paradox of sad-film enjoyment: The role of multiple appraisals and meta-appraisals. *Poetics, 38*, 319–335.

Sethares, W. A. (2005). *Tuning, timbre, spectrum, scale* (2nd ed.). London: Springer.

Shakespeare, W. (1997). *The Norton Shakespeare* (S. Greenblatt, Ed.). New York: Norton. (Original work published 1623)

Simpson, R. (1970). *Beethoven symphonies*. London: British Broadcasting Corporation.

Sloboda, J. A., & Juslin, P. N. (2001). Music and emotion: Commentary. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 453–462). Oxford, UK: Oxford University Press.

Speer, N. K., Reynolds, J. R., Swallow, K. M., & Zacks, J. M. (2009). Reading stories activates neural representations of visual and motor experiences. *Psychological Science, 20*, 989–999.

Stanislavski, C. (1936). *An actor prepares* (E. R. Habgood, Trans.). New York: Routledge.

Stolzenburg, F. (2010). A periodicity-based approach on harmony perception including non-western scales. In S. M. Demorest, S. J. Morrison, & P. S. Campbell (Eds.), *Proceedings of 11th International Conference on Music Perception and Cognition*, Seattle, WA.

Stravinsky, I. (1936). *Chronicles of my life*. New York: Simon & Schuster.

Tan, E. (1996). *Emotion and the structure of film: Film as an emotion machine*. Mahwah, NJ: Erlbaum.

Tan, E. (2008). Entertainment is emotion: The functional architecture of the entertainment experience. *Media Psychology, 11*, 28–51.

Tan, E., & Frijda, N. H. (1999). Sentiment in film viewing. In C. Plantinga & G. M. Smith (Eds.), *Passionate views: Film, cognition, and emotion* (pp. 48–64). Baltimore, MD: Johns Hopkins University Press.

Temperley, D., & Tan, D. (2013). Emotional connotations of diatonic modes. *Music Perception, 30*, 237–257.

Trabasso, T., & Chung, J. (2004). *Empathy: Tracking characters and monitoring their concerns in film*. Paper presented at the Winter Text Conference, Jackson Hole, WY.

Trainor, L. J., & Schmidt, L. A. (2003). Processing emotions induced by music. In I. Peretz & R. J. Zatorre (Eds.), *The cognitive neuroscience of music* (pp. 310–324). Oxford, UK: Oxford University Press.

Trainor, L. J., Tsang, C. D., & Cheung, V. H. W. (2002). Preference for consonance in 2- and 4-month-old infants. *Music Perception, 20*, 187–194.

Trochidis, K., & Bigand, E. (2013). Investigation of the effect of mode and tempo on emotional responses to music using EEG power asymmetry. *Journal of Psychophysiology, 27*, 142–147.

Trost, W., Ethofer, T., Zentner, M., & Vuilleumier, P. (2012). Mapping aesthetic musical emotions in the brain. *Cerebral Cortex, 22*, 2769–2783.

Västfjäll, D. (2001–2002). Emotion induction through music: A review of the musical mood induction procedure [Special issue]. *Musicae Scientiae, 5*(1), 173–211.

Walton, K. L. (1990). *Mimesis as make-believe: On the foundations of the representational arts*. Cambridge, MA: Harvard University Press.

Webster, G. D., & Weir, C. G. (2005). Emotional responses to music: Interactive effects of mode, texture, and tempo. *Motivation and Emotion, 29*, 19–39.

Zillmann, D. (1988). Mood management through communication choices. *American Behavioral Scientist, 31*, 327–340.

Zillmann, D. (1998). The psychology of the appeal of portrayals of violence. In J. H. Goldstein (Ed.), *Why we watch: The attractions of violent entertainment* (pp. 179–211). New York: Oxford University Press.

CHAPTER 5

Affect in Economic Decision Making

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Do you make decisions with your head or your heart? Do you follow your intuition or reason through your options? Was that a "hot" emotional choice, or a "cold" calculated one? In our language and our culture, the idea that emotion runs counter to reason is ubiquitous. When a choice is deemed irrational, many people cite "emotion" as the driving force behind it.

The notion that emotion and cognition are separate and opposing forces originated with Plato, who suggested that the soul had a tripartite structure, composed of cognition, emotion, and motivation. He argued that these components were separate, that they were in competition, and that cognition was superior to the others (Scherer, 2005). This theory has exerted a monumental amount of influence on Western thinkers since, including the philosopher Immanuel Kant and the father of psychoanalysis, Sigmund Freud. Therefore, it is unsurprising that "dual-systems" models of the mind and brain have been so prevalent in psychology (see Evans, 2008, for one review), and that "cognitive" and "affective" psychology research and theory are still so divided. In behavioral economics, a similar view of emotion and cognition has also emerged. Kahneman (2011) proposed that our choices are either driven by an automatic "system 1" or a deliberative "system 2"; emotion is considered a factor that contributes to system 1. In neuroscience, it has been suggested that emotion and reason are compartmentalized in the brain (Figner, Mackinley, Wilkening, & Weber, 2009; Cohen, 2005), and one must override emotional impulses that originate in the "limbic system," in order to make rational choices.

Early theories of brain anatomy supported the dual-systems view. The limbic system concept, introduced by MacLean (1952), and inspired by work by Papez (1937), refers to a phylogenetically older system of brain regions that line the inner border of the cortex. MacLean proposed that this set of regions was devoted to basic affective responses (Lambert, 2003). Meanwhile, the neocortex was responsible for higher cognitive functions. This theory was highly influential, but basic research in neuroanatomy and structure–function relationships soon revealed that the dividing line between emotion and cognition in the brain was not so clean. For example, the hippocampus—a major hub of MacLean's limbic system—has been found to be integral to memory, a largely cognitive function. In addition, areas of the neocortex, such as the orbitofrontal cortex (OFC), have been found to be important in affective processing (Damasio, 2005). Although scientists have attempted to modify the limbic system concept to take this research into account (e.g., Cohen, 2005; Rolls, 2015), it has become clear that there is no unified system that drives emotion, and affective and cognitive processes are not clearly separable in the brain (see LeDoux, 2000, for discussion).

As appealing and parsimonious as the dual-systems view is, without a clear neural instantiation, it is difficult to conceive of how it could be accurate. The bridge between neuroscience and psychology has been critical to the advancement of psychological theory. In other domains of cognition, such as memory, perception, and attention, the neural circuitry suggests, and the research supports, a modulatory role for emotion or affect (Phelps, 2006). The connections between the amygdala and hippocampus, for example, have been shown to underlie the influence of emotion on the encoding of episodic memories. Given that the amygdala shares connectivity with the striatum and the OFC—two regions that have been consistently linked with economic decision-making and valuation—it is likely that this is one pathway (of many) by which emotion may modulate the computation of subjective value during decision making, which then influences choice. This review will focus on the behavioral evidence for a modulatory role of affect in decision making, but it is important to bear in mind that there are proposed neural circuits that can support such a role (see Phelps, Lempert, & Sokol-Hessner, 2014).

In addition to being implausible on a neural level, dual-systems models are also problematic because they encourage researchers to perpetuate the idea of a competition between systems, and to cast affect in either a "good" or "bad" light. If the view is that emotion always leads to irrational choice, the focus will be on dampening those emotions, rather than investigating the circumstances under which emotion results in successful or unsuccessful decision making. If we want to have a nuanced and detailed view of affect and decision making, we need to understand how emotions modulate our evaluation of options and affect our choices.

In this chapter, we attempt to summarize the research on the role of affect in economic decision making. We restrict our review to studies that have explicitly measured or manipulated affect. Affect is not a unitary construct, but rather, it is composed of component processes. The number and precise nature of these processes is still up for debate (Ekman & Davidson, 1994), but for the purposes of this review, we adopt the framework of Scherer (2000), with some caveats. We define an *emotion* as a discrete response to an external or internal stimulus that entails some or all of five components: (1) subjective feelings, (2) physiological response, (3) motor expression, (4) action tendency, and (5) evaluation or appraisal (Scherer, 2000, 2005). Changes in these components vary in their intensity, and they may not all be present (Barrett, 2006). During a decision, the choice options and outcomes may elicit such emotions. When emotions arise from the choice at hand, and are relevant to the choice, we refer to them as *integral* emotions (Lerner, Li, Valdesolo, & Kassam, 2015).

In addition to discrete emotional responses to stimuli, we can also experience more enduring affective states. In this chapter, we discuss three such states: *stress*, *mood*, and *affect dispositions*. Although Scherer (2000, 2005) did not, we differentiate transient emotional responses from stress. Stress may be triggered by a discrete event, but it is defined by fixed physiological and neurohormonal changes (Ulrich-Lai & Herman, 2009), and the impact of these changes leads to a longer-lasting affective state (Dickerson & Kemeny, 2004). Specifically, a stressor disrupts homeostasis (McEwen, 2007), leading to sympathetic nervous system arousal, activation of the hypothalamic–pituitary–adrenal (HPA) axis, and the release of stress hormones. Stress hormones hit their peak concentration and begin to influence activity in brain regions related to affect and choice 10 to 20 minutes poststressor, and these effects can continue for hours after exposure (Joëls, 2011). Because of this longer time scale, stress may influence choices *incidentally*—that is, a stress response related to some other previous event may affect the way decision options and outcomes are processed. A discrete integral emotion, on the other hand, will likely only influence the current choice or related choices, and will not have an impact on unrelated decisions undertaken several minutes or even hours later.

A *mood* refers to a diffuse affective state, which may or may not be triggered by a stimulus, and is primarily characterized by subjective feelings. Unlike stress, moods do not have a well-defined neurohormonal or physiological substrate. Furthermore, while stress results in a negative affective state (Dickerson & Kemeny, 2004), there is greater variation in the valence and nature of mood states. In this chapter, we discuss how mood can influence choice incidentally.

Although choices themselves may be indicative of an emotional process (because they imply preference or "liking"), we do not include studies that have inferred emotional responses based on choices alone. Similarly, we do not include studies that have inferred the involvement of emotions on the basis of finding a blood-oxygenation-level-dependent (BOLD) signal in regions associated with emotion, because there is little evidence that affective components are uniquely tied to specific BOLD patterns (Phelps et al., 2014).

Finally, we use the term "affect," as Scherer (2005) does, simply as the overarching term encompassing discrete emotions as well as more diffuse states such as moods and stress. We acknowledge that other definitions of affect exist (e.g., *core affect*; Russell & Barrett, 1999), but for simplicity, we do not consider them here.

We begin the chapter by exploring the two major means by which affect can influence choice. First, affect can incidentally alter our choices, if we are in a particular affective state, such as a certain mood or under stress at the time of choice. Our affective state can influence how we process a decision, and can lead to differences in our decision making. Second, choice options and outcomes themselves may elicit integral emotions, or emotions that modulate the computation of subjective value (Lerner et al., 2015), thereby influencing choice. Finally, we discuss some strategies for changing emotions in order to change choices.

Incidental Affect

Affect can influence decision making indirectly, through incidental affect. When we are in a baseline affective state, we may change the way that we make our choices, even if the affective state is unrelated to the decision at hand. It is possible that baseline affect changes the way that we process attributes of stimuli, leading to changes in valuation or action tendencies during decision making. In experiments that manipulate incidental affect, an affective state is triggered in the participant before a decision-making task. Below, we discuss a few of these affective states: namely, stress, mood, affective priming, and affect dispositions.

Stress

It is not uncommon to hear someone say that he or she is "stressed out." The trials and tribulations of life (e.g., job pressures, financial strain, worries about loved ones) may overwhelm us, so that we have trouble coping. We try to avoid stress not only because it may affect our health and well-being but also because it may unduly influence important decisions. In a time of crisis, we do not want to make mistakes or act impulsively; we want to be able to reason through our options and make the best choice. The study of decision making under stress is important not only because stress is ubiquitous but also because it is so relevant in the clinical domain. Stressful events often precipitate the onset of depression (Kendler, Karkowski, & Prescott, 1999), and living with a psychopathological condition may increase stress (Yehuda, 2001; Checkley, 1996). Moreover, drug addicts are more likely to relapse under stress (Sinha, 2001), and this may be due to impaired decision making under stress.

"Stress" has multiple meanings and interpretations, but for the purposes of this review, we define stress as the induction of a response that results in an increase in physiological arousal, glucocorticoid release, and ratings of negative affect. Stress hormones are known to influence a number of brain regions related to affect and decisions. Notably, they seem to impair prefrontal cortex (PFC) function and executive control (Hains & Arnsten, 2008), as well as enhance the function of the amygdala (Roozendaal, McEwen, & Chattarji, 2009; see Ulrich-Lai & Hermann 2009; Arnsten, 2009, for reviews). In addition, stress has been shown to impact dopaminergic neurons in the ventral tegmental area and the striatum (Ungless, Argilli, & Bonci, 2010). Importantly, the physiological effects of acute stress extend after the event (Dickerson & Kemeny, 2004). Because stress has been shown to influence brain systems implicated in decision making, it is not surprising that stress can impact choices.

Several techniques have been used to induce acute, mild stress that reliably results in glucocorticoid release in humans (see Dickerson & Kemeny, 2004). The two most common manipulations are the "cold-pressor task" and the Trier Social Stress Test (TSST). In the cold-pressor procedure, participants immerse their hands in near-freezing water for about 3 minutes. In the TSST, research subjects are asked to give short public performances that will be evaluated by their peers. Despite differences in the nature of the stress induced in these two procedures, they have both been found to reliably engage an acute stress response (Ishizuka, Hiller, & Beversdorf, 2007; Kirschbaum, Pirke, & Hellhammer, 1993). These acute, mild stressors have also been shown to impair performance on PFC-dependent tasks (e.g., Raio, Orederu, Palazzolo, Shurick, & Phelps, 2013).

From Goal-Directed/Model-Based to Habitual/Model-Free Behavior

How does stress affect choices? One general theme that has emerged from the literature thus far is that stress leads to more automatic processing—that is, stress may lead us to switch from goal-directed action to habitual responding. An action is said to be habitual when it is no longer sensitive to the value of its outcome. One way to test for habit behavior in the lab is through a devaluation procedure. In a typical devaluation task, subjects are trained to make responses to receive two food rewards. Then, they are fed one of the food rewards to satiety, resulting in its devaluation (i.e., it no longer tastes pleasant). Following the devaluation, subjects who maintain goal directedness stop responding for the now-devalued food. Those who display habitual behavior, however, will continue to respond to receive an outcome, although it is no longer valuable to them.

Dias-Ferreira and colleagues (2009) examined how chronic restraint stress influenced the expression of goal-directed versus habitual actions using a devaluation task in rats. They found that the animals that were not stressed made fewer responses for the devalued outcome, reflecting its updated value. In contrast, stressed rats failed to modify their responses in light of the devaluation, consistent with habitual responding. Schwabe and Wolf (2011) used an instrumental learning task and a devaluation procedure in humans to test the effects of acute stress. In contrast with nonstressed participants, those stressed prior to the devaluation failed to show any change in responding, suggesting less goal-directed action following acute stress.

Another recent study took a reinforcement learning approach to comparing "model-based" and "model-free" learning under acute stress (Otto, Raio, Chiang, Phelps, & Daw, 2013; Daw, O'Doherty, Dayan, Seymour, & Dolan, 2006). In model-free learning, an individual learns which action is beneficial through direct experience with its reinforcing consequences. In more complex environments, however, the most rewarding outcome may depend on a series of sequential contingencies between events and actions. Learning these outcomes requires a model of the environment that allows one to make a series of choices that maximize reward. This kind of learning is known as model-based learning. Functional magnetic resonance imaging (fMRI) studies (e.g., Glascher, Daw, Dayan, & O'Doherty, 2010) suggest that model-based decisions depend on interactions between striatum and lateral PFC—a region that is adversely impacted under acute stress. Therefore, Otto and colleagues predicted that stress would lead to more model-free, and less model-based, behavior. In their study, stressed and nonstressed participants performed a probabilistic learning task that yields different patterns of choices depending on whether one is using a model-free or model-based strategy. In line with their hypothesis, the authors found that stress attenuated model-based, but not model-free, contributions to choice behavior. Interestingly, stress-induced changes in choice behavior varied depending on working memory capacity, which was measured in a different task prior to the stress manipulation. Since the switch to model-free behavior is likely a result of diminished prefrontal function under stress, people with higher working memory capacity may be protected from the deleterious effects of acute stress in this task.

Insufficient Adjustment from Default Responding

In more complex decision-making tasks, it is often hard to categorize responses as habitual or goal directed. Rather, in these tasks, it has been suggested that stress leads to insufficient adjustment from "default" responding (see Starcke & Brand, 2012, for a review). In one of the first investigations of induced stress on a specific decision variable, Porcelli and Delgado (2009) sought to examine risk taking after the cold-pressor procedure. After undergoing either the stress or a control manipulation, participants were presented with a series of gambles in either the loss or gain domain (i.e., choosing between two potential losses or two potential gains). Each choice was between a small monetary amount with high probability and a larger amount with lower probability. Behavioral economics research has shown that people tend to be risk seeking in the loss domain and risk averse in the gain domain (Kahneman & Tversky, 1979). In this experiment, exposure to the stressor exaggerated this tendency; individuals who had undergone stress became more conservative in the gain domain, and more risky in the loss domain—that is, under stress, participants were more likely to turn to their "default" response.

In other decision-making domains, stress has also been shown to affect decision strategies in a way consistent with insufficient adjustment from default responses. For instance, Kassam, Koslov, and Mendes (2009) found that exposure to a threatening social evaluation stressor decreased adjustment from an arbitrary anchor in a trivia task. Participants were more likely to use irrelevant information to answer difficult questions when they were under stress, and the degree of this bias was correlated with their physiological stress response. Similarly, in studies of moral decision making, Starcke, Polzer, Wolf, and Brand (2011) found that the level of stress response correlated with the egocentricity of decisions, while Youssef et al. (2012) found that stressed participants made fewer utilitarian judgments when responding to moral dilemmas.

Stress also seems to impair strategizing in games with a social component, such as the beauty contest game (Ho, Camerer, & Weigelt, 1998). In this game, all players submit a number in the interval (0, 100) into play, and the player with the number that is closest to two-thirds of the average of all players' numbers is the winner. In order to win, therefore, a player must be able to reason through what his or her peers will pick, and choose two-thirds of this amount. The assumption is that players who select smaller numbers are strategizing more than those who select higher numbers. In a 2013 study, Leder, Häusser, and Mojzisch found that players under stress selected larger numbers (i.e., strategized less about the intentions of other people) than those who were not under stress. It is hypothesized that the findings in these decision tasks could be attributed to the known impact of stress on executive control and PFC function. However, as of yet, there is no direct neuroscience evidence of diminished PFC involvement in these tasks.

Mixed Effects on Choice Attribute Processing

In more complicated paradigms, such as risky decision making and intertemporal choice tasks, the findings on stress and decision making are mixed. This is likely because these tasks involve several decision variables, and stress may impact these variables in different ways. For example, some studies find that stress increases risk taking, but primarily in men (Lighthall, Mather, & Gorlick, 2009; Preston, Buchanan, Stansfield, & Bechara, 2007; van den Bos, Harteveld, & Stoop, 2009; Lighthall et al., 2012). Others find that the effects on risk taking depend on the domain (gain or loss; Pabst, Brand, & Wolf, 2013b) or the level of risk (von Helversen & Reiskamp, 2013), and chronic stress may lead to risk aversion (Kandasamy et al., 2014). These mixed findings may be partially explained by the fact that many risky gambling tasks confound risk sensitivity, loss aversion, ambiguity aversion, consistency, and possibly other parameters.

Another domain in which the effects of stress are mixed is intertemporal choice. Intertemporal choices are decisions between rewards available at two different points in time. In these paradigms, participants choose between monetary rewards available immediately and larger rewards available after a delay. Participants tend to prefer rewards sooner in this paradigm, sometimes even at their long-term expense, but there are individual differences in how impatient individuals are in this task. One study found that people became more impulsive under stress (Kimura et al., 2013), another found that there were no effects of stress on intertemporal choice behavior (Haushofer et al., 2013), and yet another found that these effects depended on individual differences in self-reported daily perceived stress (Lempert, Porcelli, Delgado, & Tricomi, 2012). These inconsistencies may reflect the complexity of intertemporal decision making, and further study is needed to uncover the mechanism by which stress influences these choices.

Acute stress has been shown to influence a number of basic processes that are important in decision making, including reward responsiveness (Bogdan & Pizzagalli, 2006; Berghorst, Bogdan, Frank, & Pizzagalli, 2013), executive control (Hains & Arnsten, 2008), and learning from positive and negative outcomes (Petzold, Plessow, Goschke, & Kirschbaum, 2010; Lighthall, Gorlick, Schoeke, Frank, & Mather, 2013). Most decision-making tasks likely involve several of these processes and many decision variables. Therefore, carefully isolating different aspects of decision making will be worthwhile when investigating the effects of induced stress.

Important Considerations for Future Research

There are several limitations that are important to consider when evaluating studies on stress and decision making. First, one needs to distinguish between chronic and acute stress (McEwen, 2007). While our physiological stress responses are well suited to maintaining homeostasis when stressors are brief, our stress responses may become dysregulated and cause more general problems (including mental illness) when we are under "allostatic overload" (McEwen, 2007). Chronic decision-making problems may in part be a result of morphological changes in the brain due to chronic stress (Liston, McEwen, & Casey, 2009; Joëls, 2011). Most laboratory experiments in humans can only draw conclusions about the effects of acute stress in healthy participants. However, disorders like posttraumatic stress disorder and depression, which are marked by chronic stress (Yehuda, 2001; Checkley, 1996), may provide some insight into how chronic stress effects can be distinguished from acute stress effects in humans. Animal studies are also useful in this domain, since they may involve either chronic stress or acute stress.

Another important consideration in stress research is that of individual differences. The impact of stress on cognition most likely depends on the individual's reactivity to stress, and studies have shown that there is a great deal of interindividual variability in how stressors are perceived and how stress responses are regulated (see Frankenhaeuser, 1986). Furthermore, there is evidence that trait anxiety, perceived stress, gender, and working memory capacity can modulate decision making under stress (e.g., Sandi & Richter-Levin, 2009; Lempert et al., 2012; Lighthall et al., 2012; Otto et al., 2013). Another confounding variable in this literature is stressor timing. Stress effects vary depending on the timing after the stressor when effects are recorded. Acute effects include norepinephrine release and sympathetic nervous system activity. Ten to 20 minutes later, cortisol and other stress hormones hit their peak concentration and begin to influence activity in the PFC, hippocampus, amygdala, and other brain regions. An hour after exposure to a significant stressor, there may be changes in gene expression that further affect decision making (Joëls, 2011). Some studies have begun to explore this effect of time. For example, Pabst, Brand, and Wolf (2013a) found that participants exhibited more risky behavior in a game-of-dice task when they were tested 28 minutes after the stressor, but their decision making was actually improved when they were tested directly poststressor. The complicated orchestration of responses associated with stress can result in different decision-making effects at different times poststressor.

Finally, psychosocial and physical stressors result in similar, but not identical, downstream effects, and there are different confounding variables associated with different types of stressors (e.g., social anxiety may modulate the effects of the TSST social stressor, but not of the cold-pressor stressor). Especially when studying social decision making, it is important for researchers to motivate use of a specific stress paradigm.

Mood

Unlike stress, which is associated with well-defined psychophysiological and neurohormonal changes, the mechanisms of mood are less understood. Mood is a diffuse affective state that is primarily characterized by a change in subjective feelings (Scherer, 2005). A common technique for manipulating affect in the laboratory is focused on changing the mood of the subject. This technique, called *mood induction*, attempts to induce a shift in mood through the presentation of affective stimuli, such as films, sometimes combined with more effortful techniques such as imagining personal circumstances.

Appraisal Tendencies

One influential theory in the literature on mood and decision making is the *appraisal tendency framework* (ATF) originally suggested by Lerner and Keltner (2000). The ATF assumes that specific affective states give rise to specific cognitive and motivational properties. It has been argued that emotions and moods elicit *action tendencies* that enable individuals to deal with the situation at hand (Frijda, 1986). These tendencies depend on both the arousal level and valence of the mood, and they may differ for different moods of the same valence. For example, anger may be associated with a motivation to change the situation by confronting or fighting another person, while fear may be associated with withdrawal and avoidance. Much empirical work has been done to investigate the effects of specific moods on judgments, such as risk assessment, evaluations of others, and attributions of causality (see Lerner & Tiedens, 2006, for one in-depth review). Although such judgments are potentially relevant to the type of decision making that we are discussing here, the remainder of this section focuses on studies that have directly examined value-based decision making.

In a study designed to examine the impact of mood on economic decision making, Lerner, Small, and Loewenstein (2004) presented three groups of participants with film clips. Two of the clips elicited feelings of sadness and disgust, while the third was a neutral film clip. Immediately following mood induction, participants were either given a set of highlighters and asked to set a price to sell them (sell price), or they were asked how much they would pay for the set of highlighters (buy price). This paradigm explored the "endowment effect"—a well-documented phenomenon whereby sell prices exceed buy prices, since ownership of an item imbues it with added value. In the neutral condition, the traditional endowment effect was observed: buy prices were lower than sell prices. Participants who had watched the "disgust" clip showed reduced buy and sell prices. However, those in the "sad" film clip condition showed a "reverse endowment effect"; their buy prices were higher than their sell prices. To explain this striking effect, Lerner and colleagues (2004) suggested that the value of the choice option was appraised in a manner consistent with the mood. Sadness may drive an individual to appraise his or her current situation as unfavorable, and enhance the subjective value of actions that change the circumstances. One consequence might be to increase the likelihood of ownership when not endowed with the item (i.e., a higher buy price), and also increase the likelihood of expelling the item when it is owned (i.e., a lower sell price). Similarly, disgust may elicit a tendency to expel all current items, resulting in low prices for buying and selling.

Further evidence that feelings of disgust result in a tendency to dispose of current items comes from a study of the *status quo bias*, a powerful partiality toward one's current state and possessions (Samuelson & Zeckhauser, 1988). After watching a disgusting movie clip (as in Lerner et al., 2004, above), participants were given the choice between keeping one generic box filled with office supplies and switching to a different box that contained similar office supplies (Han, Lerner, & Zeckhauser, 2012). Critically, participants were not aware of what either box contained. The subjects who had undergone the disgust mood induction were more likely to switch to the new box than were subjects in the neutral condition. This result is consistent with the idea of an "expulsion" appraisal tendency when in a state of disgust.

Lerner, Li, and Weber (2013) tested whether sadness would influence financial impatience, by offering intertemporal choices to participants either after a sad or neutral mood induction. Since sadness is associated with a desire to change one's current situation, the authors hypothesized that sad participants would favor more immediate rewards. As predicted, sad participants were more impatient than those in the neutral condition. In a similar vein, Cryder, Lerner, Gross, and Dahl (2008) found that, following a sad mood induction, participants increased their willingness to pay for goods. Sad mood also biases choice toward high-risk/high-reward options, while induced anxious mood biases choice toward low-risk/low-reward options (Raghunathan & Pham, 1999).

Positive affective states have been relatively understudied in this domain, but a recent study examined the influence of a gratitude induction on intertemporal choice. Gratitude is a positive emotion that is future oriented, since when one has been helped in the past, one is more likely to help others in the future. Indeed, gratitude has been found to increase prosocial behavior (DeSteno, Bartlett, Baumann, Williams, & Dickens, 2010). Even in the absence of social context, however, induced gratitude was potent enough to make individuals more patient during intertemporal choice, possibly by making them more future oriented in general (DeSteno, Li, Dickens, & Lerner, 2014). This study provides a good example of how incidental affect can at times help people make more optimal choices.

Social Decision Making

The influence of mood has also been examined in social decision making using the ultimatum game. In this two-player game, one of the individuals plays the role of "proposer," while the other one is the "responder." The proposer is given the opportunity to divide a sum of money between the two players as he or she sees fit. The responder can then choose to accept the proposed split or reject the offer. If the offer is rejected, both players receive nothing. Despite the associated loss of utility for both players, unfair offers are often rejected in this game. For example, if the proposer chooses to keep $80 out of $100, and offers the responder only $20, there is a 50% chance that the responder will reject the offer (Thaler, 1988). To investigate how mood might affect choices among responders in this task, Harlé and Sanfey (2007) induced sadness, amusement, or neutral mood in three groups of participants using film clips. After mood induction, participants (in the role of responders) played a series of ultimatum games with different partners. There were no behavioral differences between individuals in the amusement and neutral conditions, but players who were exposed to sad film clips rejected more unfair offers than those in the neutral condition. Even though the affective state was incidental, it altered the appraisal of the offers, and changed behavior in this task. In a related study, induced disgust also led to an increased rate of rejection of unfair offers in the ultimatum game (Moretti & di Pellegrino, 2010).

Summary

Although the ATF theory has been highly influential, it bears similarity to other theoretical frameworks that warrant mention. The "affect-as-information" model (Schwarz & Clore, 1983) proposes that affect may be incorporated into the judgment process even when it is irrelevant. Similarly, the "feeling is for doing" model (Zeelenberg, Nelissen, & Pieters, 2007) holds that affective states, such as moods, serve the adaptive function of motivating behaviors.

While these models make testable predictions for behavior, and psychological evidence of mood effects on decision making is abundant, the neural mechanisms behind decision making in different mood states have been slow to emerge. This may be because of the challenges of studying the neural basis of mood in general—after all, it is difficult to study two different moods in the same individual within the same fMRI scanning session. However, future research with clever neuroimaging designs and analyses may yield important insights into the neural mechanisms that enable moods to influence our choices.

Affective Priming

While mood induction reliably evokes changes in self-reported subjective feelings, affective states can also be manipulated without explicit awareness, through *affective priming.* In priming, subjects are subliminally presented with affective stimuli, such as happy, angry, and neutral faces. These primes presumably elicit transient emotional responses that impact subsequent choices. To date, only a few studies have investigated how affective priming influences decision making.

Winkielman, Berridge, and Wilbarger (2005) subliminally presented three groups of participants with angry, happy, and neutral faces, while they performed a gender classification task. Afterward, participants poured, consumed, rated, and indicated their willingness to pay for a drink. Those who had been exposed to happy faces poured and consumed more of the beverage. They also rated the beverage more highly and increased their willingness to pay for it, relative to participants who saw neutral faces. The subjects who were presented with angry faces showed the opposite effect. Participants were unaware of the experimental manipulation and they did not report any changes in subjective feelings during the study, making these behavioral findings even more remarkable. It was suggested that the emotional primes generated subtle emotional responses, which were sufficient to alter the appraisal of the choice options, and to change behavior.

Luo, Ainslie, and Monterosso (2012) examined the effect of affective primes on intertemporal choice, by subliminally presenting the same set of subjects with angry, fearful, and happy faces, while they performed an intertemporal choice task (i.e., a series of choices between smaller/sooner and larger/later monetary rewards). In the trials that were preceded by presentation of fearful faces, subjects tended to choose larger/later rewards. The authors suggested that perhaps participants attributed the fearful emotional response to the option that was more readily available during the time of choice.

Individual differences may also influence the extent to which affective primes influence decision making. Participants performed the aforementioned intertemporal choice study during acquisition of fMRI data. The participants who showed the greatest changes in BOLD signal in the anterior cingulate cortex (along with a few other regions) also showed the largest priming effect (Luo et al., 2012). In another study highlighting individual differences in priming effects, Augustine and Larsen (2011) showed participants either positive or negative words while they made choices in an intertemporal choice paradigm. Participants also completed questionnaires that assessed personality variables. Individuals who were high in neuroticism and who were in the negative prime condition discounted delayed rewards at a significantly higher rate than those in any other condition.

Although responses to affective primes are subtle and outside of conscious awareness, this set of studies suggests that they may still influence decisions.

Affect Dispositions

Affect dispositions are stable traits that have an affective quality (Scherer, 2005). For instance, some people may be generally more anxious or happy than others. Affect dispositions may influence choices, because they affect the way that individuals process choices and act on them. They may also impact choices because they affect an individual's proneness to certain moods or stress.

So far, only a few studies have investigated the relationship between affective trait variables and decision-making tendencies. For example, trait positivity has been shown to predict more rejection of unfair offers in the ultimatum game (Dunn, Makarova, Evans, & Clark, 2010). Anhedonia has been found to correlate negatively with temporal discounting rate—that is, individuals who are anhedonic tend to be more patient (Lempert & Pizzagalli, 2010). Individuals who are anxious are more prone to the framing effect (i.e., more risk seeking in the loss domain and more risk averse in the gain domain; Xu et al., 2013; Giorgetta et al., 2012) and they are more likely to punish others in social decision-making tasks (Grecucci et al., 2013). Higher trait anxiety may be linked to less risky decisions, perhaps because anxiety results in a more negative interpretation or appraisal of potential outcomes (see Hartley & Phelps, 2012, for a review of anxiety and decision making).

The link between affect dispositions and decision making is unsurprising, because affect dispositions have been linked to psychopathology, which has profound consequences on decision making. For example, someone with very high trait anxiety might be diagnosed with generalized anxiety disorder. Given this connection, it has recently been proposed that basic neuroeconomic research may provide an important tool for translational studies in psychiatry (Sharp, Monterosso, & Montague, 2012). Much like the other types of incidental affect mentioned above, it is unlikely that a single mechanism or process will underlie the impact of affect dispositions or psychopathology on decision processes.

Integral Emotion

A primary function of emotion is to highlight the relevance of stimuli and events in order to guide adaptive behavior (Frijda, 2007). Therefore, it would make sense that the valuation of a particular option might incorporate the emotional response associated with it. This emotional response is also known as an integral emotion, because it arises from the choice and is an integral aspect of it. For instance, if one of the choice options elicits a fear reaction, that reaction would contribute to a negative evaluation of that choice, which would lead to avoidance of that option. While it may seem obvious that the emotional response to the choice options or outcomes should influence valuation, relatively few studies have explicitly measured integral emotions during decision making. In this section, we summarize studies that have attempted to correlate integral emotional variables with decision variables.

One affective variable that may be influenced by choice attributes during decision making, and is easily measured in the laboratory, is physiological arousal. Physiological arousal responses refer to objective, transient indications of autonomic nervous system arousal in response to a stimulus. One of the most common measures of emotional arousal in the laboratory is the skin conductance response (SCR), a well-established correlate of sympathetic nervous system activity. Below, we primarily focus on studies that have used this measure in the context of decision-making tasks, although we also include studies that have utilized subjective ratings of emotional reactions or feelings.

Physiological Arousal and Choice Attribute Processing

In one of the first examinations of a physiological response during decision making, Bechara, Damasio, Tranel, and Damasio (1997) studied patients with OFC damage as they performed the Iowa Gambling Task (IGT), a paradigm that assesses risk attitudes and value updating. In this paradigm, participants choose cards from decks that either yield large rewards and occasional large losses (“risky,” overall disadvantageous decks) or decks that yield small rewards and small punishments (“safe” decks). Over the course of the task, normal control participants began to generate SCRs before selecting from the risky decks. They began to avoid those decks shortly thereafter. Meanwhile, the patients with OFC damage did not generate these anticipatory arousal responses, and they did not avoid the risky decks. To explain these results, Bechara and colleagues proposed the somatic marker hypothesis. This hypothesis suggests that the anticipatory arousal response is a bodily signal of the value of the choice and serves to steer participants away from “risky” choices. According to this hypothesis, since patients with OFC damage could not generate these anticipatory emotional responses, they also could not change their assessment of risk in the task. Several studies have since questioned the somatic marker hypothesis and the specific interpretation of these results (Fellows & Farah, 2005; Maia & McClelland, 2004; Tomb, Hauser, Deldin, & Caramazza, 2002). Nevertheless, this study remains one of the first to link emotional responses and brain systems to decision patterns.

A more recent study examined SCRs during moral decision making in patients with ventromedial prefrontal cortex (vmPFC) damage and healthy controls (Moretto, Ladavas, Mattioli, & di Pellegrino, 2010). In “personal” moral dilemmas, when participants had to choose whether or not to perform a reprehensible action for a utilitarian outcome (e.g., pushing someone to death in order to save five people), patients with vmPFC damage made significantly more utilitarian choices than healthy controls did. In addition, they did not exhibit SCR responses when choosing these options, while healthy participants did. This study suggests that the emotional response associated with certain actions may influence moral decision making, and that the vmPFC may be an important region for mediating these emotional responses. From this experiment, however, it is unclear whether emotional responses to "personal" moral dilemmas underlie decisions.

Emotional arousal has also been associated with decision tendencies in social decision making in the ultimatum game. Van't Wout, Kahn, Sanfey, and Aleman (2006) assessed SCR while participants played the ultimatum game (as responders) with either another person or a computer. SCRs were greater in response to unfair offers relative to fair offers, but this effect was only seen when participants were playing against other people (and not when they played with a computer that randomly generated offers). In addition, the magnitude of the SCR response was positively correlated with offer rejection rate. These results are consistent with the interpretation that physiological arousal reflects a valuation process in the social domain, and that this emotional response to social cues is related to economic decisions.

These studies linking arousal to risky choices and social components of decisions suggest that specific cues or attributes on some trials of a decision-making task can induce an emotional reaction, which may influence the choice when those factors (i.e., heightened risk, an unfair conspecific) are present. However, just the simple act of potentially gaining or losing money can also elicit arousal responses (e.g., Delgado, Labouliere, & Phelps, 2006; Delgado, Gillis, & Phelps, 2008). In order to assess how arousal to losses and gains is linked to choice, Sokol-Hessner and colleagues (2009) gave participants a simple gambling task in which they had to choose between a certain outcome or a gamble with a 50/50 chance of winning or losing money. In gambling tasks, two variables that are often confounded are risk sensitivity and loss aversion. Loss aversion is the tendency to weigh potential losses more than gains when considering the choice options. Someone who is very loss averse may also appear to be risk averse, even if he or she is generally risk seeking when there is no potential loss. With their task, Sokol-Hessner and colleagues (2009) were able to separately quantify loss aversion and risk sensitivity for each participant. They found that loss aversion was correlated with the SCRs to monetary losses relative to gains, such that those participants who showed greater SCR to losses relative to gains were also more loss averse. They found no relationship between arousal and risk sensitivity. In a follow-up fMRI study, Sokol-Hessner, Camerer, and Phelps (2013) found that the magnitude of the amygdala BOLD response to monetary losses relative to gains correlated with loss aversion, but this activity was unrelated to risk sensitivity. Consistent with these results, patients with amygdala damage are less loss averse overall (De Martino, Camerer, & Adolphs, 2010) and administering a beta-adrenergic blocker (propranolol), which has previously been shown to diminish the amygdala's modulation of memory (Phelps, 2006), also reduces loss aversion, but does not affect risk sensitivity (Sokol-Hessner, Lackovic, Tobe, Camerer, Leventhal, & Phelps, 2015). Given that most risky decision tasks do not independently model loss aversion and risk sensitivity, it is possible that some observed effects of emotional arousal in risky decision-making tasks (e.g., Bechara et al., 1997) are due to loss aversion, and not risk attitudes.

Changing Affect, Changing Choices

Although we often think of emotional reactions as being out of our control, it has long been recognized by affective scientists that emotions are flexible. For example, emotional responses are highly susceptible to our choice environment and our expectations about that environment. If we want to make consistently adaptive choices, we should be aware of this flexibility, and use cognitive resources to change our emotions when necessary. For instance, it would be adaptive to fear a potentially dangerous snake when walking in the woods, but a similar reaction in a zoo would be inappropriate. The flexibility of emotion, or lack of it, may underlie a range of psychiatric disorders, from addiction to posttraumatic stress disorder.

In value-based decision making, the flexibility of emotion suggests that its impact on choices may also vary. If the emotional reaction to a choice or choice options is flexible, its modulation of the value calculation should change over time. Affective neuroscientists have investigated several techniques that can be used to alter emotion (see Hartley & Phelps, 2010, for a review). The technique that we discuss here is cognitive emotion regulation.

Cognitive Emotion Regulation

The aim of cognitive emotion regulation techniques is to change emotional reactions by actively manipulating one's cognitions about the situation at hand (see Ochsner & Gross, 2005; Gross, 1998, for reviews). One common strategy is to reappraise or reinterpret the meaning of the event. Appraisal is a component in determining the emotional significance of an event (Scherer, 2000, 2005) and by reappraising an event, an individual may change its emotional significance. In typical studies of reappraisal, subjects are provided with instructions to help them reinterpret a negative event or stimulus. These studies show reduced amygdala activation with reappraisal, coupled with increased activation of regions of the PFC that are thought to inhibit the amygdala's BOLD response (Ochsner & Gross, 2005).

In addition to changing emotional reactions to aversive stimuli, similar techniques can diminish the emotional response to rewarding stimuli. For instance, Delgado et al. (2008) showed participants neutral stimuli, that, over the course of the experiment, were conditioned to be associated with monetary rewards. These rewarding stimuli began to elicit an SCR response, but a simple emotion regulation instruction decreased this emotional arousal. In addition, BOLD responses in the striatum were diminished when participants were instructed to regulate their emotional response to anticipated monetary rewards. This decreased striatal activation was coupled with increased activation of the PFC.

Emotion regulation can also change the representation of value during economic decision making. In an fMRI study by Martin and Delgado (2011), participants performed a gambling task, during which they could make either risky or safe choices. When participants effectively utilized an imagery-based emotion regulation technique, their risk taking was reduced. They also exhibited decreased striatal activation during their gambling decisions. This finding suggests that emotion regulation can lead to decreased risk-seeking behavior. Critically, however, there are individual differences in how well participants can use this strategy.

In the gambling paradigm outlined earlier, Sokol-Hessner et al. (2009) examined the impact of a perspective shift intended to prompt the reappraisal of the significance of the choice. Participants were asked to make a series of risky monetary choices. For each participant, a loss aversion parameter was derived. In one set of choices, subjects were asked to "attend" to each individual choice and its potential outcome in isolation. In the other set, they were asked to "regulate," by considering each choice as one of many choices in a larger set, or portfolio. Simply asking participants to put potential losses in perspective in this way led to a reduction of SCR to losses relative to gains. Furthermore, this change in arousal to losses between conditions was directly related to a decrease in the participants' individual loss aversion. In a follow-up fMRI study, Sokol-Hessner et al. (2013) found that implementing this regulation technique reduced amygdala activation to losses, and led to an overall increase in BOLD responses in the striatum, vmPFC, and dorsolateral PFC. These findings suggest that this novel reappraisal strategy draws on the same neural circuitry that is engaged in more typical emotion regulation tasks.

Emotion regulation strategies can also change choices in social decision-making paradigms, such as in the ultimatum game. Van't Wout, Chang, and Sanfey (2010) invited participants to play the ultimatum game as responders under three different conditions: emotional reappraisal, expressive suppression, and no regulation. In the reappraisal condition, subjects were asked to adopt a neutral, nonemotional attitude when viewing the offers. Individuals in this condition were asked to come up with reasons why their opponent would give them an unfair offer (e.g., "He really needs the money," "She is a college student just like me"). In the expressive suppression condition, participants were asked to "not let their emotions show" as they chose whether or not to accept the proposed splits of $10. Participants who cognitively reappraised the offers rejected significantly fewer unfair offers than those who suppressed their emotions or those who did not regulate their emotions at all. Furthermore, when they played the game as proposers directly afterward, participants in the reappraisal condition were more likely to propose fair offers. These findings suggest that simply suppressing the expression of emotion is not sufficient to change decision-making patterns, but reinterpreting an emotional response to the offer of an unfair split can lead to a change in decision tendencies.

Integral emotions can occasionally lead to decisions that result in an overall monetary loss (e.g., rejections in the ultimatum game, risk seeking when probabilities of reward are low, forgoing larger potential gains to avoid potential losses).

However, research on emotion regulation suggests that, to the extent to which emotion is linked to these choices, they can be changed. This line of research also provides strong support for a role of emotion in the calculation of subjective value, since cognitive strategies that change the emotional significance of a choice option can change choices.

Conclusion

In this chapter, we have tried to present a review of the research that has sought to elucidate the relationship between affect and economic decision making. From the evidence, it is clear that this relationship is complex. There are many components of affect that may each have a unique influence on different aspects of the choice process. After all, both affect and decision making are general terms that describe a collection of processes, only some of which we have explored here. Investigating affect is challenging enough by itself, since manipulating and measuring affect in the laboratory can be difficult, and there is debate about how to characterize affective variables. There are also many variables that influence economic choice, and teasing these apart is a challenge for decision science. Finally, the relationship between affect and choice is flexible—although affect does influence choice, it is possible to regulate affect to change choice.

Given the complex nature of both choice and affect, a two-system approach, in which cognition and emotion play distinct, competitive roles in decision making, seems too simplistic to capture the breadth of their interaction. The repeated reference to dual systems of affect and reason in research on decision making potentially hampers scientific advances in this area by discouraging investigations that capture the detailed and nuanced relationships between unique aspects of affect and choices. It also suggests to the public and to scientists in other disciplines that the historical notion of competing forces of emotion and reason is supported by scientific evidence. Perpetuating this idea may result in misinformed efforts to inhibit emotion in order to promote rational decision making. There have been many exciting recent advances in the field of emotion and decision making. However, if we want to have a fine-grained and detailed science of decision making, moving beyond dual-systems approaches is a necessary step.

References

Arnsten, A. F. (2009). Stress signaling pathways that impair prefrontal cortex structure and function. *Nature Reviews Neuroscience, 10*(6), 410–422.

Augustine, A. A., & Larsen, R. J. (2011). Affect regulation and temporal discounting: Interactions between primed, state, and trait affect. *Emotion, 11*(2), 403–412.

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science, 1*(1), 28–58.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science, 275*(5304), 1293–1295.

Berghorst, L. H., Bogdan, R., Frank, M. J., & Pizzagalli, D. A. (2013). Acute stress selectively reduces reward sensitivity. *Frontiers in Human Neuroscience, 7*, 133.

Bogdan, R., & Pizzagalli, D. A. (2006). Acute stress reduces reward responsiveness: Implications for depression. *Biological Psychiatry, 60*(10), 1147–1154.

Checkley, S. (1996). The neuroendocrinology of depression and chronic stress. *British Medical Bulletin, 52*(3), 597–617.

Cohen, J. D. (2005). The vulcanization of the human brain: A neural perspective on interactions between cognition and emotion. *Journal of Economic Perspectives, 19*(4), 13–24.

Cryder, C. E., Lerner, J. S., Gross, J. J., & Dahl, R. E. (2008). Misery is not miserly: Sad and self-focused individuals spend more. *Psychological Science, 19*(6), 525–530.

Damasio, A. (2005). *Descartes' Error: Emotion, reason and the human brain*. New York: Penguin Books.

Daw, N. D., O'Doherty, J. P., Dayan, P., Seymour, B., & Dolan, R. J. (2006). Cortical substrates for exploratory decisions in humans. *Nature, 441*(7095), 876–879.

De Martino, B., Camerer, C., & Adolphs, R. (2010). Amygdala damage eliminates monetary loss aversion. *Proceedings of the National Academy of Sciences, 107*(8), 3788–3792.

Delgado, M. R., Gillis, M., & Phelps, E. A. (2008). Regulating the expectation of reward via cognitive strategies. *Nature Neuroscience, 11*(8), 880–881.

Delgado, M. R., Labouliere, C. D., & Phelps, E. A. (2006). Fear of losing money?: Aversive conditioning with secondary reinforcers. *Social Cognitive and Affective Neuroscience, 1*(3), 250–259.

DeSteno, D., Bartlett, M. Y., Baumann, J., Williams, L. A., & Dickens, L. (2010). Gratitude as moral sentiment: Emotion-guided cooperation in economic exchange. *Emotion, 10*(2), 289–293.

DeSteno, D., Li, Y., Dickens, L., & Lerner, J. S. (2014). Gratitude: A tool for reducing economic impatience. *Psychological Science, 25*(6), 1262–1267.

Dias-Ferreira, E., Sousa, J. C., Melo, I., Morgado, P., Mesquita, A. R., Cerqueira, J. J., et al. (2009). Chronic stress causes frontostriatal organization and affects decision-making. *Science, 325*(5940), 621–625.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin, 130*(3), 355–391.

Dunn, B. D., Makarova, D., Evans, D., & Clark, L. (2010). "I'm worth more than that": Trait positivity predicts increased rejection of unfair financial offers. *PLoS ONE, 5*(12), e15095.

Ekman, P., & Davidson, R. J. (1994). *The nature of emotion: Fundamental questions*. New York: Oxford University Press.

Evans, J. S. (2008). Dual processing accounts of reason, judgment and social cognition. *Annual Reviews in Psychology, 59*, 255–278.

Fellows, L. K., & Farah, M. J. (2005). Different underlying impairments in decision-making following ventromedial and dorsolateral frontal lobe damage in humans. *Cerebral Cortex, 15*(1), 58–63.

Figner, B., Mackinley, R. J., Wilkening, F., & Weber, E. U. (2009). Affective and deliberative processes in risky choice: Age differences in risk taking in the Columbia card task. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*(3), 709–730.

Frankenhaeuser, M. (1986). A psychobiological framework for research on humans' stress and coping. In M. H. Appley & R. Trumbull (Eds.), *Dynamics of stress: Physiological, psychological, and social perspectives* (pp. 101–116). New York: Plenum Press.

Frijda, N. H. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.

Frijda, N. H. (2007). *The laws of emotion*. Mahwah, NJ: Erlbaum.

Giorgetta, C., Grecucci, A., Zuanon, S., Perini, L., Balestrieri, M., Bonini, N., et al. (2012). Reduced risk-taking behavior as a trait feature of anxiety. *Emotion, 12*(6), 1373–1383.

Glascher, J., Daw, N., Dayan, P., & O'Doherty, J. P. (2010). States versus rewards: Dissociable neural prediction error signals underlying model-based and model-free reinforcement learning. *Neuron,* 66(4), 585–595.

Grecucci, A., Giorgetta, C., Brambilla, P., Zuanon, S., Perini, L., Balestrieri, M., et al. (2013). Anxious ultimatums: How anxiety disorders affect socioeconomic behavior. *Cognition and Emotion, 27*(2), 230–244.

Gross, J. J. (1998). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression and physiology. *Journal of Personality and Social Psychology, 74*(1), 224–237.

Hains, A. B., & Arnsten, A. F. (2008). Molecular mechanisms of stress-induced prefrontal cortical impairment: Implications for mental illness. *Learning and Memory, 15*(8), 551–564.

Han, S., Lerner, J. S., & Zeckhauser, R. (2012). The disgust-promotes-disposal effect. *Journal of Risk and Uncertainty, 44*(2), 101–113.

Harlé, K., & Sanfey, A. G. (2007). Incidental sadness biases social economic decisions in the ultimatum game. *Emotion, 7*(4), 876–881.

Hartley, C. A., & Phelps, E. A. (2010). Changing fear: The neurocircuitry of emotion regulation. *Neuropsychopharmacology, 35*(1), 136–146.

Hartley, C. A., & Phelps, E. A. (2012). Anxiety and decision-making. *Biological Psychiatry, 72*(2), 113–118.

Haushofer, J., Cornelisse, S., Seinstra, M., Fehr, E., Joëls, M., & Kalenscher, T. (2013). No effects of psychosocial stress on intertemporal choice. *PLoS ONE, 8*(11), e78597.

Ho, T., Camerer, C., & Weigelt, K. (1998). Iterated dominance and iterated best response in experimental p-beauty contests. *American Economic Review, 88*, 947–969.

Ishizuka, K., Hillier, A., & Beversdorf, D. Q. (2007). Effect of the cold pressor test on memory and cognitive flexibility. *Neurocase, 13*(3), 154–157.

Joëls, M. (2011). Impact of glucocorticoids on brain function: Relevance for mood disorders. *Psychoneuroendocrinology, 36*(3), 406–414.

Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Strauss & Giroux.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263–291.

Kandasamy, N., Hardy, B., Page, L., Schaffner, M., Graggaber, J., Powlson, A. S., et al. (2014). Cortisol shifts financial risk preferences. *Proceedings of the National Academy of Sciences, 111*(9), 3608–3613.

Kassam, K. S., Koslov, K., & Mendes, W. B. (2009). Decisions under distress: Stress profiles influence anchoring and adjustment. *Psychological Science, 20*(11), 1394–1399.

Kendler, K. S., Karkowski, L. M., & Prescott, C. A. (1999). Causal relationship between stressful life events and the onset of major depression. *American Journal of Psychiatry, 156*(6), 837–841.

Kimura, K., Izawa, S., Sugaya, N., Ogawa, N., Yamada, K. C., Shirotsuki, K., et al. (2013). The biological effects of acute psychosocial stress on delay discounting. *Psychoneuroendocrinology, 38*(10), 2300–2308.

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The "Trier Social Stress Test": A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology, 28*(1–2), 76–81.

Lambert, K. G. (2003). The life and career of Paul Maclean: A journey toward neurobiological and social harmony. *Physiology and Behavior, 79*(3), 343–349.

Leder, J., Häusser, J. A., & Mojzisch, A. (2013). Stress and strategic decision-making in the beauty contest game. *Psychoneuroendocrinology, 38*(9), 1503–1511.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Reviews of Neuroscience, 23*, 155–184.

Lempert, K. M., & Pizzagalli, D. A. (2010). Delay discounting and future-directed thinking in anhedonic individuals. *Journal of Behavior Therapy and Experimental Psychiatry, 41*(3), 258–264.

Lempert, K. M., Porcelli, A. J., Delgado, M. R., & Tricomi, E. (2012). Individual differences in delay discounting under acute stress: The role of trait perceived stress. *Frontiers in Psychology, 3*, 251.

Lerner, J. S., & Keltner, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgment and choice. *Cognition and Emotion, 14*(4), 473–493.

Lerner, J. S., Li, Y., Valdesolo, P., & Kassam, K. (2015).

Emotion and decision making. *Annual Reviews of Psychology*, 66, 33.1–33.25.

Lerner, J. S., Li, Y., & Weber, E. U. (2013). The financial costs of sadness. *Psychological Science, 24*(1), 72–79.

Lerner, J. S., Small, D. A., & Loewenstein, G. F. (2004). Heart strings and purse strings: Carryover effects of emotions on economic decisions. *Psychological Science, 15*(5), 337–341.

Lerner, J. S., & Tiedens, L. Z. (2006). Portrait of the angry decision maker: How appraisal tendencies shape anger's influence on cognition. *Journal of Behavioral Decision Making, 19*, 115–137.

Lighthall, N. R., Gorlick, M. A., Schoeke, A., Frank, M. J., & Mather, M. (2013). Stress modulates reinforcement learning in younger and older adults. *Psychology and Aging, 28*(1), 35–46.

Lighthall, N. R., Mather, M., & Gorlick, M. A. (2009). Acute stress increases sex differences in risk seeking in the balloon analogue risk task. *PLoS ONE, 4*(7), e6002.

Lighthall, N. R., Sakaki, M., Vasunilashorn, S., Nga, L., Somayajula, S., Chen, E. Y., et al. (2012). Gender differences in reward-related decision processing under stress. *Social Cognitive and Affective Neuroscience, 7*(4), 476–484.

Liston, C., McEwen, B. S., & Casey, B. J. (2009). Psychosocial stress reversibly disrupts prefrontal processing and attentional control. *Proceedings of the National Academy of Sciences USA, 106*(3), 912–917.

Luo, S., Ainslie, G., & Monterosso, J. (2012). The behavioral and neural effect of emotional primes on intertemporal decisions. *Social Cognitive and Affective Neuroscience, 9*(3), 283–291.

MacLean, P. D. (1952). Some psychiatric implications of physiological studies on frontotemporal portion of limbic system (visceral brain). *Electroencephalography and Clinical Neurophysiology, 4*(4), 407–418.

Maia, T. V., & McClelland, J. L. (2004). A reexamination of the evidence for the somatic marker hypothesis: What participants really know in the Iowa gambling task. *Proceedings of the National Academy of Sciences USA, 101*(45), 16709–16710.

Martin, L. N., & Delgado, M. R. (2011). The influence of emotion regulation on decision making under risk. *Journal of Cognitive Neuroscience, 23*(9), 2569–2581.

McEwen, B. S. (2007). Physiology and neurobiology of stress and adaptation: Central role of the brain. *Physiology Reviews, 87*(3), 873–904.

Moretti, L., & di Pellegrino, G. (2010). Disgust selectively modulates reciprocal fairness in economic interactions. *Emotion, 10*(2), 169–180.

Moretto, G., Ladavas, E., Mattioli, F., & di Pellegrino, G. (2010). A psychophysiological investigation of moral judgment after ventromedial prefrontal damage. *Journal of Cognitive Neuroscience, 22*(8), 1888–1899.

Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Science, 9*(5), 242–249.

Otto, A. R., Raio, C. M., Chiang, A., Phelps, E. A., & Daw, N. D. (2013). Working-memory capacity protects model-based learning from stress. *Proceedings of the National Academy of Sciences USA, 110*(52), 20941–20946.

Pabst, S., Brand, M., & Wolf, O. T. (2013a). Stress and decision making: A few minutes make all the difference. *Behavioral Brain Research, 250*, 39–45.

Pabst, S., Brand, M., & Wolf, O. T. (2013b). Stress effects on framed decisions: There are differences for gains and losses. *Frontiers in Behavioral Neuroscience, 7*, 142.

Papez, J. W. (1937). A proposed mechanism of emotion. *Archives of Neurology and Psychiatry, 38*(4), 725–743.

Petzold, A., Plessow, F., Goschke, T., & Kirschbaum, C. (2010). Stress reduces use of negative feedback in a feedback-based learning task. *Behavioral Neuroscience, 124*(2), 248–255.

Phelps, E. A. (2006). Emotion and cognition: Insights from studies of the human amygdala. *Annual Reviews of Psychology, 57*, 27–53.

Phelps, E. A., Lempert, K. M., & Sokol-Hessner, P. (2014). Emotion and decision making: Multiple modulatory neural circuits. *Annual Reviews of Neuroscience, 37*, 263–287.

Porcelli, A. J., & Delgado, M. R. (2009). Acute stress modulates risk taking in financial decision making. *Psychological Science, 20*(3), 278–283.

Preston, S. D., Buchanan, T. W., Stansfield, R. B., & Bechara, A. (2007). Effects of anticipatory stress on decision making in a gambling task. *Behavioral Neuroscience, 121*(2), 257–263.

Raghunathan, R., & Pham, M. T. (1999). All negative moods are not equal: Motivational influences of anxiety and sadness on decision-making. *Organizational Behavior and Human Decision Processes, 79*(1), 56–77.

Raio, C. M., Orederu, T. A., Palazzolo, L., Shurick, A. A., & Phelps, E. A. (2013). Cognitive emotion regulation fails the stress test. *Proceedings of the National Academy of Sciences USA, 110*(37), 15139–15144.

Rolls, E. T. (2015). Limbic systems for emotion and for memory, but no single limbic system. *Cortex, 1*(62), 119–157.

Roozendaal, B., McEwen, B. S., & Chattarji, S. (2009). Stress, memory and the amygdala. *Nature Reviews Neuroscience, 10*(6), 423–433.

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology, 76*(5), 805–819.

Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty, 1*, 7–59.

Sandi, C., & Richter-Levin, G. (2009). From high anxiety trait to depression: A neurocognitive hypothesis. *Trends in Neuroscience, 32*(6), 312–320.

Scherer, K. R. (2000). Psychological models of emotion. In J. Borod (Ed.), *The neuropsychology of emotion* (pp. 137–162). Oxford, UK: Oxford University Press.

Scherer, K. R. (2005). What are emotions?: And how can they be measured? *Social Science Information, 44*(4), 695–729.

Schwabe, L., & Wolf, O. T. (2011). Stress-induced modulation of instrumental behavior: From goal-directed to habitual control of action. *Behavioral Brain Research, 219*(2), 321–328.

Schwarz, N., & Clore, G. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology, 45*(3), 513–523.

Sharp, C., Monterosso, J., & Montague, P. R. (2012). Neuroeconomics: A bridge for translational research. *Biological Psychiatry, 72*(2), 87–92.

Sinha, R. (2001). How does stress increase risk of drug abuse and relapse? *Psychopharmacology (Berl), 158*(4), 343–359.

Sokol-Hessner, P., Camerer, C. F., & Phelps, E. A. (2013). Emotion regulation reduces loss aversion and decreases amygdala responses to losses. *Social Cognitive and Affective Neuroscience, 8*(3), 341–350.

Sokol-Hessner, P., Hsu, M., Curley, N. G., Delgado, M. R., Camerer, C. F., & Phelps, E. A. (2009). Thinking like a trader selectively reduces individuals' loss aversion. *Proceedings of the National Academy of Sciences, 106*(13), 5035–5040.

Sokol-Hessner, P., Lackovic, S. F., Tobe, R. H., Camerer, C. F., Leventhal, B. L., & Phelps, E. A. (2015). Determinants of propranolol's selective effect on loss aversion. *Psychological Science, 26*, 1123–1130.

Starcke, K., & Brand, M. (2012). Decision making under stress: A selective review. *Neuroscience and Biobehavioral Reviews, 36*(4), 1228–1248.

Starcke, K., Polzer, C., Wolf, O. T., & Brand, M. (2011). Does stress alter everyday moral decision-making? *Psychoneuroendocrinology, 36*(2), 210–219.

Thaler, R. H. (1988). Anomalies: The ultimatum game. *Journal of Economic Perspectives, 2*(4), 195–206.

Tomb, I., Hauser, M., Deldin, P., & Caramazza, A. (2002). Do somatic markers mediate decisions on the gambling task? *Nature Neuroscience, 5*(11), 1103–1104.

Ulrich-Lai, Y. A., & Herman, J. P. (2009). Neural regulation of endocrine and autonomic responses to stress. *Nature Reviews Neuroscience, 10*(6), 397–409.

Ungless, M. A., Argilli, E., & Bonci, A. (2010). Effects of stress and aversion on dopamine neurons: Implications for addiction. *Neuroscience and Biobehavioral Reviews, 35*(2), 151–156.

van den Bos, R., Harteveld, M., & Stoop, H. (2009). Stress and decision-making in humans: Performance is related to cortisol reactivity, albeit differently in men and women. *Psychoneuroendocrinology, 34*(10), 1449–1458.

van't Wout, M., Chang, L. J., & Sanfey, A. G. (2010). The influence of emotion regulation on social interactive decision-making. *Emotion, 10*(6), 815–821.

van't Wout, M., Kahn, R., Sanfey, A. G., & Aleman, A. (2006). Affective state and decision-making in the ultimatum game. *Experimental Brain Research, 169*, 564–568.

von Helversen, B., & Rieskamp, J. (2013). Does the influence of stress on financial risk taking depend on the riskiness of the decision? In M. Knauff, M. Pauen, N. Sebanz, & I. Wachsmuth (Eds.), *Proceedings of the 35th Annual Conference of the Cognitive Science Society* (pp. 1546–1551). Berlin: Cognitive Science Society.

Winkielman, P., Berridge, K. C., & Wilbarger, J. L. (2005). Unconscious affective reactions to masked happy versus angry faces influence consumption behavior and judgments of value. *Personality and Social Psychology Bulletin, 31*(1), 121–135.

Xu, P., Gu, R., Broster, L. S., Wu, R., Van Dam, N. T., Jiang, Y., et al. (2013). Neural basis of emotional decision making in trait anxiety. *Journal of Neuroscience, 33*(47), 18641–13653.

Yehuda, R. (2001). Biology of posttraumatic stress disorder. *Journal of Clinical Psychiatry, 62*(Suppl. 17), 41–46.

Youssef, F. F., Dookeeram, K., Basdeo, V., Francis, E., Doman, M., Mamed, D., et al. (2012). Stress alters personal moral decision making. *Psychoneuroendocrinology, 37*(4), 491–498.

Zeelenberg, M., Nelissen, R. M. A., & Pieters, R. (2007). Emotion, motivation and decision making: A feeling is for doing approach. In H. Plessner, C. Betsch, & T. Betsch (Eds.), *Intuition in judgment and decision making* (pp. 173–189). Mahway, NJ: Erlbaum.

CHAPTER 6

Computational Models of Emotion as Psychological Tools

Stacy Marsella and Jonathan Gratch

A convergence of factors over the last 50 years has led to a growing cross-disciplinary collaboration that bridges computational technologies and research into human emotion processes. On the computational side, computer systems have become more powerful and the software that runs on them both easier to use and capable of addressing a far broader range of problems. Computers have also transformed our day-to-day life. They have moved from being behind-the-scenes calculators to become central to how people socially engage with the world. Though we are often not aware of it, we interact daily with artificially intelligent systems. The last 50 years has also seen a transformation in our understanding of human emotion. Research in psychology and the neural sciences has made significant advances in detailing the functional, often adaptive role of emotion in human cognitive processes, behavior, and social interaction.

These developments have had a number of interrelated consequences. As computer systems have become more powerful and easier to use, the sciences and social sciences have turned to computer simulations as a means to model, test, and explore theories, including theories about how emotions are elicited and their impact on behavior. Research in artificial intelligence (AI) has explored whether the functional role that emotions play in humans can suggest approaches to more capable, robust AI systems. As research has argued that emotion plays a key role in human social interaction and computer systems have become actors in our world, these systems have become more socially adept at interacting with people and their emotions. This has led to research on models that infer a human user's emotional state as well as on computational systems that model the causes and mimic the expression of human emotional states, in both cases as means to facilitate human–computer interaction. Broad discussions of these various ways psychological research and computational work on emotion can benefit each other have been presented elsewhere (Blascovich et al., 2002; Cohn, 2010; Marsella & Gratch, 2014; Reisenzein et al., 2013).

This chapter takes a more specific focus on the use of computational models as a methodological tool enabling emotion research in psychology. Even this restriction leaves a broad area of discussion. The scope of computational models can differ greatly, in large measure because emotion interacts with a wide range of human mental processes and behavior. A model may seek to broadly capture the causes and consequences of emotion or selectively focus on a specific aspect.

To begin our discussion, we provide a high-level view of the use of computational models as a tool in emotion research. We then explain their use by drawing on a few illustrative examples of computational models used to explore intrapersonal and interpersonal emotion processes.

Computational Models and Emotion Research

Models implemented and simulated on a computer have become increasingly important tools in the sciences and social sciences. These computational models are especially relevant to studying the dynamic behavior of complex systems that do not admit purely analytical answers to questions about the system's behavior. Instead, simulation serves to explore the behavior and generate predictions about the real-world system.

A key benefit of computational modeling and simulation arises from a lack of complete access to the phenomena being studied (Simon, 1969). This lack of access has several manifestations. There may be gaps in the theory. There may also be gaps in the knowledge underlying the theory, such as how other mental processes influence or are influenced by emotions. There may be difficulty in manipulating parameters, ablating functionality, or evaluating dynamics *in vivo*. From the perspective of social interaction in groups, it may not be easy to conduct controlled human subject experiments into emotional phenomena such as emotional contagion in crowds. This implies conversely that the validation of computational models against human data may in fact push experimental methodology (Marsella & Gratch, 2014).

The view that computational models are also useful for research in psychology specifically is, of course, not a new idea. It is central to the stance taken in cognitive science (Simon, 1969), a view common in much of the early work in AI (Newell, 1990), and even has its own moniker: computational psychology (Sun, 2008). Computational models provide a range of potential benefits to the study of human emotion, by impacting theory construction and evaluation during the model's formulation, implementation, simulation, and integration into larger systems.

Specifically, computational models provide additional perspicuity in theory formation and evaluation—in terms of the ability to create models and artifacts that provide a concrete basis for exploring the relationship between complex phenomena, including the dynamics of emotion processes, the role of other mental processes and emotions in social interaction.

The various roles for computational models in theory formulation and evaluation can impose very different constraints on how a model is constructed and evaluated. The benefits of models and their simulation, for theory formation and testing of course hinge on the nature of this coupling between theory and model.

The goal for the model may therefore not just be accurate prediction of human behavior. Rather, the model development may provide a framework to explore virtual *in vitro* experimentation with the constructs and processes hypothesized by a theory. In that case, the model may be designed to support the manipulation of those constructs, perhaps leading to simplifications that forgo, to a degree, quantitative or qualitative accuracy with human data, preferring instead to provide explanatory power.

In actual practice, computational models of emotional processes differ greatly in what phenomena they model, mirroring the fact that emotion influences a wide range of cognitive, somatic, behavioral, and social phenomena. The scope of models can thus differ greatly: Some models focus on the cognitive or environmental factors that cause emotion (Broekens, DeGroot, & Kosters, 2008); others address the consequences of emotion on other mental processes or behavior, such as coping strategies (Bosse, Pontier, & Treur, 2010); a few even attempt to capture circular causal interactions between emotional causes and consequence (Lewis, 2005; Marsella & Gratch, 2009), arguably their most important role. Models also differ in their representational choices (e.g., simple regression models to full-blown cognitive architectures), and the specificity of the phenomena they address—for example, focusing on specific causes or consequences of emotion, such as learned responses to threat (Li, Nair, & Quirk, 2009) or the impact of emotion on attention (Itti & Baldi, 2005). There are also distinctions between models in terms of the wide range of computational and formal mechanisms used to form a model, including neural networks (Sander, Grandjean, & Scherer, 2005), symbolic systems (Gratch & Marsella, 2004), and logical formalisms (Lorini & Castelfranchi, 2007).

In the next section, we delve more deeply into these issues concerning how computational models are integrated into emotion research.

Integrating Computational Models into Emotion Research

The paths depicted in Figure 6.1 illustrate our view on the various ways theoretical, empirical, and computational activities interact to inform psychological research on emotion. Traditional

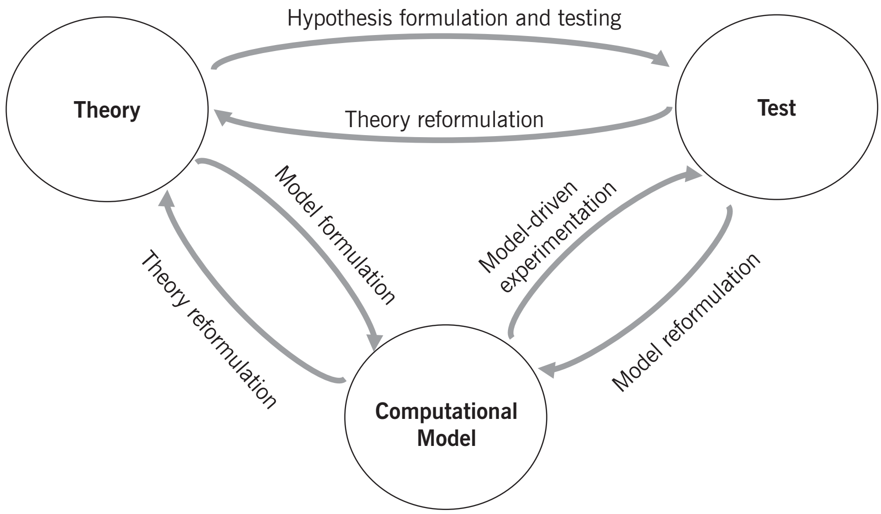


FIGURE 6.1. Points of interaction among theoretical, computational, and empirical activities surrounding the advancement of emotion research.

psychological research (i.e., research that does not involve computational modeling) is reflected in the loop at the top of this diagram. For example, classical theoretical research enters this cycle from the left: a theory is formed and hypotheses are derived and tested, confirming the theory or forcing its reformulation. Exploratory research enters this cycle from the right: data are collected and mined; a theory is formed, and then subsequently tested.

Computational models expand the range of scientific methods. The large cyclical loop in the diagram, spanning *Theory*, *Computational Model*, and *Test*, represents what we have called model-driven experimentation (Marsella & Gratch, 2014): theory is used to help formulate computational artifacts, such as a computer model of the theory or new computational approaches to creating stimuli. Constructs in the theory are essentially reified in the model. The resulting technological artifact in turn leads to empirical testing whereby those constructs are experimentally manipulated, exploiting the technology to go beyond standard human subject studies. The empirical testing can include simulation of a computational model to generate predictions as well as potentially additional human subject testing to validate those predictions. The empirical testing may also incorporate computationally generated stimuli or confederate simulacra in human subject studies. The results of this empirical testing in turn lead to results and data that can be used to reformulate the model or theory.

The lower left and lower right small loops in Figure 6.1 highlight specific ways that research integrates and exploits computational methods. In the discussion that follows, we endeavor to detail the nature of the links in these loops.

Model Formulation and Theory Reformulation

The lower left loop in Figure 6.1 between *Theory* and *Computational Model* depicts that the process of formulating a model is informed by theory (the link from *Theory* to *Computational Model*) but also can lead to reformulation or support of the theory (the link from *Computational Model* to *Theory*). We discuss these links in turn.

Consider first the link from *Theory* to *Computational Model*. Emotion theory commonly informs the development of computational models and technologies by defining the constructs that form the basis of the model, including what comprises an emotional state such as anger, as well as the antecedents and consequents of that emotion. Those constructs will in turn be manipulated as part of the empirical testing of the model. Such a close connection between theory and model fundamentally impacts the formulation of the model.

For example, theories differ considerably as to which constructs are treated as intrinsic to an emotion (such as cognitions, somatic processes, behavioral tendencies, and responses), the relationships between these constructs (such as whether cognitions precede or follow somatic processes), and representational distinctions (such as whether anger is a perceiver-dependent category or natural kind; Barrett, 2006, 2012).

Such theoretical differences impact the computational mechanisms that are used to formulate a model. The constructs of the theory must be mapped to the model's computational representations and algorithms in the model. Since theories of emotion have fundamental differences with respect to the constructs they propose, a range of computational mechanisms have been used for models of emotion processes.

For example, appraisal theories (Scherer, Schorr, & Johnstone, 2001) typically argue that emotion arises from an assessment of the person–environment relation from a subjective perspective, specifically persons' beliefs about how their concerns or goals are impacted by the environment. This view fits quite well with the belief–desire–intention (BDI) model of agency, a model common to AI research that argues an agent forms intentions to act based on its beliefs and desires (Bratman, 1987). As a consequence of this fit, the BDI model approaches can readily model appraisal theory (Steunebrink, Dastani, & Meyer, 2007). Constructs in the theory map readily to the computational formalisms. Not surprisingly, appraisal theories have provided the basis for numerous computational models of emotion (see Marsella, Gratch, & Petta, 2010, for a review), not only for their prominence in the psychological literature, but because of their close fit to representational concepts in BDI models of agency, leading to an ease with which appraisal can be incorporated into existing AI systems and cognitive architectures that employ the BDI model approaches.

On the other hand, other theories of emotion emphasize the role of specific neural regions in emotional process, informed by data that reveal the functional role of neural regions and the structure of their connectivity (Yechiam, Busemeyer, Stout, & Bechara, 2005). To realize a computational model, these constructs must be mapped to a computational model's computational mechanisms that model these regions. The researcher may also seek to impose a constraint that the resulting model's mechanisms be implementable in the neural wetware it purports to model (Armony, Servan-Schreiber, Cohen, & LeDoux, 1995). As a consequence, neural network-based computational mechanisms are often employed in these models.

The constructs that a theory posits, and relationships between such constructs, can also impact the ease with which the theory can be computationally modeled. For example, appraisal theories have led to numerous computational models of emotion not only because of their close fit to representational concepts in BDI models of agency (mentioned earlier) but also because some appraisal theories (sometimes referred to as causal, as opposed to constitutive appraisal theories; see Gross & Barrett, 2011; Clore & Ortony, 2013) either support, or can be interpreted as supporting, an essentialist, reductionist perspective to modeling emotion processes. Such an interpretation allows for a computational modularity that treats individual appraisals variables (e.g., desirability, expectedness, control) as independent computations that can be modeled in isolation. In contrast to this modularity, a psychological constructionist view of emotion rejects such an essentialist, natural kind view (Barrett & Russell, 2015). From a constructionist perspective, instances of emotion labeled as anger arise from multiple cognitive, physiological, and situational factors. Further, they may not share the same eliciting mental processes and those mental processes are not unique to emotion elicitations. The explicit modularity that facilitates straightforward breakdown into distinct computational processes is explicitly rejected by the theory, requiring instead approaches to the problem that take into account the complex interplay among these multiple influences. These distinctions between theories of course say little by themselves about the validity of the theories or the models formed from them. Rather, they speak to the nature of the phenomena posited by the theory, the level at which the theory tries to capture regularities in the phenomena, and therefore the potential challenges in formulating a model.

During formulation of a computational model, constructs in the theory (i.e., the structures and processes proposed by the theory) are formally represented and implemented on a computer. This formulation process by itself can lead to reformulations or extensions to the theory.

This reformulation occurs, in part, because the process of realizing a model as working software exposes implicit assumptions, weaknesses, or gaps in the theory. For example, appraisal theories of emotion often argue that a key variable in appraisal is the causal attribution of blame (e.g., Lazarus, 1991). But the process by which a person makes such an attribution, and the related required resources and capacities to perform this assessment, are typically not carefully laid out. And yet this attribution process may in itself be quite involved (e.g., Shaver, 1985; Weiner, 1995). Addressing such a gap would extend the scope of the theory, making the model formulation process an integral part of theory construction (e.g., see Mao & Gratch, 2005, for one example). A computational model that delves into the calculation of blameworthiness, as well as the processes that derive other appraisal variables, essentially extends the theory by filling in the gaps. As these processes are specified, synergies may also be revealed between how the individual appraisals are calculated, even to the extent of reformulation of the dimensions or variables.

Further, formulating a theory as computational processes, such as the derivation of appraisal variables, forces the question of how the derivation processes work, the time course of those processes, and the temporal relation between them. What operates in parallel, what operates in sequence, and what are the dependencies between the various subprocesses in the overall model? Answering these questions in a computational model often highlights issues that are not apparent at the level of the theory and even if they are, may end up being answered differently.

Thus, one of the key benefits of computational modeling is that it forces a mind-set of thinking in terms of the description of processes, and especially distinguishing process descriptions from the description of the output of the process. Of course, psychological theories need to describe or predict the output of a process, but that description is distinct from the process that generates it. As Simon (1969) poignantly argued in his example of the ant's circuitous navigation in sand, the complexity of the path may be due to the ant's reactions to the local topology as opposed to the complexity of the processes driving the behavior (p. 53). A theory of the ant's behavior needs to incorporate how the environment induces the complex behavior but should not seek to explain the complex behavior independent of the environment that evokes it. See a further discussion of this point in the section "Impact of Model Formulation on Theory Reformulation."

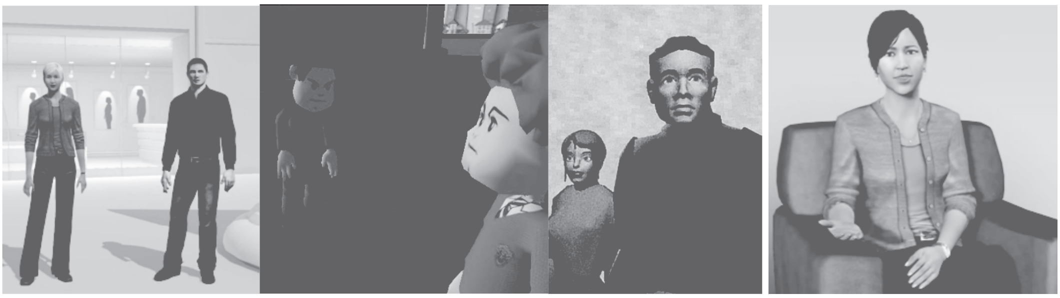
This in turn highlights that we can view computational modeling as also extending the language of emotion theorizing by incorporating concepts, processes, and metaphors drawn from computation, much as concepts such as *information processing* and *symbol systems* impacted cognitive psychology in general. For example, several computational models have recast the appraisal theory in terms of concepts drawn from AI and computer science generally, including knowledge representation (e.g., Gratch & Marsella, 2004), planning (e.g., Dias & Paiva, 2005; Gratch, 2000), neural networks (Sander et al., 2005), and decision making (Lisetti & Gmytrasiewicz, 2002; Ito, Pynadath, & Marsella, 2010; Si, Marsella, & Pynadath, 2010).

Models of emotion processes can also be integrated into larger systems. This can also expose hidden questions behind traditional conceptualizations and extend the scope of theorizing. For example, several computational models of emotion have been incorporated into larger systems that seek to model emotion's relation to other mental processes and behavior (Marsella & Gratch, 2001; Dias & Paiva, 2005; Becker-Asano, 2008; Rank, 2009).

In particular, models of emotion and affective expression have been incorporated into virtual humans—software artifacts that look and act like humans—capable of perception, dialogue, and action in a virtual world that they can cohabit with people and interact with using the same verbal and nonverbal behavior people use in face-to-face interaction. These systems essentially allow for the study of emotion in a virtual ecology, a form of synthetic *in vivo* experimentation (see Figure 6.2).

Integration into larger virtual human systems forces the researcher to explore the relationships between processes in ways that move across traditional academic boundaries in psychology. In the process, the underlying psychological theories that initially drove the design of the model can be transformed as researchers are required to address fundamental architectural questions about the relation of emotion processes to other cognitive processes, perception, behavior, and social interaction (Rickel et al., 2002; Becker-Asano, 2008).

The modeling of emotion and emotional expression in virtual humans has also led to new ways to create stimuli for human subject experimentation. Virtual humans are highly compliant and controllable confederates for experiments. A virtual human can be manipulated systematically to elicit behavior from human subjects. For example, virtual humans have been used to show that subtle changes in physical appearance or behavior can profoundly impact social interaction, including changes to people's willingness to cooperate



Hartholt, Traum, Marsella, Shapiro, Stratou, et al. (2013) | Zoll, Enz, Schaub, Aylett, and Paiva (2006) | Hoyt, Blascovich, and Swinth (2003) | DeVault et al. (2014)

FIGURE 6.2. Examples of virtual humans.

(Krumhuber et al., 2007), the fluidity of their conversation (Gratch, Wang, Gerten, & Fast, 2007), learning outcomes (Baylor & Kim, 2008), and even their level of social aggression (McCall, Blascovich, Young, & Persky, 2009).

Yet another form of integration is to place emotion models in multiagent-based social simulations where multiple autonomous software agents are interacting with one another. In particular, such simulations have been used to study emotional contagion processes (Tsai, Bowring, Marsella, & Tambe, 2013).

The key point here is that the formulation into a computational model can lead to reassessment and reinterpretation of the theory using the computational tools of representation, function, and process. In fact, overly faithfully "reimplementing" a psychological theory may do a disservice both to computational science and the original theory.

Decoupled Theory and Model

In our discussion so far, we assumed a close coupling of theory and model, where the theory provides the constructs that become the starting basis for the model. In practice, there are several ways this coupling can be loosened and even eliminated.

There may not be a theory as the genesis for the model. Rather, the model itself is treated as the theory, forgoing preexisting theory as a central basis for the modeling. For example, the Bayesian model of surprise proposed by Itti (Itti & Baldi, 2005) and the complexity (Kolmogorov) model of surprise proposed by Dessalles (2011) largely start from a computational perspective.

Computational work may also draw on constructs from differing theories. For example, the neural network model of personality by Read et al. (2010) is influenced by several different theories of personality and temperament including approach–avoidance motivational systems, goal-based models of traits, and affective neuroscience work on motivational systems. Some work draws together even competing theories of emotion—for example, Becker-Asano (2008) combines appraisal theories of emotion with pleasure–arousal–dominance dimensional theories (Russell, 1980, 2003).

For these amalgam models (models with multiple theoretic influences), one issue is that coherence across the theories for the model may combine theories that have seemingly inconsistent constructs—for example, the originating theories may have fundamental disagreements about what constitutes an emotion. Somewhat less obvious, however, is that they break or at least complicate the link back from empirical results of the model to the originating theories because the result from any manipulation of the model in a simulation may not be readily attributed to any specific theory used in forming the model. For these reasons, the model de facto becomes the theory.

Empirical Simulation and Validation

The computational realization of a theory can also increase the capacity to generate data and draw predictions from theory by extending empirical methods beyond human subject testing by inclusion of the simulation of the model. Computational models thereby provide an empirical framework for studying emotion processes that goes beyond what is feasible in more traditional laboratory settings. In particular, computational models are commonly process models. Computer simulations of the model *behave*: they provide a means to explore systematically the temporal dynamics of emotion processes and form predictions about the time course of those processes.

Manipulations of experimental conditions may be explored more extensively with a computational model, such as by ablating certain functionalities or testing responses under adverse conditions that may be costly, risky, or raise ethical concerns *in vivo* (e.g., Armony, Servan-Schreiber, Cohen, & LeDoux, 1997). Simulations can reveal unexpected model properties that suggest further exploration.

However, validating these simulated results against human behavior raises interesting, difficult challenges for traditional laboratory studies. A computational model that posits dynamics, for example, may push traditional experimental methodology to derive similar temporal dynamics in human subject studies in order to compare those results against the model's results. Further ablation studies done with the model may simply be impossible to do *in vivo*.

Traditional methods and measurement techniques for the study of human emotion may not in fact be well suited for the validation of computational models. Because computational models are often process models, they can make explicit predictions about the features of situations in which emotions arise and the dynamic interplay of emotion with other mental processes over time as situations evolve. However, existing empirical work on emotion has often shied away from directly exploring or manipulating such features and dynamics. For example, mood-induction studies may shape a participant's mood independently from the situation (such as by listening to happy or sad music; Schwarz & Clore, 1983) or by creating "one-shot" situations (such as watching reactions to the spinning of a roulette wheel; Reisenzein, 2000), as they provide experimental control. To explore a model's prediction about how emotions arise in an evolving situation, and to explore the interplay between emotion and other mental processes, pushes the experimental methodology and measurement techniques beyond such approaches (Butler, 2011).

Further, the construction and simulation of the model may not solely have a goal of accurate prediction but rather be part of a larger theory formation process where the model serves as a platform that can be experimentally manipulated to generate predictions for subsequent study. For example, as we discuss below, Armony et al. (1997) ablated parts of a neural net model of conditioned threat response in rats in order to make predictions about the role those parts play, which were later borne out in studies with real-world rats. As a consequence, it is not simply the predictions of the model that mattered under normal conditions. Rather, for such ablations to be meaningful and useful, there must be a mapping at an internal functional and structural level between the model and the real-world mental processes it is designed to model so that the ablation can be related to the real-world phenomena and ideally have predictive value in studying it.

Models in Actual Practice

A broad range of computational work has leveraged theories of emotion. Here we focus more selectively on work that illustrates a tight coupling of emotion research and computational approaches that was discussed earlier. In illustrating these examples it is useful to distinguish work on intrapersonal emotion from work on interpersonal emotion, not only because they explore phenomena from a system as opposed to individual perspective but because the interpersonal perspective employs different computational approaches. For example, a theory or model of social interaction can be specified at the individual level or the systems level.

Intrapersonal Emotion Modeling

Emotion modeling on intrapersonal phenomena seek to explore emotion from the perspective of the processes operating in the individual as that individual interacts in the physical or social environment. As we noted earlier, computational modeling of these internal processes can benefit emotion research in a variety of ways, including exposing gaps in theories and generating predictions through simulation. Additionally, models provide a framework in which processes can be described, employing a range of computational and mathematical frameworks often in part because theories differ in terms of the conceptual levels used to describe them.

To illustrate the various ways computational models can benefit intrapersonal emotion research as well as the computational frameworks employed, we consider two illustrative examples.

Model-Driven Experimentation and Fear Conditioning

The Armony et al. (1995) work on auditory fear conditioning (or threat response) provides a powerful example of the use of a computational model in which simulation studies with the model suggest new *in vivo* studies and subsequent reformulation of the theory that informed model formulation. The Armony work is a connectionist model of LeDoux's (2012) dual-route, cortical, and subcortical theory of "fear conditioning"[1] in rats. LeDoux's theory, based on animal studies, argues that the amygdala receives input from the thalamus and the cortex, with the thalamus providing fast but less selective discrimination of audio frequencies, while the cortical response is slower but more selective.

The formulation of Armony et al.'s (1995) connectionist model captures the essence of the theory and associated empirical findings but at a more abstract level. The formulation into a computational model by itself had no ramifications for the original theory. The simulation studies with the model, however, revealed interesting phenomena that did have impact on subsequent animal studies and the theory.

The model was first trained to recognize a range of audio frequencies. When the model was then trained under conditions where fear stimuli was associated with frequencies, the model readjusted its recognition to those frequencies. This result from the model simulation studies was subsequently verified in animal studies. Additionally, an ablation study that removed the cortical pathway in the connectionist model revealed that the cortical pathway was not as critical to the model selective response to stimulus frequencies as one would have expected from the theory. This computational prediction was then validated in animal lesion studies, thus suggesting modification of the original theory's assumptions about the discriminatory capabilities of the subcortical processing.

Impact of Model Formulation on Theory Reformulation: Appraisal Theory and Coping

As we noted earlier, often the formulation of a model can expose important gaps and limitations in a theory, suggesting reformulations of the theory prior to any simulation or empirical testing of the model. Work on the emotion and adaptation (EMA) model of appraisal (Gratch & Marsella, 2004) provides an interesting example of this reformulation process.

At inception, the EMA model was based on Lazarus's (1991) theory of appraisal and coping. It is a symbolic model, cast at a high level in terms of an agent's beliefs, desire, and intentions as opposed to lower-level connectionist pathways seen in the Armony et al. (1995) work. Of course these distinctions are in line with differences in the theories that motivated the two models.

The EMA model is also integrated into the cognitive processes of a virtual human capable of interaction in real time both with physical events as well as high-level social interaction. This integration raised explicit questions about how emotion processes must respond to a wide range of stimuli, and must often do this on widely different time scales, as well as interact with an agent's perception, cognition, language, and behavior in order to achieve this flexibility in response. The integration also provided a computational framework to explore those issues that is unavailable to more traditional theoretical work on appraisal that typically is posited at a more abstract and comparatively less specified level. Addressing those questions led to a formulation of the EMA model that in turn suggested reformulations of theory.

In contrast to the Armony et al. (1995) model, the EMA model attempts to provide a comprehensive model of the causes and consequences of human emotion. Specifically, the EMA model is designed to respond to the wide range of eliciting conditions that give rise to different emotions in people, whether it is a nearby loud explosion that elicits fear, or responsibility for a blameworthy event eliciting guilt. The processes underlying these emotions may be on different time scales and have different causal elements. The explosion reaction is likely to be fast but emotions may have a much slower response, driven by burgeoning beliefs about the consequences of events. The EMA model is also sought to model the myriad consequences of emotion on human cognitive processes and behavior, as befitted the different eliciting conditions.

Like the explosion and guilt examples, the EMA model's emotions needed to be driven by a wide range of eliciting conditions and lead to a variety of coping responses in line with those conditions, spanning physical actions and more cognitive response such as informing belief revision and language response. It is such issues that led to an approach in the model that reformulated constructs in Lazarus's (1991) theory, arguing that appraisal was a very lightweight, reactive feature-detection process that leveraged representations maintained by other mental processes that are not unique to appraisal and emotion elicitation.

Because the EMA model's appraisal leverages other internal and external processes, it argues that the temporal course of the appraisal process is an unfolding interaction between an entity and its environment over time (see Marsella & Gratch, 2009). Rather than reflecting fixed constraints that require explicit reification in the model, the temporal sequencing of appraisals has more to do with the structure of the environment (e.g., Are appraisals self-evident or do they require inference?) and recent experience (e.g., Are appraisals already active in working memory?).

In contrast, consider the multilevel sequential checking theory of Klaus R. Scherer (Scherer, 2001), one of the more recent and sophisticated appraisal theories. This theory of appraisal posits three levels of appraisal processing: innate (sensory–motor), learned (schema based), and deliberative (conceptual), and posits a fixed sequential ordering of appraisals, based on physiological and functional considerations. Specifically, the theory asserts that appraisals unfold in a sequential order beginning with relevance, then goal implications, coping potential, and, finally, normative significance. The relevance check includes assessment of novelty as well as relevance to one's goals. The implication check includes assessments of cause, goal conduciveness, and urgency. Coping potential includes assessments of control (whether the situation is controllable) and power (whether the individual has the power to control it). Finally, normative significance includes assessments of compatibility with internal and external standards.

Arguments can be made for either view proposed by these two approaches. The sequence of appraisals might unfold in the order Scherer (2001) suggests—when confronted with an unexpected threat, it is rational to assess the implications to oneself before considering other social actors—but if social concerns are already salient in the environment, the reverse pattern seems likely (e.g., if we already suspect someone has violated a social norm, if they admit to the crime, it makes sense to jump straight to blame and anger).

The point relevant to the current discussion is that the formulation of the computational model forces one to address questions about how appraisal processes are realized and their time course. In addressing this question by constructing a model, one comes face to face with questions about how the time course of the output of some process arises. Is it explicitly stipulated as is suggested by sequential checking, or is it, like Simon's (1969) ant, an emergent property of a computation in some larger context that spans other mental and environmental factors?

Interpersonal Emotion Modeling

Emotions shape social behavior (Keltner & Haidt, 1999) and computational methods are playing an ever increasing role in informing theories on how emotions and emotional signaling shape social interactions. Most readers will be familiar with the growing use of computational techniques to instrument social interactions—for example, automatic techniques for recognizing facial expressions (Zeng, Pantic, Roisman, & Huang, 2009), speech (Schuller, Rigoll, & Lang, 2003), or paralanguage (Lee & Narayanan, 2005). Social interactions increasingly occur through technology, such as Twitter, Facebook, or Skype, and these create novel opportunities to measure, or even manipulate, emotional signaling (Kramer, Guillory, & Hancock, 2014). There is even growing acceptance that computers and robots serve as social partners and many of the social phenomena that occur between people, to some extent, are manifest in interactions with technology (Reeves & Nass, 1996; von der Pütten, Krämer, Gratch, & Kang, 2010), thereby expanding the scope and impact of social psychological findings. Indeed, researchers in the engineering sciences increasingly draw on psychological theories and imbue their systems with something akin to emotion (Gratch & Marsella, 2013; Lee & See, 2004; Sloman & Croucher, 1981).

These innovations, while important, are complementary but distinct from the notion of computational models outlined above. Techniques like computer sensing can be seen as incremental extensions of the traditional loop of hypothesis generation and testing, albeit with much more sophisticated ways of measuring and manipulating theoretically posited factors. Automatic facial-action annotation can radically transform the efficiency of experimentation over highly trained human coders, but it does not change the nature of the experimental process. In contrast, computational modeling opens up new pathways to theory development through the processes of model formulation and model-driven experimentation. Here we illustrate exemplars of model-driven research in the social domain.

In the *intrapersonal context*, a computational model captures theoretically posited processes operating within the individual. In contrast, in the *interpersonal context*, a computational model must simulate processes acting both within and between individuals, as well as the communication pathways between individuals. Thus, one straightforward way to model social emotional processes would be to take several individual computational models of emotion, allow them to interact through some simulated communication, and see if the unfolding social process conforms to theoretical predictions. This entails a great many complexities so, in practice, a variety of hybrid approaches are considered where only some of these processes are explicitly modeled in automation, where others are "driven" by human participants.

Figure 6.3 distinguishes the traditional approach to study social emotions (Figure 6.3a) from approaches that use computational models. The most ambitious approach, where all aspects are computationally modeled, we refer to as multiagent simulation (Figure 6.3d). However, two other hybrid cases are worth distinguishing. First (Figure 6.3b), Bailenson and colleagues introduced the term "transformed social interaction" to refer to social situations where the communicative processes between individuals was computational modeled and subject to experimental manipulation (Bailenson, Beall, Loomis, Blascovich, & Turk, 2004). Second (Figure 6.3c), building on the idea of human confederates in social science research, researchers are increasingly exploring social interactions where one of the parties is a computer model, with either a digital or robotic manifestation. We give examples of the use of computational models for each of these variations and illustrate how they exercise some of the paths outlined in Figure 6.1.

Transformed Social Interaction

Transformed social interaction is a technique that uses models to illuminate social theories, a class of modeling methods that can illuminate social theories, especially theoretical mechanisms associated with the form and frequency of interpersonal signals. This line of modeling approaches takes advantage of the fact that social interactions increasingly occur through technology, such as video teleconferencing or virtual worlds like Second Life. This creates opportunities to "hijack" these communication channels to shape and alter the way in which information is exchanged. Of course this is not an entirely new idea. For example, Murray and Trevarthen (1985) manipulated videoteleconference delays to examine the importance of contingency in social interactions between parents and infants. What has changed is the level of sophistication by which communicative signals are modeled and manipulated, including subtle dynamic and interactional features. Rather than

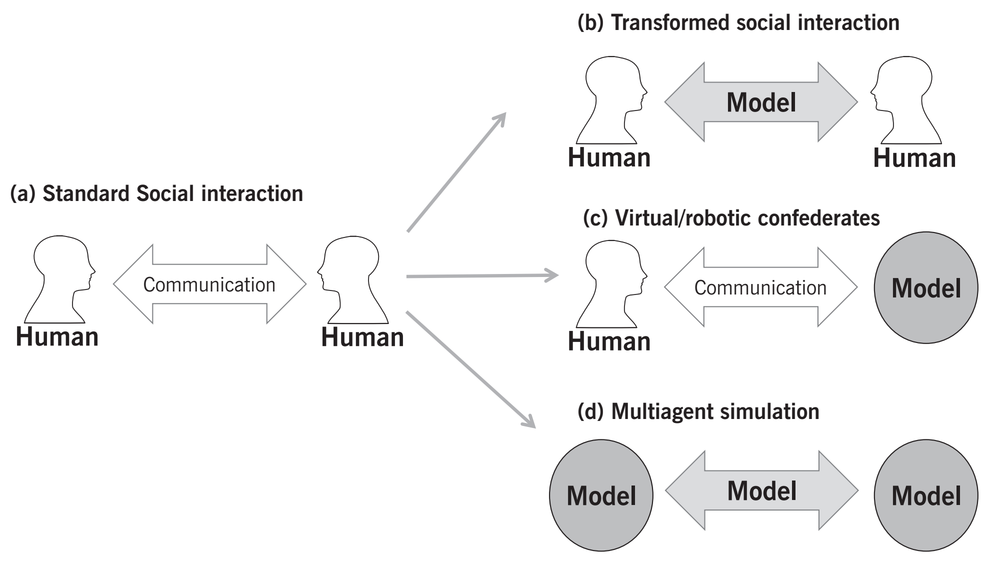


FIGURE 6.3. An illustration of the different approaches to computationally modeling interpersonal emotional processes.

blunt manipulations, like adding a communication delay, researchers are increasingly creating detailed computational models of the communication process and ablating this model to assess the impact of specific theoretical mechanisms.

Facial expressions are prominent in many theories of social emotions, so it is not surprising that the face is a central focus of modeling efforts. Many tools now exist to create life-like digital faces, and these are increasingly used in psychological research (Mumenthaler & Sander, 2012; Todorov, 2008). The developers of these tools often adopt theoretical principles in formulating these models (though this is not always done in an explicit way and rarely in collaboration with psychologists). For example, to animate a face, one has to define a set of parameters and these parameters could be informed by theories that suggest discrete emotions, by dimensional approaches, or as a set of facial action units. In that faces move, modelers must formulate models of motion dynamics, and here emotion theory offers far less guidance (cf. Krumhuber, Cosker, Manstead, Marshall, & Rosin, 2005).

Given a computational model of the face, one can transform this model in actual social interactions to test theoretical assumptions. For example, several lines of research suggest that the level of emotional expressivity can shape the nature of social interactions, for instance, by altering perceptions of trustworthiness (e.g., Boone & Buck, 2003; Parkinson, Fischer, & Manstead, 2005; Schug, Matsumoto, Horitaa, Yamagishi, & Bonnet, 2010). Such studies are correlational in nature, or involve manipulations, such as telling participants to be more or less expressive (Parkinson, Phiri, & Simons, 2012), that have obvious confounds. An alternative is to use social interaction where participants are blind to the fact that their facial expressions are being altered. Boker and colleagues demonstrate one approach along these lines. They use automatic facial recognition techniques to "puppet" a digital model of the face. Participant facial expressions are used to drive the motion parameters of this digital model, however, they then process this signal, experimentally suppressing or amplifying the emotional expressivity to investigate the impact of this factor on social interactions (Boker et al., 2009).

As social interactions move more into the digital world, such transformations are increasingly possible. One recent and controversial example involved the use of computer technology to examine the possibility of emotional contagion in online social networks. Researchers at Facebook altered the way emotional information is communicated among their users. Using Pennebaker's linguistic inquiry and word count tool (Pennebaker, Francis, & Booth, 2001), they automatically detected emotionally positive and negative postings, systematically altered the percentage of positive or negative posts that users saw, and measured their social responses.

Confederate Models

Manipulating interparty communication is but one way to simulate and manipulate social systems. A second approach is to replace one of the parties in a social interaction with a computational model. As in transformed social interaction, elements of this approach have a long tradition in psychology. For example, studies of emotional mirroring might employ a human confederate that, in a sense, acts as an automaton—for example, by being "programmed" to "model" certain theoretical processes (e.g., mimic the facial expressions of participants). Confederates allow a measure of experimental control but come with their own host of methodological concerns (Rosenthal, 1966). Replacing human confederates with a computational model can address some of these concerns (e.g., see de Melo, Carnevale, & Gratch, 2014, for a more complete discussion of these tradeoffs).

Social interactions involve a number of processes—social perceptions, social cognitions, and social behavior—and models could be used to automate all of these factors, or perhaps only a subset, leaving other processes unmodeled. Here we illustrate this distinction by considering two different ways to use computation models to attack the same problem. DeSteno et al. (DeSteno, Petty, Wegener, & Rucker, 2000) and de Melo et al. (de Melo, Carnevale, Read, & Gratch, 2014) consider the question of how nonverbal communication impacts cooperation in economic exchanges. The former uses computer models that capture the low-level physical aspects of nonverbal behavior (this is similar to research on transformed social interaction, but here they use automation, rather than another participant, to drive the interaction). The latter attempts to model the cognitive processes that precede communicative acts.

In the first approach, DeSteno and colleagues (2012) use a robot confederate to unpack how the surface realization of communication gestures impact trust decisions. A rich tradition of research has shown that people can infer, with some accuracy, a person's trustworthiness from "thin slices" of behavior. For example, people can distinguish those who will cooperate from those who will defect in Prisoner's Dilemma through a short off-task interaction before the game (Brosig, 2002; Frank, Gilovich, & Regan, 1993). However, finding the "golden cue" that predicts trustworthiness has been elusive (e.g., Todorov, 2008). DeSteno et al. proposed the innovative use of a robot to validate a model of nonverbal trust signaling.

To address the problem of finding cues of trustworthiness, DeSteno and colleagues (2012) use a two-stage approach: first, they formulate a statistical model of nonverbal cues; second, they engage in model-driven experimentation—they insert this model into an anthropomorphic robot and show that the behaviors, indeed, evoke trust in human interaction partners. For the first portion, they collected a large corpus of nonverbal behaviors that preceded a variation of a trust game. Using stepwise regression, they constructed a model of behaviors that predicted trust (including head motions, gestures, and postures). Next, they programmed a robot to exhibit these behaviors in a pregame "ice-breaking" interaction. These robot behaviors reliably influenced trust impressions and trusting behavior when people subsequently played a trust game with the robot, lending support for their communicative model.

The work of de Melo, Carnevale, Read, and Gratch (2014) illustrates a different approach to using models to explore social interactions. Whereas DeSteno et al. (2012) model the communication signal, de Melo, Carnevale, Read, and Gratch (2014) model the cognitive processes that underlie nonverbal signals. Their research uses virtual confederates to replicate and extend theories of *social appraisal* (Hareli & Hess, 2010; Manstead & Fischer, 2001). Social appraisal theory builds on appraisal theories of emotion (Scherer et al., 2001) and extends them to social domains. Whereas appraisal theory claims that emotions arise from comparison of world events with an individual's goals (e.g., a score by my favorite sporting team would evoke joy), social appraisal theory essentially turns this process on its head, arguing that people reconstruct how an individual is appraising a situation (and thereby derive his or her goals) by observing his or her emotional reactions to events (e.g., a frown by my neighbor in the sporting arena tells me he or she is rooting for the opposing team).

De Melo et al. (2014) evaluate social appraisal theory using model-driven virtual confederates. Taking inspiration from the EMA computational model of emotion (Gratch & Marsella, 2004; Marsella & Gratch, 2009), he created a digital human face who's expressions could be driven by the emotion model. Participants then played iterated Prisoner's Dilemma games with digital opponents. These opponents either appraised game events as if they had a goal of cooperation or, alternatively, of competition. For example, a competitive character might show joy after successfully exploiting its opponent. People reliably recovered this goal (and acted upon it by either collaborating or competing), as predicted by social appraisal theory. De Melo et al. (2014) were also able to show this was statistically mediated by attributions of appraisals to the virtual agent, again supporting the theory.

Collectively, these two approaches illustrate the variety of ways that models can drive the behavior of simulated social partners. DeSteno et al. (2012) modeled the communicative signal. De Melo et al. (2014) modeled the cognitions that precede these signals. These approaches also illustrate the variety of ways that computers can help realize such experiments. DeSteno et al. (2012) had people interact with a physical robot, whereas de Melo et al. (2014) used a "virtual" robot. In either case, they illustrate how model-driven experimentation allows systematic manipulation of key theoretical principles.

Multiagent Simulations

So far we have considered models where some aspect of social interaction is computationally modeled (e.g., the communication channel or one of the participants) with other aspects of the social situation left in the control of human participants. Multiagent simulations take this to its logical conclusion by modeling all aspects of a social interaction. This approach is most common in sociology, where agents tend to be very simple (e.g., finite-state automata) but incorporate large numbers of agents (Macy & Willer, 2002). Such models can be used to explore macro-sociological theories, for example, by experimentally manipulating structural factors within a simulated society, such as social mobility, and observing how patterns of behavior evolve over time (e.g., Roos, Gelfand, Nau, & Carr, 2014). However, such models can be applied to smaller social units such as crowds (Tsai et al., 2013), small groups (Li, Chang, & Maheswaran, 2013), or even dyadic interactions (Traum, Rickel, Gratch, & Marsella, 2003), and here we illustrate this through an agent-based model of emotional contagion in crowds.

Several empirical studies suggest that people "catch" the emotions around them (Hatfield, Cacioppo, & Rapson, 1994), though the specific mechanism by which this occurs remains controversial. Bosse and colleagues (2010) sidestep the question of cognitive mechanisms but attempted to model the temporal dynamics of contagion in crowds. Specifically, they were interested in predicting how panic spreads through a crowd and shapes their movement in disaster situations. Such a model could be important for engineering purposes (e.g., informing the placement of exits in a building to facilitate safe egress).

Bosse et al.'s (2010) modeling efforts were informed by Barsade's (2002) theory of contagion in groups. Barsade adopts a dimensional approach to emotional signaling, characterizing emotion in terms of valence and arousal, and also posits the mediating role of attention. Specifically, people will tend to adopt an emotional state with the same valence as their neighbors, and this is moderated by the intensity of the neighbors' responses and the level of attention given to the neighbors. In formulating a model based on this theory, Bosse and colleagues mapped these principles into computational models of particle systems. The resulting model essentially reformulates Barsade's theory into a model of heat dissipation in physical materials: in thermodynamics, heat dissipates to a state of maximum entropy and the speed of this dissipation is dictated by the material's specific heat capacity; by analogy, emotion dissipates through a crowd and people have different susceptibility to catching emotion.

After developing this model, Bosse et al. (2010) evaluated it through model-driven experimentation. They examined if a simulation of the model produces temporal dynamics similar to a real-world event. For this, they compared their model with a real-world panic that happened on Dam Square in Amsterdam in 2010 under full view of several cameras. The panic resulted from a man screaming (apparently due to mental illness) and produced a stampede that resulted in several injuries. The videos were hand analyzed, tracing the movement of 35 individuals throughout the panic. These trajectories were then compared with the simulation results and showed good correspondence.

Trends and Directions

As we have seen, the work on computational models of emotion phenomena span a considerable range and differ along several dimensions. Fundamentally, they differ in the empirical phenomena and theories they seek to model and explore, not surprisingly, given the range of theories and empirical work that addresses the causes and consequences of emotion. A range of computational representations and processes have been employed, again, often in keeping with the constructs that the underlying theory or empirical work posits, from cognitive constructs like beliefs and desires to specific neural pathways.

The differing computational mechanisms and the range of phenomena explored is indicative of a vibrant research community. On the other hand, there is a cautionary tale here as well. Often, computational models are developed in isolation, with little comparison between alternative models—computational models are often crafted from whole cloth, with comparatively little effort to compare to, or build on, prior work. There are, for example, numerous models of appraisal theories but concrete comparisons between them have been quite rare. The existence of alternative models that have not been compared in turn limits their impact on psychological theories.

And yet, a key benefit of computational models is that they *behave*. They can be simulated and thereby readily generate predictions that can be very concretely compared across models. Research may identify differences at a structural, descriptive level but not at the level of predictions. Realizing the full empirical potential role of models presumes that research goes beyond studying models in isolation to comparing alternative models' predictions.

On a positive note, however, there are notable exceptions that do highlight the empirical capabilities of computational work. Alternative models of Ledoux's (2012) dual-pathway model, for example, have been undertaken (Armony et al., 1995; den Dulk, Rokers, & Hans Phaf, 1999; Lowe, Humphries, & Ziemke, 2009), including work that very explicitly reimplemented the Armony et al., 1995; model and then contrasted alternative extensions (Lowe et al., 2009).

For complex models that span multiple phenomena, however, the reimplementation required to compare alternative models may be a considerable challenge. Efforts to compare models may also be impeded if alternative models cover overlapping but not identical phenomena. An alternative to reimplementation of entire models is to decompose the model along theoretical lines and evaluate the resulting components in isolation. Marsella et al.

(2010) propose, in particular, that appraisal-based models can be decomposed into components of the overall appraisal process, the modeling of the *person–environment relationship*, the process of *appraisal derivation*, the set of *appraisal variables* the model assumes, the processes of *affect derivation* and *affect intensity*, how affect is represented, and the modeling of *affect consequents* (the impact that affect has on behavior and cognition). Such a decomposition suggests comparing and evaluating models on a component level, as was done when comparing alternative models of appraisal-based affect intensity calculations (Gratch, Marsella, Wang, & Stankovic, 2009).

Despite the challenge of comparing models, we envision that the use of computational models as a tool for emotion research will continue to grow, for the reasons identified in this chapter. As computers and the software that runs on them becomes more powerful and easier to use, emotion research, like the other sciences and social sciences, will increasingly exploit the research benefits they provide. Through computational models, researchers can explore phenomena at granularities that they have limited access to in standard empirical research, whether it be modeling internal processes in the brain or studying large-scale social interactions through multiagent simulations. Through computational techniques researchers can alter the way processes are implemented, ablate functionality, or transform social interaction. Thus, computational models support the exploration of emotion in ways not feasible in the real world.

Note

1. LeDoux no longer refers to his work as "fear conditioning" (see LeDoux, 2012).

References

Armony, J. L., Servan-Schreiber, D., Cohen, J. D., & LeDoux, J. E. (1995). An anatomically constrained neural network model of fear conditioning. *Behavioral Neuroscience, 109*(2), 246.

Armony, J. L., Servan-Schreiber, D., Cohen, J. D., & LeDoux, J. E. (1997). Computational modeling of emotion: Explorations through the anatomy and physiology of fear conditioning. *Trends in Cognitive Science, 1*(1), 28–34.

Bailenson, J., Beall, A., Loomis, J., Blascovich, J., & Turk, M. (2004). Transformed social interaction: Decoupling representation from behavior and form in collaborative virtual environments. *Presence: Teleoperators and Virtual Environments, 13*(4), 428–441.

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science, 1*(1), 28–58.

Barrett, L. F. (2012). Emotions are real. *Emotion, 12*, 413–429.

Barrett, L. F., & Russell, J. A. (Eds.). (2015). *The psychological construction of emotion*. New York: Guilford Press.

Barsade, S. G. (2002). The ripple effect: Emotional contagion and its influence on group behavior. *Administrative Science Quarterly, 47*(4), 644–675.

Baylor, A. L., & Kim, S. (2008). *The effects of agent nonverbal communication on procedural and attitudinal learning outcomes*. Paper presented at the International Conference on Intelligent Virtual Agents, Tokyo, Japan.

Becker-Asano, C. (2008). *WASABI: Affect simulation for agents with believable interactivity* Unpublished doctoral dissertation, University of Bielefeld, Bielefeld, Germany.

Blascovich, J., Loomis, J., Beall, A., Swinth, K., Hoyt, C., & Bailenson, J. N. (2002). Immersive virtual environment technology as a methodological tool for social psychology. *Psychological Inquiry, 13*, 103–124.

Boker, S. M., Cohn, J. F., Theobald, B.-J., Matthews, I., Brick, T. R., & Spies, J. R. (2009). Effects of damping head movement and facial expression in dyadic conversation using real-time facial expression tracking and synthesized avatars. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1535), 3485–3495.

Boone, R. T., & Buck, R. (2003). Emotional expressivity and trustworthiness: The role of nonverbal behavior in the evolution of cooperation. *Journal of Nonverbal Behavior, 27*(3), 163–182.

Bosse, T., Pontier, M., & Treur, J. (2010). A computational model based on Gross' emotion regulation theory. *Cognitive Systems Research, 11*(3), 211–230.

Bratman, M. (1987). *Intention, plans and practical reason*. Cambridge, MA: Harvard University Press.

Broekens, J., DeGroot, D., & Kosters, W. A. (2008). Formal models of appraisal: Theory, specification, and computational model. *Cognitive Systems Research, 9*(3), 173–197.

Brosig, J. (2002). Identifying cooperative behavior: Some experimental results in a prisoner's dilemma game. *Journal of Economic Behavior and Organization, 47*, 275–290.

Butler, E. A. (2011). Temporal interpersonal emotion systems: The "TIES" that form relationships. *Personality and Social Psychology Review, 15*(4), 367–393.

Clore, G., & Ortony, A. (2013). Psychological construction in the OCC model of emotion. *Emotion Review, 5*, 335–343.

Cohn, J. F. (2010). Advances in behavioral science using automated facial image analysis and synthesis [Social Sciences]. *Signal Processing Magazine, IEEE, 27*(6), 128–133.

de Melo, C., Carnevale, P. J., & Gratch, J. (2014). *Using virtual condederates to research intergroup bias and conflict*. Paper presented at the 74th annual meeting of the Academy of Management, Philadelphia, PA.

de Melo, C., Carnevale, P. J., Read, S. J., & Gratch, J. (2014).

Reading people's minds from emotion expressions in interdependent decision making. *Journal of Personality and Social Psychology, 106*(1), 73–88.

den Dulk, P., Rokers, B., & Phaf, R. H. (1996). Connectionist simulations with a dual route model of fear conditioning. In B. Kokinov (Ed.), *Perspectives on cognitibe science* (Vol. 4, pp. 102–112). Sofia, Bulgaria: New Bulgarian University Press.

Dessalles, J.-L. (2011). *Simplicity effects in the experience of near-miss*. Paper presented at the 33rd Annual Conference of the Cognitive Science Society, Austin, TX.

DeSteno, D., Breazeal, C., Frank, R. H., Pizarro, D., Baumann, J., Dickens, L., et al. (2012). Detecting the trustworthiness of novel partners in economic exchange. *Psychological Science, 23*(12), 1549–1556.

DeSteno, D., Petty, R. E., Wegener, D. T., & Rucker, D. D. (2000). Beyond valence in the perception of likelihood: The role of emotion specificity. *Journal of Personality and Social Psychology, 78*, 397–416.

DeVault, D., Artstein, R., Benn, G., Dey, T., Fast, E., Gainer, A., et al. (2014). *SimSensei Kiosk: A virtual human interviewer for healthcare decision support*. Paper presented at the Proceedings of the 2014 International Conference on Autonomous Agents and Multi-Agent Systems, Paris, France.

Dias, J., & Paiva, A. (2005). *Feeling and reasoning: A computational model for emotional agents* (pp. 127–140). Paper presented at the Proceedings of 12th Portuguese Conference on Artificial Intelligence, EPIA 2005, Covilhá, Portugal.

Frank, R. H., Gilovich, T., & Regan, D. T. (1993). The evolution of one-shot cooperation: An experiment. *Ethology and Sociobiology, 14*, 247–256.

Gratch, J. (2000, June). Emile: Marshalling passions in training and education. In *Proceedings of the 4th International Conference on Autonomous Agents* (pp. 325–332). Barcelona, Spain.

Gratch, J., & Marsella, S. (2004). A domain independent framework for modeling emotion. *Journal of Cognitive Systems Research, 5*(4), 269–306.

Gratch, J., & Marsella, S. (2013). *Social emotions in nature and artifact*. Oxford, UK: Oxford University Press.

Gratch, J., Marsella, S., Wang, N., & Stankovic, B. (2009). *Assessing the validity of appraisal-based models of emotion*. Paper presented at the International Conference on Affective Computing and Intelligent Interaction, Amsterdam, The Netherlands.

Gratch, J., Wang, N., Gerten, J., & Fast, E. (2007). *Creating rapport with virtual agents*. Paper presented at the 7th International Conference on Intelligent Virtual Agents, Paris, France.

Gross, J. J., & Barrett, L. F. (2011). Emotion generation and emotion regulation: One or two depends on your point of view. *Emotion Review, 3*, 8–16.

Hareli, S., & Hess, U. (2010). What emotional reactions can tell us about the nature of others: An appraisal perspective on person perception. *Cognition and Emotion, 24*(1), 128–140.

Hartholt, A., Traum, D., Marsella, S., Shapiro, A., Stratou, G., Leuski, A., et al. (2013). *All together now, introducing the virtual human toolkit*. Presented at the 13th Annual Conference on Intelligent Virtual Agents, Ediburgh, Scotland.

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (Eds.). (1994). *Emotional contagion*. Cambridge, UK: Cambridge University Press.

Hoyt, C., Blascovich, J., & Swinth, K. (2003). Social inhibition in immersive virtual environments. *Presence, 12*(2), 183–195.

Ito, J., Pynadath, D., & Marsella, S. (2010). Modeling self-deception within a decision-theoretic framework. *Journal of Autonomous Agents and Multi-Agent Systems, 20*(1), 3–13.

Itti, L., & Baldi, P. F. (2005). *Bayesian surprise attracts human attention*. Paper presented at the Advances in Neural Information Processing Systems, Vancouver, British Columbia, Canada.

Keltner, D., & Haidt, J. (1999). Social functions of emotions at four levels of analysis. *Cognition and Emotion, 13*(5), 505–521.

Kramer, A. D., Guillory, J. E., & Hancock, J. T. (2014). Experimental evidence of massive-scale emotional contagion through social networks. *Proceedings of the National Academy of Sciences, 111*(24), 8788–8790.

Krumhuber, E., Cosker, D., Manstead, A., Marshall, D., & Rosin, P. L. (2005). *Temporal aspects of smiles influence employment decisions: A comparison of human and synthetic faces*. Paper presented at the 11th European Conference Facial Expressions: Measurement and Meaning, Durham, United Kingdom.

Krumhuber, E., Manstead, A., Cosker, D., Marshall, D., Rosin, P. L., & Kappas, A. (2007). Facial dynamics as indicators of trustworthiness and cooperative behavior. *Emotion, 7*(4), 730–735.

Lazarus, R. (1991). *Emotion and adaptation*. New York: Oxford University Press.

LeDoux, J. (2012). Rethinking the emotional brain. *Neuron, 73*(4), 653–676.

Lee, C. M., & Narayanan, S. (2005). Towards detecting emotions in spoken dialogs. *IEEE Transactions on Speech and Audio Processing, 13*(2), 293–302.

Lee, J. D., & See, K. A. (2004). Trust in automation: Designing for appropriate reliance. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 46*(1), 50–80.

Lewis, M. D. (2005). Bridging emotion theory and neurobiology through dynamic systems modeling. *Behavioral and Brain Sciences, 28*(2), 169–194.

Li, G., Nair, S. S., & Quirk, G. J. (2009). A biologically realistic network model of acquisition and extinction of conditioned fear associations in lateral amygdala neurons. *Journal of Neurophysiology, 101*(3), 1629–1646.

Li, Z., Chang, Y.-H., & Maheswaran, R. (2013). Graph formation effects on social welfare and inequality in a networked resource game. In A. M. Greenberg, W. G. Kennedy, & N. D. Bos (Eds.), *Social computing, behavioral-cultural modeling and prediction* (pp. 221–230). Berlin: Springer-Verlag.

Lisetti, C., & Gmytrasiewicz, P. (2002). Can a rational agent afford to be affectless?: A formal approach. *Applied Artificial Intelligence, 16*, 577–609.

Lorini, E., & Castelfranchi, C. (2007). The cognitive structure of surprise: Looking for basic principles. *Topoi: An International Review of Philosophy, 26*(1), 133–149.

Lowe, R., Humphries, M., & Ziemke, T. (2009). The dual-route hypothesis: Evaluating a neurocomputational model of fear conditioning in rats. *Connection Science, 21*(1), 15–37.

Macy, M. W., & Willer, R. (2002). From factors to actors: Computational sociology and agent-based modeling. *Annual Review of Sociology, 28*, 143–166.

Manstead, A. S. R., & Fischer, A. H. (2001). Social appraisal: The social world as object of and influence on appraisal processes. In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 221–232). New York: Oxford University Press.

Mao, W., & Gratch, J. (2005). *Social causality and responsibility: Modeling and evaluation.* Paper presented at the International Working Conference on Intelligent Virtual Agents, Kos, Greece.

Marsella, S., & Gratch, J. (2001). *Modeling the interplay of plans and emotions in multi-agent simulations.* In Proceedings of the 23rd Annual Conference of the Cognitive Science Society, Edinburgh, Scotland.

Marsella, S., & Gratch, J. (2009). EMA: A process model of appraisal dynamics. *Journal of Cognitive Systems Research, 10*(1), 70–90.

Marsella, S., & Gratch, J. (2014). Computationally modeling human emotion. *Commun. ACM, 57*(12), 56–67.

Marsella, S., Gratch, J., & Petta, P. (2010). Computational models of emotion. In K. R. Scherer, T. Bänziger, & E. Roesch (Eds.), *A blueprint for affective computing: A sourcebook and manual* (pp. 21–46). New York: Oxford University Press.

McCall, C., Blascovich, J., Young, A., & Persky, S. (2009). Proxemic behaviors as predictors of aggression towards black (but not white) males in an immersive virtual environment. *Social Influence, 4*(2), 138–154.

Mumenthaler, C., & Sander, D. (2012). Social appraisal influences recognition of emotions. *Journal of Personality and Social Psychology, 102*(6), 1118–1135.

Murray, L., & Trevarthen, C. (1985). Emotional regulation of interactions between two-month-olds and their mothers. In T. M. Fields & N. A. Fox (Eds.), *Social perception in infants* (pp. 177–197). Norwood, NJ: Ablex.

Newell, A. (1990). *Unified theories of cognition*. Cambridge, MA: Harvard University Press.

Parkinson, B., Fischer, A. H., & Manstead, A. S. R. (2005). *Emotion in social relations: Cultural, group, and interpersonal processes.* New York: Psychology Press.

Parkinson, B., Phiri, N., & Simons, G. (2012). Bursting with anxiety: Adult social referencing in an interpersonal balloon analogue risk task (BART). *Emotion, 12*(4), 817–826.

Pennebaker, J. W., Francis, M. E., & Booth, R. J. (2001). *LIWC: Linguistic inquiry and word count*. Mahwah, NJ: Erlbaum.

Rank, S. (2009). *Behaviour coordination for models of affective behaviour.* Unpublished dissertation, Vienna University of Technology, Vienna, Austria.

Read, S. J., Monroe, B. M., Brownstein, A. L., Yang, Y., Chopra, G., & Miller, L. C. (2010). A neural network model of the structure and dynamics of human personality. *Psychological Review, 117*(1), 61.

Reeves, B., & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places.* New York: Cambridge University Press.

Reisenzein, R. (2000). Exploring the strength of association between the components of emotion syndromes: The case of surprise. *Cognition and Emotion, 14*(1), 1–38.

Reisenzein, R., Hudlicka, E., Dastani, M., Gratch, J., Hindriks, K., Lorini, E., et al. (2013). Computational modeling of emotion: Toward improving the inter- and intradisciplinary exchange. *IEEE Transactions on Affective Computing, 4*(3), 242–245.

Rickel, J., Marsella, S., Gratch, J., Hill, R., Traum, D., & Swartout, W. (2002, July/August). Toward a new generation of virtual humans for interactive experiences [Special issue]. *IEEE Intelligent Systems, 17*(4), 32–38.

Roos, P., Gelfand, M., Nau, D., & Carr, R. (2014). High strength-of-ties and low mobility enable the evolution of third-party punishment. *Proceedings of the Royal Society of London B: Biological Sciences, 281*(1776), 2013–2661.

Rosenthal, R. (1966). *Experimenter effects in behavioral research.* New York: Appleton-Century-Crofts.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39*(6), 1161–1178.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*(1), 145–172.

Sander, D., Grandjean, D., & Scherer, K. R. (2005). A systems approach to appraisal mechanisms in emotion. *Neural Networks, 18*, 317–352.

Scherer, K. R. (2001). Appraisal considered as a process of multilevel sequential checking. In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 92–120). New York: Oxford University Press.

Scherer, K. R., Schorr, A., & Johnstone, T. (Eds.). (2001). *Appraisal processes in emotion.* Oxford, UK: Oxford University Press.

Schug, J., Matsumoto, D., Horitaa, Y., Yamagishi, T., & Bonnet, K. (2010). Emotional expressivity as a signal of cooperation. *Evolution and Human Behavior, 31*, 87–94.

Schuller, B., Rigoll, G., & Lang, M. (2003). *Hidden Markov model-based speech emotion recognition.* Paper presented at the IEEE International Conference on Acoustics, Speech, and Signal Processing, Hong Kong.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology, 45*(3), 513–523.

Shaver, K. G. (1985). *The attribution of blame: Causality,* *responsibility, and blameworthiness*. New York: Springer-Verlag.

Si, M., Marsella, S., & Pynadath, D. (2010). Modeling appraisal in theory of mind reasoning. *Journal of Autonomous Agents and Multi-Agent Systems, 20*(1), 14–31.

Simon, H. (1969). *The sciences of the artificial*. Cambridge, MA: MIT Press.

Sloman, A., & Croucher, M. (1981). *Why robots will have emotions*. Paper presented at the International Joint Conference on Artificial Intelligence, Vancouver, Canada.

Steunebrink, B. R., Dastani, M., & Meyer, J.-J. C. (2007). *A logic of emotions for intelligent agents*. Paper presented at the Proceedings of the National Conference on Artificial Intelligence, Vancouver, Britissh Columbia, Canada.

Sun, R. (2008). *The Cambridge handbook of computational psychology*. New York: Cambridge University Press.

Todorov, A. (2008). Evaluating faces on trustworthiness. *Annals of the New York Academy of Sciences, 1124*(1), 208–224.

Traum, D., Rickel, J., Gratch, J., & Marsella, S. (2003). *Negotiation over tasks in hybrid human–agent teams for simulation-based training*. Paper presented at the International Conference on Autonomous Agents and Multiagent Systems, Melbourne, Australia.

Tsai, J., Bowring, E., Marsella, S., & Tambe, M. (2013). Empirical evaluation of computational fear contagion models in crowd dispersions. *Autonomous Agents and Multi-Agent Systems*, 1–18.

von der Pütten, A., Krämer, N. C., Gratch, J., & Kang, S.-H. (2010). "It doesn't matter what you are!":Explaining social effects of agents and avatars. *Computers in Human Behavior, 26*(6), 1641–1650.

Weiner, B. (1995). *The judgment of responsibility*. New York: The Guilford Press.

Yechiam, E., Busemeyer, J. R., Stout, J. C., & Bechara, A. (2005). Using cognitive models to map relations between neuropsychological disorders and human decision-making deficits. *Psychological Science, 16*(12), 973–978.

Zeng, Z., Pantic, M., Roisman, G. I., & Huang, T. S. (2009). A survey of affect recognition methods: Audio, visual, and spontaneous expressions. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 31*(1), 39–58.

Zoll, C., Enz, S., Schaub, H., Aylett, R., & Paiva, A. (2006). *Fighting bullying with the help of autonomous agents in a virtual school environment*. Paper presented at the 7th International Conference on Cognitive Modelling (ICCM-06), Trieste, Italy.

PART II

Biological Perspectives

CHAPTER 7

From Pleasure to Happiness

"Liking" and "Wanting" in Mind and Brain

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The psychological processes of "liking" versus "wanting" are components within many positive emotions. These processes may also be relevant to understanding hedonic aspects of sustained states of well-being in happy people, as mechanisms of pleasure and reward. The liking and wanting aspects of reward often seem to merge together in psychological experience, but evidence from affective neuroscience suggests that the psychological processes of liking versus wanting are quite different from each other, and have separable brain mechanisms within mesocorticolimbic circuitry. Here we examine how these brain mechanisms may help give distinct identity to the two psychological components in ways that impact emotions. In particular, we consider how wanting and liking may help in understanding the brain bases of human happiness, which is sought by nearly all individuals, and to understanding the bases of drug addiction or related addictive disorders, which destroy happiness for some.

Our thesis is that in everyday life, the liking and wanting processes may occur together primarily as relatively transient psychological paired states, which contribute to many rewarding emotions. If the liking component, in optimal balance with the wanting component, is recruited in a more enduring or frequently recurring fashion, these components may also factor into understanding more sustained states of well-being or happiness, which is a goal for many individuals psychologically as well as a societal goal to promote more generally. Finally, liking and wanting can sometimes dissociate in certain situations. When this happens in a fashion that the wanting component becomes specifically and pathologically strong, the resulting imbalance between the two processes may contribute to addictions, which have powerfully detrimental effects on well-being.

Happiness, "Liking," and "Wanting"

We begin with well-being or happiness and the relation to the hedonic psychology of liking and wanting. The first question is "Can explanations of the brain bases of liking and wanting contribute to a better understanding of the hedonic side of happiness?" In Western psychological and philosophical frameworks for over 2,000 years, ever since originally proposed by Aristotle, happiness has been usefully thought of as consisting of at least two aspects: *hedonia* (pleasure) and *eudaimonia* (a life well-lived in terms of meaningfulness; Aristotle, 350 B.C.E./2009). Based on this Aristotelian distinction, some choose to emphasize the eudaimonic side of happiness, positing happiness and well-being to turn solely on a sense of life *meaning*. A purely eudaimonic view can de-emphasize the hedonic side of happiness, holding that a well-lived and meaningful life must be happy regardless of whether the person takes any pleasure in his or her life. An example of the purely eudaimonic view of happiness was famously expressed 150 years ago by John Stuart Mill: "It is better to be a human being dissatisfied than a pig satisfied; better to be Socrates dissatisfied than a fool satisfied" (Mill, 1861/1998, p. 57). By Mill's view as quoted here, a life filled with the most intense pleasures of pigs or fools would never be enough for happiness. Rather, true happiness was presumed by that view to hinge on a superior kind of richness of life meaning and engagement that was possessed fully by the enlightened Socrates, even when facing a death sentence, no matter how much hedonically dissatisfied he might have been.

Yet even Mill (1861/1998) himself seemed to imply elsewhere that hedonic pleasure was important to happiness too. And conversely, other psychologists have emphasized the hedonic side of happiness, sometimes at the expense of eudaimonia. For example, Sigmund Freud (1930) appeared nearly to take a purely hedonic view of happiness in his book *Civilization and Its Discontents.* Freud wrote there, in response to his own question "What do people ask of life and wish to achieve in it?" his personal reply:

> The answer to this can hardly be in doubt. They strive after happiness; they want to become happy and to remain so. This endeavor has two sides, a positive and a negative aim. It aims, on the one hand, at an absence of pain and displeasure, and, on the other, at the experiencing of strong feelings of pleasure. (p. 76)

Freud's answer essentially equates pleasure with happiness. According to this view, the more pleasure you have (while avoiding displeasure), the happier you will be.

It may not be necessary to choose either hedonia or eudaimonia over the other. Most modern psychologists who study happiness tend to fall in between the poles illustrated by Mill and Freud, and hold hedonic factors to be crucially important to well-being (Kahneman, Diener, & Schwarz, 1999; Gilbert, 2006; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2006; Biswas-Diener, Kashdan, & King, 2009; Diener, 2012; Jayawickreme, Forgeard, & Seligman, 2012), even when espousing views that on the whole emphasize eudaimonic factors (Peterson & Park, 2009; Seligman, Railton, Baumeister, & Sripada, 2013). We similarly presume that a capacity for taking pleasure in life is an important feature of happiness, but do not reduce happiness to pleasure nor ignore the importance of eudaimonic aspects of well-being.

However, our main point is simply that if happiness involves a pleasurable or hedonic component, then finding brain mechanisms for pleasure may give insight into the hedonic aspects of well-being. A better understanding of the hedonic component of happiness in turn might be used as a first step toward understanding the brain mechanisms of happiness more generally, given that both aspects tend to cluster together in happy individuals. It is important to note that our focus on the hedonia component of happiness should not be confused with hedonism, which is the pursuit of pleasure for pleasure's own sake, and more akin to the addiction features we describe below. Also, to focus on hedonics does not deny that some ascetics may have found bliss through painful self-sacrifice, but simply reflects that positive hedonic tone is indispensable to most people seeking happiness.

Most important to our suggestion that it is not necessary to choose between hedonia and eudaimonia is the empirical finding that a high correlation actually exists between the pleasurable and the life-meaning aspects of happiness when rated by individuals—that is, the same lucky individuals who tend to score highest on a eudaimonic measure of happiness also tend to score highest on their hedonic ratings of happiness (Diener, Kesebir, & Lucas, 2008; Kuppens, Realo, & Diener, 2008). Those who have one also have the other. Conversely, individuals who are lowest on a hedonic measure tend to also be lowest on the eudaimonic measure. Fortunately, it turns out that most people report themselves to be reasonably happy. For example, in happiness surveys, over 80% of people rate their overall eudaimonic life satisfaction as "pretty to very happy," and 80% also rate their current hedonic mood as positive (e.g., positive = 6–7 on a 10–point valence scale, where 5 is "hedonically neutral"; Diener et al., 2008; Kuppens et al., 2008). A lucky happy few may even live consistently around a hedonic point of 8.

In our view, this tendency of pleasure ratings and meaningfulness ratings to correlate together opens a potential window of opportunity to affective neuroscience in understanding the brain bases of happiness. Hedonic well-being in particular, which can be studied relatively easily, presents a practical gateway to the more difficult-to-study state of eudaimonic well-being (Urry, et al., 2004; Kringelbach & Berridge, 2009). In other words, if both hedonia and eudaimonia co-occur in the same happy people, then identifying neural markers of hedonia may offer a toehold into identifying neural bases of eudaimonia. In this way, studies of hedonic well-being, which tend to be more amenable to neuroscience approaches than eudaimonic meaningfulness of life, may help to identify brain markers that distinguish happy people, including at least some brain markers that will turn out to overlap with eudaimonic well-being.

Many Different Pleasures but One Brain Pleasure System?

Subjectively, the sensory pleasure of a delicious-tasting food feels very different from the sensory pleasures of sex or of drugs. And subjectively there is even more difference between such sensory pleasures and any higher social or cognitive pleasures, such as seeing a loved one or listening to music. Yet affective neuroscience evidence has emerged in the past decade to suggest that brain mechanisms of sensory pleasures overlap to a surprising degree with brain mechanisms of cognitive, cultural, and social pleasures, and even with mechanisms of hedonic well-being. Evidence from neuroimaging studies suggests there is a single shared core process of positive affect shared by many diverse hedonic experiences and positive emotions, even those that may each subjectively feel quite different and unique (Rozin, Haidt, & Fincher, 2009; Kringelbach & Berridge, 2010b; Lindquist, Wager, Bliss-Moreau, Kober, & Barrett, 2012; Wilson-Mendenhall, Barrett, & Barsalou, 2013). The list of brain structures activated by all these pleasures includes several limbic regions within the prefrontal cortex: for example, the orbitofrontal, anterior cingulate, and insula cortices. Brain structures activated by diverse pleasures also include several subcortical limbic structures, such as the nucleus accumbens (NAc), ventral pallidum, amygdala, and mesolimbic tegmentum (which contains dopamine neurons; Beauregard & Paquette, 2006; Harris et al., 2009; Frijda, 2010; Leknes & Tracey, 2010; Skov, 2010; Vuust & Kringelbach, 2010; Salimpoor, Benovoy, Larcher, Dagher, & Zatorre, 2011; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012; Wilson-Mendenhall et al., 2013). The range of pleasures that activate such overlapping brain structures spans from mere sensory pleasures of food, sex, or addictive drugs to human cognitive, social, and even moral pleasures such as the encounter of favorite music, art, a loved one, or religious ecstasy.

The strong degree of neural overlap in hedonic circuitry gives rise to the hypothesis that there is a shared underlying "neural currency" or mesocorticolimbic mechanism for generating the pleasure of all those psychologically diverse experiences and emotions (Kringelbach & Berridge, 2010b). Evolutionarily, this could be understood by saying that the brain seems to have conserved the mechanisms that evolved originally to generate sensory pleasures, and extended their pleasure functions to higher pleasures that appeared later in human evolution. Rather than having to invent entirely new brain systems for generating abstract social or cognitive pleasures, the human brain seems to have simply adapted original sensory pleasure mechanisms, and integrated them with new cognitive inputs, to produce the higher human pleasures.

This overlap or common neural currency idea implies that what can be learned about the details of how the brain generates one pleasure may also apply to many other forms of pleasure. Most of what affective neuroscience has learned so far about pleasure in the brain has come from studies of sensory pleasures, such as food pleasures or drug pleasures. But based on the common neural currency idea, we suggest that what has been learned about how those sensory pleasures are produced by brain systems may also provide insights into how the same brain systems produce higher pleasures. So for example, conclusions described below about how sensory pleasure is coded by the orbitofrontal cortex or generated by limbic hedonic hot spots may similarly apply the coding and generation of cognitive and social pleasures too. This extension of shared hedonic mechanisms is useful at least as a hypothesis for guiding future studies of higher pleasures.

Of course, it is possible that future studies with improved technology will find subtle differences in neurobiological operation or tiny patterns of subregional anatomical localization within a particular brain structure that may help distinguish different types of pleasures. But alternatively, the reason why they feel so different may have to do with other nonhedonic sensory and cognitive aspects of the pleasurable experiences, which are mediated by other brain structures, rather than hedonic differences in the pleasures themselves.

The common neural currency idea may extend even to the sustained and free-floating pleasant state of happiness itself. Some direct evidence for this idea comes from an intriguing study by Heller and colleagues (2013), which reported that high subjective ratings in response to questions such as "In general, [do] I feel confident and positive about myself?" were correlated with high sustained functional magnetic resonance imaging (fMRI) measures of brain activation in the subcortical nucleus accumbens (ventral striatum). The nucleus accumbens is a major target of the brain's mesolimbic dopamine "wanting" system for reward, and also contains an opioid hedonic hot spot for generating the intense "liking" of a sensory pleasure, as discussed below. Thus there appears to be substantial overlap between brain mechanisms of abstract human pleasures, including hedonic happiness, with the older mechanisms of specific sensory pleasures, shared with animals, which we describe next.

Sensory Pleasures: From Sensation to "Liking" to Hedonic Feelings

What makes a pleasure so nice? Pleasure or positive affect is never merely a sensation, not even for a sensory pleasure such as sweetness (Ryle, 1954; Frijda, 2010; Kringelbach, 2010; Kringelbach & Berridge, 2010b). Instead, the hedonic quality always requires the recruitment of specialized pleasure-generating brain systems to actively paint an additional "hedonic gloss" onto a sensation. Active recruitment of brain pleasure-generating systems is what makes a pleasant experience liked. These pleasure-generating systems have been shown by recent studies to take the form of a network of small "hedonic hot spots" distributed at several layers throughout the brain. Together, those hedonic hot spots interact together to make a sensation become positively liked.

Pleasure is always added to stimuli actively by the brain to make them positively hedonic, and is not an immutable feature of any external stimulus or event itself. The capacity of certain stimuli, such as a sweet taste or a loved one, to reliably elicit pleasure—to nearly always be painted with a hedonic gloss—reflects their privileged ability to activate those hedonic brain systems responsible for manufacturing and applying the gloss.

Hedonic brain systems involving multiple coding sites and generating hot spots are well developed in the brain, spanning subcortical and cortical levels. The basic circuitry wiring pattern is quite similar across humans and other animals (Heimer, Van Hoesen, Trimble, & Zahm, 2008). Why hedonic brain networks are so robust, and why they are relatively similar across humans and other animals, is probably because hedonic reactions have long had adaptive function. The basic hedonic circuits of the brain were formed and selected rather early in mammalian evolution. It seems unlikely so much neural machinery would have been preserved across evolutionary time if it had no function. Basic pleasure reactions have always had objective consequences, and brain mechanisms for hedonic reactions have long been functionally useful—even before any additional mechanisms appeared that characterize any human-unique aspects of subjective feelings of pleasure. In a sense, hedonic reactions have been too important to survival for pleasure to be exclusively in the realm of subjective experience.

Pleasure as an adaptive evolutionary feature is not so hard to imagine. For example, tasty food is one of the most universal routes to pleasure, as well as an essential requirement to survival. Not accidentally, food is also one of the most accessible experimental methods available to psychology and neuroscience studies of pleasure (Rozin, 1999; Kringelbach, 2005; Peciña, Smith, & Berridge, 2005; Berridge, Ho, Richard, & DiFeliceantonio, 2010; Gottfried, 2010; Kringelbach & Berridge, 2010a; Veldhuizen, Rudenga, & Small, 2010). Much of what is currently known about pleasure in the brain comes from such studies, including which cortical sites most faithfully code pleasure and which brain sites are hedonic hot spots to help generate pleasure.

Identifying Pleasure Generators in the Brain

Pleasant experiences such as a sensory pleasure or a positive emotion may appear in experience to be a unitary process, but virtually all are complex composites of affective and cognitive processes (Russell & Barrett, 1999; Clore & Ortony, 2000; Lambie & Marcel, 2002; Ellsworth & Scherer, 2003; Lindquist, Wager, Bliss-Moreau, et al., 2012; Chapter 15, this volume). Affective neuroscience studies have further indicated that even the simplest pleasant experience, such as a mere sensory reward, is actually a more complex set of processes containing several psychological components, each with distinguishable neurobiological mechanisms (Berridge, Robinson, & Aldridge, 2009; Kringelbach & Berridge, 2009; Leknes & Tracey, 2010). These include, in particular, distinct components of reward *wanting* versus reward *liking* (as well as reward *learning*), and each psychological component has both conscious and nonconscious subcomponents. Liking is the actual pleasure component or hedonic impact of a reward; wanting is the motivation for reward; and learning includes the associations, representations, and predictions about future rewards based on past experiences. Each of these components has brain mechanisms that are different from mechanisms of the other components, and each plays a central role in the cyclical time course of a pleasant experience (Plates 7.1 and 7.2; see color insert for plates).

The conscious experience of pleasure is so striking that pleasure has seemed purely subjective by definition to many thinkers. But related to the notion that pleasure naturally evolved, we think that pleasure also has objective aspects that can be detected in brain and behavior. This is related to the underlying similarities of brain limbic mechanisms for generating sensory pleasures across the brains of most mammals, both humans and nonhumans alike. The objective aspect has been invaluable in identifying the brain generators of pleasure described below.

We distinguish between the conscious and nonconscious aspects of these subcomponents because both exist in people (Winkielman, Berridge, & Wilbarger, 2005). And at least the latter can also be studied in other animals in ways that help reveal the underlying neural-generating mechanisms. At the potentially nonconscious level, we use quotation marks to indicate that we are describing objective, behavioral, or neural measures of these underlying brain processes. As such, "liking" reactions result from activity in identifiable brain systems that paint hedonic value on a sensation such as sweetness, and produce observable affective reactions in the brain and in behavior such as facial expressions. Similarly, "wanting" includes incentive salience or motivational processes within reward that mirror hedonic "liking" and make stimuli into motivationally attractive incentives. "Wanting" helps spur and guide motivated behavior, when incentive salience is attributed to stimulus representations by the mesolimbic brain systems. Finally, "learning" includes a wide range of processes linked to implicit knowledge as well as associative conditioning, such as basic Pavlovian and instrumental associations.

At the conscious level, "liking" is the subjective feeling of pleasure in the ordinary sense of the word, which may be elaborated out of (mostly subcortical) core liking reactions by cognitive brain mechanisms of awareness. Conscious wanting includes conscious desires for incentives or cognitive goals, while conscious learning includes the updating of explicit and cognitive predictions (Friston & Kiebel, 2009; Zhang, Berridge, Tindell, Smith, & Aldridge, 2009).

By themselves, core "liking" and "wanting" processes can occur nonconsciously, even in normal people. For example, viewing a subliminally brief happy facial expression or angry facial expression for just one-sixtieth of a second produces no change in people's conscious emotional feelings, and they remain unaware of having seen the emotional expressions. They are unable to pick the photo they saw out of a lineup (especially if the subliminal emotional expression is followed by a longer view of a neutral face, and if the experience is embedded in a task that distracts the viewers because they are concentrated on performing it correctly). Yet subliminal exposures to the happy face can make the viewers subsequently go on to evaluate a new stimulus (e.g., a flavored drink presented as a new marketing product) much more positively and to consume more of that stimulus, whereas exposure to the angry face makes viewers evaluate the new stimulus more negatively and consume less of it, indicating that the subliminal emotional expressions had induced nonconscious "liking" versus "disliking" reactions that never surfaced into conscious emotional feelings but remained able to alter their behavior under particular circumstances (Berridge & Winkielman, 2003). Such observations of nonconscious hedonic reactions suggests that additional brain circuitry is needed to convert a core "liking" reaction into a consciously liked experience of felt pleasure. Of course, it remains a major mystery precisely which brain circuits or neural operations are responsible for generating consciousness, including conscious experiences of subjective pleasure or of subjective feelings of desire. Traditional answers have tended to favor neocortex, and especially perhaps the prefrontal lobe of the cortex. The prefrontal cortex is quite prominent in humans, and includes several limbic regions such as the orbitofrontal cortex, anterior cingulate cortex, and insula (deep in the lateral surface of the prefrontal cortex, buried under the temporal lobe). However, this consciousness assignment to the prefrontal cortex may have more to do with tradition, and with the traditional assumption that what appears anatomically well developed in humans must necessarily have to do with human consciousness, than with any particular evidence.

Indeed, to the contrary, what evidence is available suggests that conscious feelings of liking, wanting, or other emotions can persist surprisingly well even in humans in essentially the complete absence of the prefrontal cortex. For example, a recent study reported remarkably normal emotion in a man who had lost the orbitofrontal cortex, insula, and ventral anterior cingulate (plus hippocampus and amygdala) due to encephalitis (Damasio, Damasio, & Tranel, 2012). He was left with severe memory and cognitive deficits, but still retained a rich emotional life for 20 years as far as could be told, including a remarkable capacity to talk about his emotional feelings. For example, when asked about himself in a social setting, he said, "I have a strong feeling of happiness, that we are here together working on these wonderful games and feeling happy together. I am glad to be here with you." The patient also socially learned to prefer a friendly caregiver to a grumpy one, and learned fears of medical syringe needles and noisy fMRI machines. Similarly, many thousands of patients in the 1950s were subjected to a surgical operation known as prefrontal lobotomy, in which their prefrontal cortex was removed or disconnected from the rest of the brain. Those patients often tended to make bad or risky decisions afterward, but appeared to keep the hedonic capacity for all intense emotions, including strong pleasure and displeasure experiences. Such observations suggest that the prefrontal cortex may not be the sole locus of emotional consciousness, and can lead one to entertain alternative hypotheses that deeper brain structures may be rather competent at generating basic emotional feelings even in people (Damasio, 1999; Berridge & Kringelbach, 2011; Panksepp, 2011; Damasio et al., 2012).

Pleasure Generators: Hedonic Hot Spots in the Brain

How is pleasure as an intense liking reaction actually generated within a brain? This is the question of hedonic causation. The brain appears frugal in mechanisms that that are causally sufficient to generate "liking" or magnify pleasure to high levels. These few mechanisms are candidate brain wellsprings for hedonic happiness.

Compelling evidence for pleasure causation as increases in 'liking' reactions has so far been found for only a few brain substrates, or hedonic hot spots. Those hedonic hot spots may be found in some regions of the prefrontal cortex, but mostly reside—perhaps surprisingly, if one thought pleasure to be exclusively a product of the brain's top-level cortex—in subcortical structures deep below the cortex (though heavily connected with limbic regions of the prefrontal cortex). Our strategy to find such neural generators of pleasure gloss has relied on activating neural mechanisms underlying natural liking reactions to intensely pleasant sensations. Such neural activations can be ethically induced only in animal studies, via painless brain manipulations that excite neural activity or activate neurochemical receptors on neurons. An example of "liking" is the positive affective facial expression elicited by the hedonic impact of sweet tastes in newborn human infants (Plate 7.1), such as tongue protrusions for licking the lips. By contrast, nasty bitter tastes instead elicit facial "disliking" expressions of disgust such as gapes, nose and brow wrinkling, and shaking of the head. These affective expressions are displayed by human infants in the very first days of life (Steiner, 1973). Such "disgust" expressions or "liking" expressions have been called the most basic and earliest stage of emotion exhibited as action patterns in children (Chapter 15, this volume). The infant hedonic expressions are quickly influenced by learning. For example, if infants are regularly fed artificial formula diets made from hydrolized caseins, which are nutritious but can taste more bitter than milk, the formula-fed infants subsequently express fewer "disgust" faces and more "liking" faces to bitter tastes than other infants who have consumed mostly their mother's breast milk or formula made from cows' milk (Mennella, Forestell, Morgan, & Beauchamp, 2009).

Many of these affective "liking" versus "disgust" expressions to tastes by human infants are similar and homologous to facial expressions elicited by sweet versus bitter tastes from orangutans, chimpanzees, monkeys, and even rats and mice (Steiner, 1973; Grill & Norgren, 1978a; Steiner, Glaser, Hawilo, & Berridge, 2001). Homology in the origin of "liking" reactions implies that the underlying hedonic brain mechanisms are similar in humans and other animals (e.g., sharing features such as identical allometric timing laws in each species that scale speed of expressions to body size). That similarity opens the way for an affective neuroscience of pleasure generators that bridges humans and animals.

Subcortical Hedonic Hot Spots in the Nucleus Accumbens, Ventral Pallidum, and Brainstem

We believe that the way to gain the clearest understanding of how the brain produces pleasure is to combine the best perspectives from both human studies and animal studies in affective neuroscience. Human studies provide windows into subjective experience and into neuroimaging identification of the brain structures that underlie diverse uniquely human pleasures. Animal studies provide windows into which neural mechanisms actually cause pleasure, and how they work. Integrated together, the two perspectives form a powerful viewpoint for understanding the nature of pleasure and its sources in the brain.

An example of how the causation of pleasure can be revealed comes from affective neuroscience studies in rodents, which have identified hedonic hot spots that when activated can magnify a sensory pleasure. These help reveal the locations and neurotransmitter identities of the generating mechanism for intense "liking." A hedonic hot spot is capable of generating enhancements of liking reactions to a sensory pleasure such as sweetness, when stimulated by opioid, endocannabinoid, or particular other neurotransmitters, or stimulated by drug microinjections that elevate or mimic those neurotransmitters (Peciña & Berridge, 2005; Smith & Berridge, 2005; Peciña et al., 2006; Mahler, Smith, & Berridge, 2007; Richard, Castro, DiFeliceantonio, Robinson, & Berridge, 2013). In rodent studies, the hot spots can be activated by painless microinjections of tiny drug droplets that stimulate neurotransmitter receptors on neurons contained within the site. Another recently developed way of probing pleasure mechanisms is to activate neurons by optogenetic laser light, shone painlessly on neurons in a hot spot through an optic fiber previously implanted in the brain. Neurons near the fiber also have previously been infected with a virus that gives them a new gene, allowing them to sprout photoreceptors that respond to the laser light, by opening neuronal membrane gates to outside ions and so to suddenly become excited and to fire action potentials. In this way, the laser light electrically stimulates the gene-infected neurons, and so functionally activates the hot spot's circuitry (Castro & Berridge, 2013). Within the hot spot, particular opioid drug microinjections or laser light pulses may activate pleasure-generating circuitry to magnify the hedonic impact of a sweet taste, increasing the number of "liking" reactions elicited by a squirt of sugar-flavored water. Outside the border of the hot spot the same neural manipulations would completely fail to elevate liking. The spatial difference between effective versus ineffective sites for enhancing hedonic impact therefore maps the anatomical location and boundaries of a pleasure-generating hedonic hot spot (Plate 7.1).

The results of such studies reveal a network of several brain hedonic hot spots, distributed as a chain of "liking"-enhancing islands of brain tissue across several deep structures of the brain (Plate 7.2). The network of separate but interconnected hedonic hot spots acts together as a coordinated whole to amplify core pleasure reactions. Activating one recruits the others as a system (Smith, Berridge, & Aldridge, 2011). Each brain hot spot may be merely a cubic millimeter or so in volume in the brain of a rat (and would be expected to be a cubic centimeter or so in a human, if proportional to the larger human volume of the whole brain). The small size of each anatomical hot spot indicates a surprisingly localized concentration of sufficient-cause mechanisms for generating intense pleasure in the brain. The network properties reveal a fragile substrate for pleasure enhancement that requires unanimity across the several parts in order to elevate hedonic "liking" (Peciña, 2008; Peciña & Smith, 2010; Smith, Mahler, Peciña, & Berridge, 2010; Smith et al., 2011).

One major hot spot has been found in the nucleus accumbens, a brain structure at the bottom font of the brain, specifically in its medial shell region near the center of the structure (Plates 7.1 and 7.2). Other hot spots are emerging above in the prefrontal cortex, and have been found farther back in the brain. For example, a very important hedonic hot spot lies in the ventral pallidum, which is near the hypothalamus near the very bottom center of the forebrain and receives most outputs from the nucleus accumbens (Plate 7.2). That ventral pallidal hot spot is especially important in that it is the only one that not only can enhance pleasure to high intensities but also where damage obliterates normal pleasure, so that, for example, even sweetness becomes disgusting (Ho & Berridge, 2014). In the prefrontal cortex, additional hot spots at least able to enhance pleasure may be found in the orbitofrontal cortex and in a lateral bit of frontal cortex called the insula (D. C. Castro & K. C. Berridge, personal communication). Finally, pleasure circuitry may extend deep in the brain, as far as to a hot spot in the brainstem region called the parabrachial nucleus, located near the top of the pons (Soderpalm & Berridge, 2000).

Analogous to scattered islands that form a single archipelago, the distributed network of hedonic hot spots forms a functional integrated circuit, which obeys control rules that are largely hierarchical and organized into brain levels (Grill & Norgren, 1978b; Berridge & Fentress, 1986; Aldridge, Berridge, Herman, & Zimmer, 1993; Peciña et al., 2006). At the highest levels, the hot spot network may function as a more democratic heterarchy, in which unanimity of positive votes across hot spots is required in order to generate greater pleasure (Smith & Berridge, 2007). For example, any successful enhancement that starts in one hot spot involves recruiting neuronal activation across other hot spots simultaneously, to create a network of several that all vote "yes" together for more pleasure (Smith et al., 2011). Conversely, a pleasure enhancement initiated by opioid activation of one hot spot can be vetoed by an opposite vote of "no" from another hot spot where opioid signals are suppressed. Such findings reveal the need for unanimity across hot spots in order for greater pleasure to be produced, and the potential fragility of hedonic enhancement if any hot spot defects (Smith & Berridge, 2007; Smith et al., 2010).

All of the findings above help identify brain pleasure generators capable of generating high hedonic peaks that make an event more "liked." These generators for sensory pleasure are excellent candidate mechanisms for also generating the more abstract pleasures of human cognition and social life, and even for generating hedonic happiness. Future studies that focus on hedonic hot spot networks may eventually be able to confirm whether pleasure-generating networks are truly shared across such diverse pleasures, as we have suggested, and more generally in other pleasant emotions (Barrett & Wager, 2006).

Pleasure Coding in the Cortex

In contrast to the causation of pleasure that may arise chiefly from subcortical brain circuitry, brain regions decoding pleasure and relating it to psychological functions such as cognitive evaluation are found mostly in the cortex. Hedonic evaluation of pleasure valence is anatomically distinguishable from precursor operations such as sensory computations, suggesting the existence of a hedonic cortex proper (Plates 7.2 and 7.3; Kringelbach, 2005). The hedonic cortex involves regions such as the orbitofrontal, insula, medial prefrontal, and cingulate cortices (Craig, 2002; Kringelbach, 2005; Amodio & Frith, 2006; Beckmann, Johansen-Berg, & Rushworth, 2009), which a wealth of human neuroimaging studies have shown to code for hedonic evaluations (including anticipation, appraisal, experience, and memory of pleasurable stimuli) and have close anatomical links to subcortical hedonic hot spots.

Pleasure encoding may reach an apex of cortical localization in a midanterior subregion within the orbitofrontal cortex (Plate 7.3), where neuroimaging activity correlates strongly to subjective pleasantness ratings of food varieties (Kringelbach, O'Doherty, Rolls, & Andrews, 2003)—and to other pleasures—such as sexual orgasms (Georgiadis, Kringelbach, & Pfaus, 2012), drugs (Vollm et al., 2004), chocolate (Small, Zatorre, Dagher, Evans, & Jones-Gotman, 2001), music (Blood & Zatorre, 2001), and other emotions (Wilson-Mendenhall et al., 2013). Most important, midanterior orbitofrontal activity tracks changes in subjective pleasure, such as a decline in palatability when the reward value of one food was reduced by eating it to satiety (while remaining high to another food; Kringelbach et al., 2003; Kringelbach, 2005). The midanterior subregion of orbitofrontal cortex is thus a prime candidate for the coding of the subjective experience of pleasure (Plate 7.3; Kringelbach, 2005).

Another coding site for positive affect in the orbitofrontal cortex may be along its medial edge that has activity related to the valence of positive and negative events (Kringelbach & Rolls, 2004; Wilson-Mendenhall et al., 2013), contrasted to lateral portions that have been suggested to code unpleasant events (O'Doherty, Kringelbach, Rolls, Hornak, & Andrews, 2001), although the activity in the lateral part is more likely to reflect a signal to escape the situation, rather than displeasure per se (Kringelbach et al., 2003; Hornak et al., 2004; Kringelbach, de Araujo, & Rolls, 2004; Kringelbach, 2005).

The medial-lateral hedonic gradient in the orbitofrontal cortex interacts with an abstraction–concreteness gradient in the posterior-anterior dimension, so that more complex or abstract reinforcers (such as monetary gain and loss; O'Doherty et al., 2001) are represented more anteriorly in the orbitofrontal cortex than less complex sensory rewards (such as taste; Small et al., 2001). The medial region does not, however, appear to change its activity with reinforcer devaluation, and so may not reflect the full dynamics of pleasure.

Some studies have also shown lateralization of affect or hemispheric differences in humans, with the left hemisphere of the prefrontal cortex sometimes being implicated more in positive affect than the right hemisphere (Davidson, 2004). For example, individuals who give higher ratings of subjective well-being may have higher activity in the left prefrontal cortex, and left subcortical striatal activity is also more tightly linked to pleasantness ratings in some studies than right-side activity (Price & Harmon-Jones, 2011; Kuhn & Gallinat, 2012; Lawrence, Hinton, Parkinson, & Lawrence, 2012). However, many other studies have found more equal bilateral activity patterns and so the precise role of lateralization in pleasure still remains somewhat unclear.

"Wanting" Mechanisms Are Separable from "Liking" Mechanisms

People typically want things that they like. From the brain's point of view, in addition to liking mechanisms, pleasure must be translated into motivational processes in part by activating a second component of reward, which turns out to be psychologically distinct from pleasure, even if often also associated as occurring together with pleasant events. This second component is termed "wanting" or incentive salience, which is attributed to perceived stimuli and events (or vivid imagery) that are related to rewards. Incentive salience is generated by mesolimbic brain systems, and makes targeted stimuli become attractive and motivating, at high intensities even to the point of compelling temptation (Berridge & Robinson, 2003). Incentive salience depends in particular on mesolimbic dopamine neurotransmission between select regions of the pleasure network, although opioid and other neurotransmitter mechanisms widely distributed throughout the nucleus accumbens and related structures are also involved.

Incentive salience is a "wanting" (in quotes) process that is just one of several types of what is meant ordinarily by the word wanting (no quotes). As a distinct module, incentive salience is psychologically most visible in its cue-triggered "wanting" and motivational magnet effects that cause individuals to be strongly attracted to particular reward stimuli. By comparison, "cognitive wanting," in the more familiar sense of the word, is quite a different form of desire. If one has a cognitive want, one has a conscious desire for a specific reward—one knows what one wants. Cognitive wanting has declarative goals, involving explicit expectations of future outcomes. Incentive salience "wanting" has causes and targets, but not so much explicit goals except to the degree that incentive salience can color cognitive desires. When the two forms of desire are congruent, "wanting" adds a visceral "oomph" to cognitive desires. Ordinarily, "wanting" and wanting work together toward the same incentives, but in certain situations the two psychological processes can be momentarily dissociated. This decoupling may become especially problematic in addiction.

Most important, incentive salience is not hedonic impact or pleasure "liking" (Berridge, 2007). This is why an addicted individual can "want" a reward without necessarily "liking" the same reward. Irrational "wanting" without "liking" can occur, especially in addiction via incentive sensitization of the mesolimbic dopamine system and connected structures (Robinson & Berridge, 2003). At an extreme, the addict may come to "want" what is neither liked nor expected to be liked, a dissociation possible because "wanting" mechanisms are largely subcortical and separable from cortically mediated declarative expectation and conscious planning. This is a reason why addicts may compulsively "want" to take drugs even if, at a more cognitive and conscious level, they do not want to do so.

Motivational Salience: A Building Block Shared Between Desire and Dread?

"Wanting" an object of desire seems a completely different psychological process from fear of something we perceive to be a potential threat. These are diametrically opposite emotions in terms of their affective valence: One is positively valenced, the other negatively valenced. But desire and dread may share something in common at the level of the brain, and possibly at the level of a psychological building block shared by both. A frightening stimulus is attention grabbing and compels a motivated response of avoidance, almost as an incentive stimulus does, but is perceived as threatening or sinister.

Incentive salience may thus have a negatively valenced equivalent in fearful salience. Both may be generated by brain circuitry involving the nucleus accumbens, in the form of a motivational salience process whose affective valence can even be flipped between positive and negative. Affective neuroscience experiments have produced this flexible motivation in rats, by tapping an appropriate emotional key on a limbic keyboard, done through a cortical signal-blocking microinjection placed in the nucleus accumbens. One part of the nucleus accumbens (called the medial shell) is arranged as an emotional keyboard, front to back, that organizes incoming signals about the outside world. Tapping keys in the front of this structure elicits strong desires, for example, stimulating intense eating and creating a desire to return to the place where the keys were tapped (Reynolds & Berridge, 2008). Tapping keys located farther in the back conversely elicits strongly fearful behavior (antipredator reactions to the sight or touch of people, sometimes accompanied by fearful squealing and escape attempts, or even attempts to bite a person who touches the rat that is normally quite tame).

Desire and dread are opposite emotions, but taps in the middle of the accumbens keyboard reliably elicit both together. For example, intense increases in appetitive eating and intense fearful reactions may be emitted by the same rat in the same hour following the microinjection in the middle of its nucleus accumbens. This observation of emotional ambivalence first made us wonder whether a shared motivational salience mechanism might contribute to generate both fear and desire, so that they could closely overlap in the mechanism. If so, we hoped it might be possible to flip the intermediate neural key in the accumbens back and forth between generating fear and generating desire, as a flexible psychological building block, depending on the psychological context in which it was activated (Reynolds & Berridge, 2008).

This shared mechanism possibility was tested by comparing the motivational effects of the nucleus accumbens microinjections in two emotionally opposite situations: either a soothing ambience (the rat's own home room, dark and quiet, and with familiar smells) or a stressful ambience (a brightly lit room that played a loud soundtrack of punk rock music). The results showed that microinjection taps at many middle keys in the nucleus accumbens were found to switch between producing intense desire and intense dread. In the comfortable situation, most taps produced desire. In the stressful situation, the same taps in the nucleus accumbens instead produced mostly fearful reactions. Some brain sites flipped completely, changing from purely fear generating to purely desire generating, or vice versa. This is consistent with the possibility that a common psychological operation exists in both as a truly flexible building block.

The psychological flip involves a neurobiological switch too. Subsequent studies have found that when a nucleus accumbens site psychologically flips between generating desire versus dread, the site also neurobiologically flips in its use of dopamine signals by neurons in the location of the microinjection. Dopamine is used by the nucleus accumbens to generate both emotions, but in different ways (Faure, Reynolds, Richard, & Berridge, 2008)—that is, dopamine is sensed by two different classes of neuronal receptors (called D_1 receptors vs. D_2 receptors) that modulate the neuron in distinct ways. When the nucleus accumbens generates incentive salience, after a rat receives a nucleus accumbens tap in a situation of comfortable ambience, its neurons in the vicinity of the microinjection require only the D_1 type of dopamine signal to produce the intense desire (Richard & Berridge, 2011). By contrast, the same neurons require both the D_1 type and D_2 type of dopamine stimulation to generate dread, after the same microinjection tap in a stressfully stimulating situation (Richard & Berridge, 2011). Thus, the same anatomical building block in nucleus accumbens appears to flip between neurobiological modes in order to generate two emotional states of opposite valence. Although the idea that desires and fears may share the same psychological kernel, in the form of a motivational salience process that is able to flip valence, seems counterintuitive, it does fit with other evidence that the brain shares overlapping circuitry in generating quite diverse emotions (Lindquist, Wager, Kober, et al., 2012).

Conclusion

Brain systems for liking generate many sensory pleasures as well as abstract social and cognitive pleasures that help to make life so rewarding. The same hedonic brain systems may even generate or contribute to the sustained and free-floating sense of hedonic well-being that characterizes human happiness—at least in those individuals lucky enough to be happy.

Thus, one way to conceive of hedonic happiness is as "liking" without "wanting." That would be a state of pleasure without disruptive desires, a state of contentment (Kringelbach & Berridge, 2009). A different possibility is that moderate "wanting," matched to positive "liking," facilitates engagement with the world. A little incentive salience may add zest to the perception of life and perhaps even promote the construction of meaning, just as in some patients therapeutic deep brain stimulation may help lift the veil of depression or the suffering of chronic pain by making life events more appealing. However, too much "wanting" can readily spiral into maladaptive patterns such as addiction, and is a direct route to great unhappiness. Thus, gaining a clearer picture of how the brain mediates pleasure-"liking" and motivation-"wanting" components of reward thus has implications for understanding many emotional experiences. These experiences range from basic sensory pleasures to the most abstract emotions and states of well-being.

References

Aldridge, J. W., Berridge, K. C., Herman, M., & Zimmer, L. (1993). Neuronal coding of serial order: Syntax of grooming in the neostriatum. *Psychological Science, 4*, 391–395.

Amodio, D. M., & Frith, C. D. (2006). Meeting of minds: The medial frontal cortex and social cognition. *Nature Reviews Neuroscience, 7*(4), 268–277.

Aristotle. (2009). *The Nicomachean ethics* (D. Ross, Trans.). Oxford, UK: Oxford University Press. (Original work published 350 B.C.E.)

Barrett, L. F., & Wager, T. D. (2006). The structure of emotion: Evidence from neuroimaging studies. *Current Directions in Psychological Science, 15*(2), 79–83.

Beauregard, M., & Paquette, V. (2006). Neural correlates of a mystical experience in Carmelite nuns. *Neuroscience Letters, 405*(3), 186–190.

Beckmann, M., Johansen-Berg, H., & Rushworth, M. F. S. (2009). Connectivity-based parcellation of human cingulate cortex and its relation to functional specialization. *Journal of Neuroscience, 29*(4), 1175–1190.

Berridge, K. C. (2007). The debate over dopamine's role in reward: The case for incentive salience. *Psychopharmacology, 191*(3), 391–431.

Berridge, K. C., & Fentress, J. C. (1986). Contextual control of trigeminal sensorimotor function. *Journal of Neuroscience, 6*(2), 325–330.

Berridge, K. C., Ho, C. Y., Richard, J. M., & DiFeliceantonio, A. G. (2010). The tempted brain eats: Pleasure and desire circuits in obesity and eating disorders. *Brain Research, 1350*, 43–64.

Berridge, K. C., & Kringelbach, M. L. (2011). Building a neuroscience of pleasure and well-being. *Psychology of Well-Being, 1*(1), 1–3.

Berridge, K. C., & Robinson, T. E. (2003). Parsing reward. *Trends in Neurosciences, 26*(9), 507–513.

Berridge, K. C., Robinson, T. E., & Aldridge, J. W. (2009). Dissecting components of reward: "Liking," "wanting," and learning. *Current Opinion in Pharmacology, 9*(1), 65–73.

Berridge, K. C., & Winkielman, P. (2003). What is an unconscious emotion? (The case for unconscious "liking"). *Cognition and Emotion, 17*(2), 181–211.

Biswas-Diener, R., Kashdan, T. B., & King, L. A. (2009). Two traditions of happiness research, not two distinct types of happiness. *Journal of Positive Psychology, 4*(3), 208–211.

Blood, A. J., & Zatorre, R. J. (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proceedings of the National Academy of Sciences USA, 98*(20), 11818–11823.

Castro, D. C., & Berridge, K. C. (2013). *Optogenetic enhancement of food "liking" versus "wanting" in the ventral pallidum hotspot and lateral hypothalamus*. Paper presented at the Society for Neuroscience Conference, San Diego, CA.

Clore, G. L., & Ortony, A. (2000). Cognition in emotion: Always, sometimes, or never? In R. D. Lane, L. Nadel, & G. Ahern (Eds.), *Series in Affective Science: Cognitive neuroscience of emotion* (pp. 24–61). New York: Oxford University Press.

Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. *Nature Reviews Neuroscience, 3*(8), 655–666.

Damasio, A., Damasio, H., & Tranel, D. (2012). Persistence of feelings and sentience after bilateral damage of the insula. *Cerebral Cortex, 23*(4), 833–846.

Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness*. New York: Harcourt Brace.

Davidson, R. J. (2004). Well-being and affective style: Neural substrates and biobehavioural correlates. *Philosophical Transactions of the Royal Society B: Biological Sciences, 359*(1449), 1395–1411.

Diener, E. (2012). New findings and future directions for subjective well-being research. *American Psychologist, 67*(8), 590–597.

Diener, E., Kesebir, P., & Lucas, R. (2008). Benefits of accounts of well-being: For societies and for psychological science. *Applied Psychology: An International Review, 57*, 37–53.

Ellsworth, P. C., & Scherer, K. R. (2003). Appraisal processes in emotion. In R. J. Davidson, H. H. Goldsmith, & K. R. Scherer (Eds.), *Handbook of affective sciences* (pp. 572–595). New York: Oxford University Press.

Faure, A., Reynolds, S. M., Richard, J. M., & Berridge, K. C. (2008). Mesolimbic dopamine in desire and dread: Enabling motivation to be generated by localized glutamate disruptions in nucleus accumbens. *Journal of Neuroscience, 28*(28), 7184–7192.

Freud, S. (1930). *Civilization and its discontents* (J. Strachey, Trans.). New York: Norton.

Frijda, N. (2010). On the nature and function of pleasure. In M. L. Kringelbach & K. C. Berridge (Eds.), *Pleasures of the brain* (pp. 99–112). Oxford, UK: Oxford University Press.

Friston, K., & Kiebel, S. (2009). Predictive coding under the free-energy principle. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1521), 1211–1221.

Georgiadis, J. R., Kringelbach, M. L., & Pfaus, J. G. (2012). Sex for fun: A synthesis of human and animal neurobiology. *Nature Reviews Urology, 9*, 486–498.

Gilbert, D. T. (2006). *Stumbling on happiness*. New York: Knopf.

Gottfried, J. (2010). Olfaction and its pleasures: Human neuroimaging perspectives. In M. L. Kringelbach & K. C. Berridge (Eds.), *Pleasures of the brain* (pp. 125–145). Oxford, UK: Oxford University Press.

Grill, H. J., & Norgren, R. (1978a). The taste reactivity test: I. Mimetic responses to gustatory stimuli in neurologically normal rats. *Brain Research, 143*(2), 263–279.

Grill, H. J., & Norgren, R. (1978b). The taste reactivity test: II. Mimetic responses to gustatory stimuli in chronic thalamic and chronic decerebrate rats. *Brain Research, 143*(2), 281–297.

Harris, S., Kaplan, J. T., Curiel, A., Bookheimer, S. Y., Iacoboni, M., & Cohen, M. S. (2009). The neural correlates of religious and nonreligious belief. *PLoS ONE, 4*(10), e7272.

Heimer, L., Van Hoesen, G. W., Trimble, M., & Zahm, D. S. (2008). *Anatomy of neuropsychiatry: The new anatomy of the basal forebrain and its implications for neuropsychiatric illness*. Amsterdam: Elsevier/Academic Press.

Heller, A. S., van Reekum, C. M., Schaefer, S. M., Lapate, R. C., Radler, B. T., Ryff, C. D., et al. (2013). Sustained striatal activity predicts eudaimonic well-being and cortisol output. *Psychological Science, 24*(11), 2191–2200.

Ho, C.-Y., & Berridge, K. C. (2014). Excessive disgust caused by brain lesions or temporary inactivations: Mapping hotspots of the nucleus accumbens and ventral pallidum. *European Journal of Neuroscience, 40*, 3556–3572.

Hornak, J., O'Doherty, J., Bramham, J., Rolls, E. T., Morris, R. G., Bullock, P. R., et al. (2004). Reward-related reversal learning after surgical excisions in orbito-frontal or dorsolateral prefrontal cortex in humans. *Journal of Cognitive Neuroscience, 16*(3), 463–478.

Jayawickreme, E., Forgeard, M. J. C., & Seligman, M. E. P. (2012). The engine of well-being. *Review of General Psychology, 16*(4), 327–342.

Kahneman, D., Diener, E., & Schwarz, N. (Eds.). (1999). *Well-being: The foundations of hedonic psychology*. New York: Sage Foundation.

Kahneman, D., Krueger, A. B., Schkade, D., Schwarz, N., & Stone, A. A. (2006). Would you be happier if you were richer?: A focusing illusion. *Science, 312*(5782), 1908–1910.

Kringelbach, M. L. (2005). The human orbitofrontal cortex: Linking reward to hedonic experience. *Nature Reviews Neuroscience, 6*(9), 691–702.

Kringelbach, M. L. (2010). The hedonic brain: A functional neuroanatomy of human pleasure. In M. L. Kringelbach & K. C. Berridge (Eds.), *Pleasures of the brain* (pp. 202–221). Oxford, UK: Oxford University Press.

Kringelbach, M. L., & Berridge, K. C. (2009). Towards a functional neuroanatomy of pleasure and happiness. *Trends in Cognitive Sciences, 13*(11), 479–487.

Kringelbach, M. L., & Berridge, K. C. (2010a). The functional neuroanatomy of pleasure and happiness. *Discovery Medicine, 9*(49), 579–587.

Kringelbach, M. L., & Berridge, K. C. (Eds.). (2010b). *Pleasures of the brain*. Oxford, UK: Oxford University Press.

Kringelbach, M. L., de Araujo, I. E., & Rolls, E. T. (2004). Taste-related activity in the human dorsolateral prefrontal cortex. *NeuroImage, 21*(2), 781–788.

Kringelbach, M. L., O'Doherty, J., Rolls, E. T., & Andrews, C. (2003). Activation of the human orbitofrontal cortex to a liquid food stimulus is correlated with its subjective pleasantness. *Cerebral Cortex, 13*(10), 1064–1071.

Kringelbach, M. L., & Rolls, E. T. (2004). The functional neuroanatomy of the human orbitofrontal cortex: Evidence from neuroimaging and neuropsychology. *Progress in Neurobiology, 72*(5), 341–372.

Kuhn, S., & Gallinat, J. (2012). The neural correlates of subjective pleasantness. *NeuroImage, 61*(1), 289–294.

Kuppens, P., Realo, A., & Diener, E. (2008). The role of positive and negative emotions in life satisfaction judgment across nations. *Journal of Personality and Social Psychology, 95*(1), 66–75.

Lambie, J. A., & Marcel, A. J. (2002). Consciousness and the varieties of emotion experience: A theoretical framework. *Psychological Review, 109*(2), 219–259.

Lawrence, N. S., Hinton, E. C., Parkinson, J. A., & Lawrence, A. D. (2012). Nucleus accumbens response to food cues predicts subsequent snack consumption in women and increased body mass index in those with reduced self-control. *NeuroImage, 63*(1), 415–422.

Leknes, S., & Tracey, I. (2010). Pleasure and pain: Masters of mankind. In M. L. Kringelbach & K. C. Berridge (Eds.), *Pleasures of the brain* (pp. 320–336). Oxford, UK: Oxford University Press.

Lindquist, K. A., Wager, T. D., Bliss-Moreau, E., Kober, H., & Barrett, L. F. (2012). What are emotions and how are they created in the brain? *Behavioral and Brain Sciences, 35*(03), 172–202.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*(3), 121–143.

Mahler, S. V., Smith, K. S., & Berridge, K. C. (2007). Endocannabinoid hedonic hotspot for sensory pleasure: Anandamide in nucleus accumbens shell enhances "liking" of a sweet reward. *Neuropsychopharmacology, 32*(11), 2267–2278.

Mennella, J. A., Forestell, C. A., Morgan, L. K., & Beauchamp, G. K. (2009). Early milk feeding influences taste acceptance and liking during infancy. *American Journal of Clinical Nutrition, 90*(3), 780S–788S.

Mill, J. S. (1998). *Utilitarianism*. New York: Oxford University Press. (Original work published 1861)

O'Doherty, J., Kringelbach, M. L., Rolls, E. T., Hornak, J., & Andrews, C. (2001). Abstract reward and punishment representations in the human orbitofrontal cortex. *Nature Neuroscience, 4*, 95–102.

Panksepp, J. (2011). Cross-species affective neuroscience decoding of the primal affective experiences of humans and related animals. *PLoS ONE, 6*(9), e21236.

Peciña, S. (2008). Opioid reward "liking" and "wanting" in the nucleus accumbens. *Physiology and Behavior, 94*(5), 675–680.

Peciña, S., & Berridge, K. C. (2005). Hedonic hot spot in nucleus accumbens shell: Where do mu-opioids cause increased hedonic impact of sweetness? *Journal of Neuroscience, 25*(50), 11777–11786.

Peciña, S., & Smith, K. S. (2010). Hedonic and motivational roles of opioids in food reward: Implications for overeating disorders. *Pharmacology Biochemistry and Behavior, 97*(1), 34–46.

Peciña, S., Smith, K. S., & Berridge, K. C. (2006). Hedonic hot spots in the brain. *Neuroscientist, 12*(6), 500–511.

Peterson, C., & Park, N. (2009). Increasing happiness in lasting ways. *Psychologist, 22*(4), 304–307.

Price, T. F., & Harmon-Jones, E. (2011). Approach motivational body postures lean toward left frontal brain activity. *Psychophysiology, 48*(5), 718–722.

Reynolds, S. M., & Berridge, K. C. (2008). Emotional environments retune the valence of appetitive versus fearful functions in nucleus accumbens. *Nature Neuroscience, 11*(4), 423–425.

Richard, J. M., & Berridge, K. C. (2011). Nucleus accumbens dopamine/glutamate interaction switches modes to generate desire versus dread: D_1 alone for appetitive eating but D_1 and D_2 together for fear. *Journal of Neuroscience, 31*(36), 12866–12879.

Richard, J. M., Castro, D. C., DiFeliceantonio, A. G., Robinson, M. J., & Berridge, K. C. (2013). Mapping brain circuits of reward and motivation: In the footsteps of Ann Kelley. *Neuroscience and Biobehavioral Reviews, 37*(9), 1919–1931.

Robinson, T. E., & Berridge, K. C. (2003). Addiction. *Annual Review of Psychology, 54*(1), 25–53.

Rozin, P. (1999). Preadaptation and the puzzles and properties of pleasure. In D. Kahneman, E. Diener, & N. Schwarz (Eds.), *Well-being: The foundations of hedonic psychology* (pp. 109–133). New York: Sage Foundation.

Rozin, P., Haidt, J., & Fincher, K. (2009). Psychology: From oral to moral. *Science, 323*(5918), 1179–1180.

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology, 76*(5), 805–819.

Ryle, G. (1954). Pleasure. *Proceedings of the Aristotelian Society, 28*, 135–146.

Salimpoor, V. N., Benovoy, M., Larcher, K., Dagher, A., & Zatorre, R. J. (2011). Anatomically distinct dopamine release during anticipation and experience of peak emotion to music. *Nature Neuroscience, 14*(2), 257–262.

Seligman, M. E. P., Railton, P., Baumeister, R. F., & Sripada, C. (2013). Navigating into the future or driven by the past. *Perspectives on Psychological Science, 8*(2), 119–141.

Skov, M. (2010). The pleasures of art. In M. L. Kringelbach & K. C. Berridge (Eds.), *Pleasures of the brain* (pp. 270–286). Oxford, UK: Oxford University Press.

Small, D. M., Zatorre, R. J., Dagher, A., Evans, A. C., & Jones-Gotman, M. (2001). Changes in brain activity related to eating chocolate: From pleasure to aversion. *Brain, 124*, 1720–1733.

Smith, K. S., & Berridge, K. C. (2005). The ventral pallidum and hedonic reward: Neurochemical maps of sucrose "liking" and food intake. *Journal of Neuroscience, 25*(38), 8637–8649.

Smith, K. S., & Berridge, K. C. (2007). Opioid limbic circuit for reward: Interaction between hedonic hotspots of nucleus accumbens and ventral pallidum. *Journal of Neuroscience, 27*(7), 1594–1605.

Smith, K. S., Berridge, K. C., & Aldridge, J. W. (2011). Disentangling pleasure from incentive salience and learning signals in brain reward circuitry. *Proceedings of the National Academy of Sciences USA, 108*(27), E255–E264.

Smith, K. S., Mahler, S. V., Peciña, S., & Berridge, K. C. (2010). Hedonic hotspots: Generating sensory pleasure in the brain. In M. L. Kringelbach & K. C. Berridge (Eds.), *Pleasures of the brain* (pp. 27–49). Oxford, UK: Oxford University Press.

Soderpalm, A. H., & Berridge, K. C. (2000). The hedonic impact and intake of food are increased by midazolam microinjection in the parabrachial nucleus. *Brain Research, 877*(2), 288–297.

Steiner, J. E. (1973). The gustofacial response: Observation on normal and anencephalic newborn infants. *Symposium on Oral Sensation and Perception, 4*, 254–278.

Steiner, J. E., Glaser, D., Hawilo, M. E., & Berridge, K. C. (2001). Comparative expression of hedonic impact: Affective reactions to taste by human infants and other primates. *Neuroscience and Biobehavioral Reviews, 25*(1), 53–74.

Urry, H. L., Nitschke, J. B., Dolski, I., Jackson, D. C., Dalton, K. M., Mueller, C. J., et al. (2004). Making a life worth living: Neural correlates of well-being. *Psychological Science, 15*(6), 367–372.

Veldhuizen, M. G., Rudenga, K. J., & Small, D. (2010). The pleasure of taste flavor and food. In M. L. Kringelbach & K. C. Berridge (Eds.), *Pleasures of the brain* (pp. 146–168). Oxford, UK: Oxford University Press.

Vollm, B. A., de Araujo, I. E., Cowen, P. J., Rolls, E. T., Kringelbach, M. L., Smith, K. A., et al. (2004). Methamphetamine activates reward circuitry in drug naive human subjects. *Neuropsychopharmacology, 29*(9), 1715–1722.

Vuust, P., & Kringelbach, M. L. (2010). The pleasure of music. In M. L. Kringelbach & K. C. Berridge (Eds.), *Pleasures of the brain* (pp. 255–269). Oxford, UK: Oxford University Press.

Wilson-Mendenhall, C. D., Barrett, L. F., & Barsalou, L. W. (2013). Neural evidence that human emotions share core affective properties. *Psychological Science, 24*(6), 947–956.

Winkielman, P., Berridge, K. C., & Wilbarger, J. L. (2005). Unconscious affective reactions to masked happy versus angry faces influence consumption behavior and judgments of value. *Personality and Social Psychology Bulletin, 31*(1), 121–135.

Zhang, J., Berridge, K. C., Tindell, A. J., Smith, K. S., & Aldridge, J. W. (2009). A neural computational model of incentive salience. *PLoS Computational Biology, 5*(7), e1000437.

CHAPTER 8

Neural Fingerprinting

Meta-Analysis, Variation, and the Search for Brain-Based Essences in the Science of Emotion

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Scholars have been interested in the physical basis of emotion for as long as they have been questioning how the human mind works. For the vast majority of this time, their examinations began with phenomenologically inspired categories (called folk psychology categories; Aristotle & Bostock, 1994). Whether they were searching in the heart or the brain, ancient scholars—including Hippocrates, Aristotle, and Descartes—attempted to find a biological "fingerprint" that was specific to each one. In the 19th century, as psychology emerged as a distinct, scientific discipline, researchers began to augment these subjective assessments with more quantitative data, using tools from physiology, neurology, and anatomy. It was merely assumed that the structure of experience would be revealed in the structure of biology so that these fingerprints could be used objectively (without a perceiver) to distinguish one category from another.

A century of experimentation has taught us, however, that there is tremendous variation in the physical manifestations of emotion categories, and that our experiences may not be the best guide for revealing the underlying processes that cause them. For example, there is substantial variation in the autonomic physiology associated with different instances within the same emotion category (Cacioppo, Tassinary, & Berntson, 2000; Siegel, Sands, Condon, Chang, Dy, et al., 2015). Some of this variation is, surely, methodological—the byproduct of weak emotion inductions, poor experimental methods, and insensitive statistical tools (cf. Ekman, 2004; Friedman, 2010; Levenson, 2011, 2014; Stemmler, 1989). Some might also be due to the fact that, until recently, we have been limited to "downstream organs" (the autonomic nervous system, facial muscle movements, vocal acoustics) rather than the source of emotion: the brain. An additional hypothesis, however, is that some of this variation might also be *meaningful* (i.e., inherent in the underlying phenomenon), and thus a feature for which we must account in our theoretical frameworks and methodological approaches (Barrett, 2006, 2009, 2013; Cacioppo et al., 2000; Siegel et al., 2015).

With the advent of modern neuroimaging, scientists are now able to study emotion in ways that previous generations would never have thought possible, peering into the brains of living, breathing humans, in near real time, as they experience and perceive emotion. This has afforded us an unprecedented opportunity to address the physical basis of emotion in humans and ask whether there is there real physical variability within instances of the same category, as well as similarities across categories we believe to be psychologically distinct—possibilities that would fundamentally change the way we've understood emotion for centuries.

In this chapter, we summarize more than 20 years of neuroimaging research on emotion to examine the degree to which (1) positive versus negative affect, (2) individual emotion categories (e.g., anger, sadness, fear), and (3) emotion generation versus emotion regulation are associated with distinct neural fingerprints. In so doing, we emphasize the results of meta-analyses of the relevant literatures. Meta-analyses are powerful tools, both for testing existing hypotheses about the brain basis of psychological phenomena, and also for identifying networks in the brain that show a consistent increase in activity during emotion where none may have been expected. After examining each question in turn, we use the meta-analyses generatively, to offer new hypotheses for examining the brain basis of affect and emotion.

Can Positivity and Negativity Be Distinguished in the Brain?

"Valence"—the dimension that differentiates good from bad, positive from negative, appealing from appalling—is a fundamental psychological property. Every waking moment of life can be described as having some degree of valence (Barrett & Russell, 1998, 1999; Bradley, Codispoti, Cuthbert, & Lang, 2001; Feldman, 1995; Larsen & Diener, 1992; Watson & Tellegen, 1985). Valence is not emotion, but it is related to it. We tend to associate positivity and negativity with particular emotions, but this need not be so. You can feel pleasantly happy or unpleasantly happy, furiously angry or exuberantly angry, dreadfully afraid or excitedly afraid (Wilson-Mendenhall, Barrett, & Barsalou, 2014). The deliciousness of a drink, the distastefulness of the food you dislike, the fatigue you feel after not enough sleep or exercise—these are also moments with positivity or negativity that many scientists would not call "emotion." Valence is universal, unlike emotion, whose universality is debated (see Gendron, Roberson, van der Vyver, & Barrett, 2014a, 2014b; Gendron, Roberson, & Barrett, 2015; Sauter, Eisner, Ekman, & Scott, 2010, 2015; Osgood, 1952; Osgood, May, & Miron, 1975; Russell, 1991; Wierzbicka, 1992, for examples and discussion). Valence is also ubiquitous across the developmental spectrum; from birth, infants can feel pleasure and pain, comfort and discomfort (e.g., Lewis, 1993). From just a few days old, they may also be able to differentiate these states in others as well (Farroni, Menon, Rigato, & Johnson, 2007), although they are not able to differentiate emotions until many months (Kotsoni, de Haan, & Johnson, 2001) or years (Widen & Russell, 2008) later. Despite valence's broad relevance, however, and the hundreds of studies in which it has been a primary focus, there is still little consensus about how positivity and negativity are related to each other (e.g., whether they must be inversely correlated, or whether they can be experienced simultaneously), and how they are each instantiated within the brain (see Barrett & Bliss-Moreau, 2009, for a review).

The Underlying Structure of Valence: Testing the Bipolarity, Bivalence, and Affective Workspace Models

To date, three distinct hypotheses have been advanced for how positivity and negativity are represented in neural activity. The first (and most intuitive) hypothesis is the *bipolarity hypothesis*. The bipolarity hypothesis, originally described by Wundt (1897/1998), proposes that positivity and negativity anchor opposite ends of a single dimension (Barrett & Russell, 1998, 1999; Russell, 1980). It has received support from hundreds of studies of semantics, self-reports of experience, and emotion perception in faces and vocal acoustics, which have reported positive and negative valence to be strongly negatively correlated (see Barrett & Bliss-Moreau, 2009; Larsen & Diener, 1992; Osgood et al., 1975; Barrett & Russell, 1999; Russell, 2003, for reviews). At the level of the brain, the bipolarity hypothesis suggests that neurons that encode affect should encode the relative valence (e.g., increasing in response to positive events and decreasing in response to negative ones). Translated into a neuroimaging context, brain "voxels" (a volume of tissue encompassing approximately 5.5 million neurons) associated with increased positive affect should also be associated with reduced negative affect, and vice versa (i.e., voxels should respond monotonically across affective valence (positive > neutral > negative, or negative > neutral > positive; Lindquist, Satpute, Wager, Weber, & Barrett, 2015).

The *bivalence hypothesis* proposes that positivity and negativity are two *separate*, bipolar, but independent, dimensions—one each for positive and negative valence (Cacioppo, Gardner, & Berntson, 1999; Norris, Golan, Berntson, & Cacioppo, 2010; Watson & Tellegen, 1985). This hypothesis was formulated in response to, and is supported by, the observation that self-reports of subjective positivity and negativity are often uncorrelated—

not negatively correlated (as would be expected based on the bipolarity hypothesis; Larsen, McGraw, Mellers, & Cacioppo, 2004; Larsen, McGraw, & Cacioppo, 2001; Watson & Clark, 1997; Zautra, Potter, & Reich, 1997; although see Barrett & Russell, 1998; Russell & Carroll, 1999, for methodological explanations for the correlational patterns). The bivalence model makes specific predictions about the nature of the physical systems necessary to produce these dimensions, positing that there should exist separate physical mechanisms within the brain (e.g., Cacioppo, Crites, Berntson, & Coles, 1993; Berntson & Cacioppo, 2008; Norman et al., 2011). This could take the form of spatially separate regions or networks, one exclusively responding to represent positivity and one exclusively responding to represent negativity.[1]

Finally, the *affective workspace* hypothesis predicts that both positive and negative affects are the product of a valence-general system, within which neurons combine in a probabilistic and context-dependent fashion (Barrett & Bliss-Moreau, 2009). Whereas the bipolar and bivalence hypotheses originated from behavioral and self-report data, the affective workspace hypothesis is grounded in observations from the neuroscience literature that there is significant heterogeneity (variability) across instances of both positivity and negativity, in terms of how they are represented within the brain (Barrett & Bliss-Moreau, 2009). Specifically, no single region or structure appeared to be consistently and specifically associated with either positive or negative affect, suggesting that the same areas might somehow give rise to both phenomena. The affective workspace hypothesis also draws on the concept of degeneracy, which is the ability of a system to take on "many-to-one" structure–function mappings (Edelman & Gally, 2001). Degeneracy allows a system to be both flexible and efficient, and it has previously been identified within both genetic and immunological systems (Friston & Price, 2003).[2]

As applied to the brain basis of valence, degeneracy means that positivity and negativity can be represented by any number of distinct neural assemblies, the nature of which, in any particular instance, is contextually determined. Within the data from a given experiment (or set of experiments) therefore, one would expect valence-responsive regions to be associated with both positive and negative affect. One would also expect significant variation across specific instances (trials, or studies), in terms of how positive and negative affects are represented. For example, a specific set of voxels need not participate in every instance of, say, positivity, or even in the exact same instance at two different points in time. Rather than a one-to-one structure–function mapping between specific brain networks and positivity or negativity, therefore, the affective workspace hypothesis proposes that instances of positivity and negativity are represented probabilistically as different neural assemblies within a population of neurons (the workspace), so that instances of positivity or negativity should be modeled as a "brain state"[3] rather than as activity in a specific region or network (see Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012; Salzman & Fusi, 2010; Edelman, 1989, for a discussion of brain state or workspace reasoning).

Evidence for the Affective Workspace Hypothesis

We recently completed a meta-analysis to test these three hypotheses about the brain basis of positivity and negativity, using a database of 397 neuroimaging studies (functional magnetic resonance imaging [fMRI] and positron emission tomography [PET]) of affective and discrete emotional experiences and perceptions published between 1993 and 2011 (Lindquist et al., 2015). First, we identified voxels that consistently showed an increase in activity during both positivity and negativity (*both* positive > neutral and negative > neutral contrasts; see Table 8.1). Voxels fitting this profile would be consistent with the pattern predicted by the affective workspace hypothesis, which predicts that both positive and negative affect are the product of a single, valence-general system. A wide swath of regions were identified, including many of those that we typically think of as related to affect: the anterior insula, orbitofrontal cortex (OFC), amygdala, ventral striatum, thalamus, and dorsal anterior cingulate cortex, plus a few others, such as the dorsomedial prefrontal cortex, ventrolateral prefrontal cortex, and lateral portions of the right temporal/occipital cortex (Plate 8.1; see color insert for plates).

To test the remaining hypotheses, these voxels (responding during both positive affect and negative affect relative to neutral affect) were first masked out, since they violate both the monotonic relationship predicted by bipolarity, and the independence criterion central to bivalence. To identify regions that fit the profile outlined by the bipolarity hypothesis, we searched for voxels in which there was greater activity when one type of valence was contrasted with the other as opposed

TABLE 8.1. Hypotheses Regarding the Structure of Valence

Hypothesis	Description	Support would be found if . . .	How this has been operationalized
Bipolarity	Valence is a single, bipolar dimension, anchored at either end by positivity and negativity.	A given region, network, or population of neurons responds monotonically as affect changes from positive to neutral to negative (or vice versa).	1. Mask out voxels responsive to both positive and negative affect inductions. 2. Identify voxels in which there is greater activity when one type of valence was compared against another as opposed to against neutral (e.g., *positive affect vs. negative affect* > *positive affect vs. neutral*).
Bivalence	Valence comprises two unipolar dimensions, ranging from neutral to positive and neutral to negative.	Spatially independent regions, networks, or populations of neurons could be identified that demonstrated consistent changes in activity for either positivity, or negativity, but not the other.	1. Mask out voxels responsive to both positive and negative affect inductions. 2. Identify voxels outside of this area that are more responsive to positive versus negative affect, and negative versus positive (e.g., *positive affect vs. negative; negative affect vs. positive*). 3. Compare the positive versus negative and negative versus positive contrasts to contrasts of positive affect versus neutral, or negative affect versus neutral (e.g., *positive affect vs. neutral; negative affect vs. neutral*). Keep only those regions that are more responsive to positive versus negative than positive versus neutral (and the same for negative contrasts).
Affective workspace	Valence is realized in a probabilistic, whole-brain fashion, where the specific population responsive to positivity or negativity in a given instance is dependent on context.	Regions, networks, or populations of neurons were shown to be responsive to both positivity and negativity, with their functional preference dependent on the context in which the response was elicited.	1. Identify voxels responsive to both positive and negative affect inductions. Compute a conjunction of positive versus neutral and negative versus neutral contrasts (the "affective workspace"). 2. Identify voxels with functional specificity for positivity or negativity, by searching *within* the affective workspace for regions sensitive to positivity (*positive vs. negative*) and negativity (*negative vs. positive*). (Lindquist et al., 2015)

Note. This violates the expectations of both the bipolarity hypothesis, which would not allow for positivity and negativity to be encoded at once, and the bivalence hypothesis, which would allow for the simultaneous representation of both positive and negative valence, but not in the same cells.

to with a neutral stimulus (e.g., positive affect vs. negative affect > positive affect vs. neutral). Only one set of voxels met this criterion: a cluster in the ventromedial prefrontal cortex (vmPFC) with adjacent voxels in the anterior cingulate cortex (ACC); these voxels were more frequently active in response to positively relative to negatively valenced stimuli.[4] To identify regions that fit the profile for bivalence, we compared negative affect > positive affect, and further compared the probability of these activations to study contrasts of positive affect > neutral affect. No voxels were found that matched the hypothesized pattern.

Even if individual voxels are not selective for positive or negative affect, however, it is still possible that affect is represented at the population level, in terms of patterns of activity distributed across voxels and networks. To investigate this possibility, Lindquist and colleagues (2015) performed a classification analysis using the same meta-analytic database, in which they tried to differentiate negative versus neutral and positive versus neutral contrasts using a simple support vector machine (Chang & Lin, 2011). They found that the classifier was unable to diagnose whether individual contrast maps represented activation during negative versus neutral or positive versus neutral contrasts, with an average accuracy of only 53%. Together with the other results, this suggests that across paradigms, stimuli, modalities, and populations, the representations of positive and negative valence cannot be differentiated in the brain, at least at the level of granularity that one is able to achieve with this kind of database.

These results are largely in line with those reported by previous meta-analyses of positive and negative affect (e.g., Hayes, Duncan, Xu, & Northoff, 2014), in which there was spatial overlap between the brain activity correlated with experiencing and perceiving positively and negatively valenced stimuli. The results reported by Lindquist et al. (2015) differ from previous meta-analyses, however, insofar as these previous analyses also find additional regions that are interpreted as being functionally selective for either positive or negative valence. These analyses, however, were not specifically designed to compare different theoretical predictions regarding the nature of valence. In contrast, Lindquist and colleagues (2015) utilized more specific inclusion criteria for contrasts, which allowed us to better test competing hypotheses, and which may account for this difference in the results.[5] These findings of spatial overlap between the brain activity correlated with experiencing and perceiving positively and negatively valenced stimuli are also similar to those reported by meta-analyses that have used different operationalizations of positivity and negativity—including approach–avoidance (Murphy, Nimmo-Smith, & Lawrence, 2003),[6] reward–loss (Liu, Hairston, Schrier, & Fan, 2011), and subjective value (Bartra, McGuire, & Kable, 2013). It is also notable that, although the identification of valence selectivity within the vmPFC/ACC is consistent with other recent findings (Shenhav, Botvinick, & Cohen, 2013; Roy, Shohamy, Wager, 2012), these analyses do not exclude regions that respond during both positivity *and* negativity, as would be required in a rigorous test of the bipolarity hypothesis. There are furthermore additional studies within the literature showing that—*at the regional level*—these areas are activated by both positive and negative valence (e.g., Chikazoe, Lee, Kriegeskorte, & Anderson, 2014), suggesting that they are not specific to either valence, in a strict localization sense.

This pattern of results—and the affective workspace hypothesis by which it was predicted—is also in agreement with evidence from other methods including electroencephalography, lesion, electrical stimulation, and neurochemical studies in humans, and single neuron recordings in nonhuman animals that show that neural responses to positive and negative valence may be more flexible and context specific, than previously understood. For example, the human P300 event-related potential responds to both positively and negatively valenced stimuli (Olofsson, Nordin, Sequeira, & Polich, 2008). Similarly, electrical stimulation of the human medial temporal lobe (Halgren, Walter, Cherlow, & Crandall, 1978) has been shown to produce both pleasure and displeasure, and a recent review of human intracranial electrophysiological recordings reveals that when stimulated, the limbic, paralimbic, and cortical regions produce both positive and negative affective responses across instances (Guillory & Bujarski, 2014). Finally, some neurons in monkey OFC (area 13) have been shown to respond equally to appetitive and aversive stimuli (Morrison & Salzman, 2009). This violates the expectations of both the bipolarity hypothesis, which would not allow for positivity and negativity to be encoded at once, and also the bivalence hypothesis, which would allow for the simultaneous representation of both positive and negative valence, but not in the same cells (see Belova, Paton, & Salzman, 2008; Paton, Belova, Morrison, & Salzman, 2006, for other examples).

All together, these results suggest that valence is represented flexibly, and that instances of both positivity and negativity are represented as probabilistic assemblies of neurons within a single neural reference space, in line with the concept of degeneracy. In contrast, these results provided little support for bipolar or bivalent organization of affect. However, these conclusions are limited to the voxel (or voxel cluster) level of analysis. It remains possible that examining processes that are currently impossible to resolve using fMRI—such as neurochemistry or single-circuit or neuron activity—might reveal a different pattern. Single-neuron recording studies in animals, for example, have demonstrated specificity with respect to positive or negative valence at the level of the individual neuron (Morrison & Salzman, 2009; Namburi et al., 2015) and circuit (Tye & Deisseroth, 2012). Others have identified cells whose relative preference for positive versus negative stimuli appears to shift, depending on the presence of specific neurochemicals (Reynolds & Berridge, 2008; Tsunozaki, Chalasani, & Bargmann, 2008). Recently, it has been argued that optogenetic and pharmacogenetic methods provide superior ability to infer circuits when compared with classic neuroscientific methods (lesions, electrical stimulation, microinjections), and these methods clearly show that the neuronal circuits mediating positivity and negativity are separable within the same neural population, but not always separate in a spatial or even temporal sense (see, e.g., Tovote, Fadok, & Luthi, 2015; Lammel, Ion, Roeper, & Malenka, 2011; Lammel, Lim, Ran, Huang, Betley, et al., 2012). It is important to bear in mind, therefore, that a complete picture of valence must account for patterns across multiple levels of architecture. This notwithstanding, these results have important implications for the study of emotion in humans, as the voxel (or "region") level is the one at which human neuroimaging results are currently interpreted and communicated.

Whereas the meta-analysis conducted by Lindquist et al. (2015) found no support for consistent coding of positivity versus negativity, it is important to note that this was an analysis that averaged studies over many different contexts. Conceiving of valence as being flexibly assembled by a more general affective workspace does not rule out the potential for differentiating between positivity and negativity within a single study (which necessarily holds context constant). Chikazoe et al. (2014) recently demonstrated this. In this study, participants viewed picture stimuli and rated their positivity and negativity while neuroimaging data were collected. The authors first conducted a canonical univariate analysis, using positivity and negativity as independent predictors. The authors reported that a large proportion (>75%) of known valence-sensitive regions in medial and lateral OFC were responsive to *both* positivity and negativity, consistent with the results reported by Lindquist et al. (2015). The authors then employed a novel multivariate technique (representational similarity analysis) that identifies patterns of activation that may be distributed across voxels, rather than grouped together contiguously, in an anatomical fashion (as would be required for them to be identified in typical univariate analysis; Kriegeskorte, Mur, & Bandettini, 2008; Kriegeskorte & Kievit, 2013). This approach is therefore sensitive to representational properties underlying multivariate data. If the brain supports a valence code, then increasing dissimilarity in valence experience (which Chikazoe et al. [2014] reported to be negatively correlated: $r = -.53$) would be associated with increasing dissimilarity in population activity as well.

Using this approach, Chikazoe et al. (2014) were able to identify specific patterns with significant correlations to the degree of positivity and negativity reported by participants, in the ventral temporal and anterior insular cortex, as well as the medial and lateral OFC. They furthermore demonstrated that the representations within the medial and lateral OFC were independent of the sensory modality of the stimuli (visual vs. chemosensory). Finally, they reported that representations of valence within the OFC were also independent of the individual *subjects*. In other words, the patterns associated with positivity and negativity within one subject's OFC could be used to correctly classify the valence within other subjects' data as well, suggesting that these patterns displayed a significant degree of similarity across individuals.[7]

Together, the Chikazoe et al. (2014) findings demonstrate that—at the level of the region—areas typically associated with valence (e.g., OFC) may respond to both positive and negative stimuli. These findings are contrary to the predictions made by the bipolarity and bivalence hypotheses, but similar to the results reported by Lindquist et al. (2015). They also show that the encoding of positivity and negativity within these regions are best represented at the population level, as a pattern distributed across the brain as a whole, as predicted by the affective workspace hypothesis. It is important to note, however, that these results do *not* suggest that there is a single pattern or representation of positive or negative valence that should appear in every instance, and that is not what Chikazoe et al. (2014) demonstrate. A pattern classification analysis that can diagnose cases for positivity and negativity above chance does not produce a fingerprint or an essence for positivity or for negativity; each pattern is not a representation of voxels that can be actually found in every (or even any) individual subject's data, or across stimulus modalities.[8] The pattern of voxels for category (positivity or negativity) is a statistical summary of a sample of varying instances, and the pattern itself need not (and does not) appear in any individual instance within the category, in the same way that the mean of a population is an abstract representation and does not appear in any of its instances. We return to a discussion of this "population thinking" in greater detail in the next section.

All together, these results therefore support the affective workspace hypothesis, and provide evidence that the predictions made by the bipolarity and bivalence models may be misguided. In so doing, they also highlight somewhat counterintuitive inference: Specifically, the affective workspace hypothesis and the variable, context-dependent encoding it predicts, allows for the possibility that positivity and negativity may not be single constructs, as we typically think of them, but rather broad *categories*, each comprising a wide range of instances. In other words, whereas we tend to think of positivity and negativity as specific things—clearly definable, and differentiable characteristics—they may be more akin to fuzzy categories, within which the characteristics of any given instance are tied to the context in which it is realized. This is important not only for how we think about localizing valence within the brain, as reflected in many and varied neural representations, rather than by the activity of a single region or structure alone, but how we think about valence from a psychological standpoint as well.

There are also important conclusions to be drawn from the distribution of the valence sensitive voxels identified in these studies. The affective workspace, as described empirically above, contains regions that are part of the traditional (but outdated) "limbic system" concept. Of note, the workspace contains limbic cortical structures (agranular and dysgranular in structure; Barbas, 2015). Some of these regions form an intrinsic interoceptive network, so named because their anatomical and functional connections clearly indicate that they control and represent autonomic, hormonal, and inflammatory systems in the body (Barrett & Simmons, 2015). This network helps to maintain homeostasis and allostasis, and issues the interoceptive predictions that become your experience of affect. These regions fall into several canonical intrinsic or "resting state" networks, known as the "salience network" (Seeley et al., 2007), the default mode network (Andrews-Hanna, Smallwood, & Spreng, 2014), and the ventral attention network (e.g., Corbetta & Shulman, 2002). Narrowly, the regions in the workspace perform a salience function by directing the brain's resourcing capacities toward the most homeostatically and metabolically relevant information, particularly when incoming input is ambiguous and the brain needs to learn about them to encode information and better prepare its response next time. If based on past experience, your brain predicts that something will be metabolically costly, or if the cost is uncertain, then the brain will sample more information about that thing (i.e., it will pay more attention to it), encode it better, and prioritize action toward it. This is what it means to say that something is salient. In this sense, the "salience" network is a body-oriented source of attention within the human brain (Barrett & Satpute, 2013). More broadly, many of the regions in the affective workspace are considered to be "rich club hubs" (van den Heuvel & Sporns, 2013), meaning that they are among the most connected regions of the brain. All other networks in the brain are connected to these hubs. So, we would expect the affective workspace to be engaged during many other psychological phenomena, even those that are not explicitly "affective" in nature. And indeed it is (see Plate 8.2). This may explain why the concept of affect is relevant to virtually all phenomena in psychology (see Barrett & Bliss-Moreau, 2009) and it suggests that regardless of what folk psychology categories we use, psychological phenomena like reading, memory, decision making, language, attention, and so on are, at their basis, homeostatic processes.

Can Emotions Be Distinguished in the Brain?

Perhaps the question that has garnered the most interest in the science of emotion is whether each emotion category has specific, dedicated neural circuitry in the brain (e.g., Barrett, 2006, 2013; Barrett, Lindquist, et al., 2007; Izard, 2007; Panksepp, 2007; Tracy & Randles, 2011). Emotions, for example, play a crucial role in the formation and maintenance of social relationships by facilitating the communication of needs (Parkinson, 1996). They are also central to the diagnosis and treatment of every major mental disorder (Kring, 2008). The autonomic and neuroendocrine changes that accompany emotion may furthermore play an important role in physical health via peripheral gene expression pathways (e.g., Irwin & Cole, 2011). Because of their broad relevance, there have been tremendous empirical efforts to resolve ongoing debates over the brain basis of emotion. Nonetheless, there is still a lack of agreement across scientists, in terms of what the data demonstrate, and how this supports (or fails to support) existing theories. Meta-analysis is particularly useful for answering this question because it can potentially identify emotion-associated brain patterns that generalize across studies and experimental contexts.

The Classical versus Construction Theories of Emotion

As with valence, one barrier to a consensus based on the current literature is the existence of multiple models of emotion and predictions as to their neural bases, but a lack of systematic comparisons among them. With regard to emotion, whereas there are a multitude of individual theories, these can be grouped into two main schools of thought: The first—the *classical view of emotion*—posits that individual emotions have diagnostic psychological and neurobiological features, in which there should be relatively little (if any) variation across instances. Adhering to this viewpoint are, most notably, the basic emotion theories (e.g., Panksepp, 1998; Tomkins, 1962, 1963; Ekman, 1972; Izard, 1993), which propose that emotions are (a limited) set of universal programs, evolved to deal with recurrent challenges faced by our ancestors (Cosmides & Tooby, 2004). According to this perspective, emotion categories are natural kinds (Ekman & Cordaro, 2011) where the instances of each category emerge from a dedicated, specific neural circuit or network. For example, recently in their review of basic emotion theories, Tracy and Randles (2011) stated that an agreed-upon gold standard for the existence of basic emotions is "the presence of neurons dedicated to the emotion's activation" (p. 399). Others further specify that the distinct neural circuits must be subcortical in nature (Ekman, 1999; Panksepp & Watt, 2011). It has also been suggested that these circuits must be heritable, and homologous in nonhuman animals. From the basic emotion perspective, therefore, evidence for emotion "fingerprints" would have to demonstrate that (1) each emotion can be localized to a specific brain region or network; (2) is modular (because it should not involve regions involved in processing language), preferably subcortical, and inheritable; and (3) homologous in nonhuman animals.

Some versions of the more recent "appraisal" theories—the "causal" appraisal theories—also fall into the classical view of emotion as well (Barrett, Mesquita, Ochsner, & Gross, 2007; Gross & Barrett, 2011). In contrast to basic emotion theories, which posit that emotions are elicited by specific types of stimuli whose meaning is evolutionarily conferred, appraisal models suggest that meaning is assigned by the individual (the person experiencing or perceiving the stimulus), by cognitive evaluations (i.e., appraisals) of the eliciting stimulus, of the context in which it was encountered, and his or her own coping potential (Frijda, 1986; Lazarus, 1991; Roseman & Smith, 2001; Scherer, 1984; Smith, 1989). These appraisals produce, in turn, the physical response associated with the emotion. Within the brain, one should therefore expect emotions to manifest as activity distributed *across* different structures and/or functional networks, including those associated with higher-order thinking (contrary to the predictions made based upon basic emotion theories.) Similar to basic emotion models, however, causal appraisal theories provide reason to believe that these distributed signatures should be highly *reproducible*, with a specific pattern of activation that occurs in all instances of a given emotion category. Specifically, they suggest that different types of appraisals are synchronized during an emotion episode (Scherer, 1984, 1993, 2001). To the extent that the dimensions along which eliciting events are appraised are consistent across people and across cultures (Mauro, Sato, & Tucker, 1992), and to the extent that an appraisal along a specified dimension (e.g., novelty) consistently draws on the same neural substrate each time it is performed, we should therefore expect to see highly reproducible distributed signals within the brain.

In contrast to the classical view, the *construction view of emotion* proposes that emotions are not natural kinds, but rather folk categories within which there is significant variation across instances. "Anger," in other words, refers not to an individual stimulus, thought, or reaction, but instead a population of many different experiences, each of which cannot be disentangled from the situations in which they are realized. As a result, emotion categories are unlikely to have distinct and innate physical correlates within the brain that are replicable across different contexts. Rather, instances of emotion are proposed to emerge from the flexible combination and recombination of more domain-general core systems (e.g., perception, categorization, memory), and the functional neural architecture underlying them. This is called the conceptual act theory of emotion (Barrett, 2006, 2009, 2013; Barrett & Satpute, 2013; Lindquist & Barrett, 2012; Oosterwijk, Touroutoglou, & Lindquist, 2015). As a result, different instances of the same emotion category will be variably represented in the brain and instances belonging to different emotion categories (or even nonemotional categories, such as cognitions or perceptions) have some degree of similarity to one another. Appraisal models that view cognitive evaluations as part of the experience of an emotion, which are themselves composed of more basic functions instead of indivisible processes that define when an emotion is experienced ("constitutive appraisal models"), also fall into this category (e.g., Clore & Ortony, 2013; Smith & Ellsworth, 1985; see also Barrett, Mesquita, et al., 2007; Gross & Barrett, 2011). (Other neutrally inspired constructionist theories of emotion exist; see, e.g., LeDoux, 2012; Cunningham, 2013; Thagard & Schroder, 2013).

Emotion Categories Can Be Summarized as Distributed Patterns of Activity

Though there are now more than 300 neuroimaging studies on emotion (Lindquist et al., 2012), meta-analyses examining this literature have generally been unable to pinpoint unique identifiers of individual emotion categories (anger, sadness, happiness, etc.; Kober et al., 2008; Lindquist et al., 2012; Phan, Wager, Taylor, & Liberzon, 2002; Wager, Phan, Liberzon, & Taylor, 2003; Vytal & Hamann, 2010). Indeed, many of the regions most commonly activated (e.g., the anterior cingulate, anterior insula, amygdala, and OFC) are implicated across a wide *range* of emotions (Lindquist et al., 2012), and are also associated with many other sensory, perceptual, and cognitive (i.e., "nonemotional") tasks (LeDoux, 2012; Yarkoni, Poldrack, Nichols, Van Essen, & Wager, 2011), suggesting that they are fundamentally nonspecific. Beyond this, it is furthermore not obvious that the patterns identified in any single study as representative of an emotion category, or as differentiating one category from another, are *reproducible* across experiments.

The extant literature therefore suggests that the primary hypothesis of the classical view of emotion, that there should exist a consistent and specific region or anatomically prescribed network within the brain for each emotion category, has little support. Studies of intrinsic brain networks (Touroutoglou, Lindquist, Dickerson, & Barrett, 2015) and intracranial brain stimulation in humans (Guillory & Bujarski, 2014) further support this observation. Until recently, however, the alternative hypothesis proposed by appraisal and constructivist theories, that emotion-related activity is distributed across the whole brain and draws on a mix of structures and networks, had not been similarly tested. Using a database of 148 neuroimaging studies, Wager et al. (2015) did just this, analyzing patterns of brain activity associated with different emotion categories. To do this, they used a novel hierarchical Bayesian model that captures patterns of both activation and coactivation between different regions. The model incorporates both activation and coactivation into a generative model for each of five emotion categories—a model of the brain configuration associated with each category on average. This approach can be contrasted with previous approaches, which have usually either (1) looked for either activation or coactivation-related features without integrating them into a model, or (2) used a series of data-driven classifier models to decode emotion categories without developing a model for what a particular category "looks like" in the brain.

Thus, the Bayesian generative model approach allows for a better test of the construction models in particular, as they can help specify the brain configuration that is most strongly associated with each emotion category, and which brain features are needed to identify an emotional instance's category (e.g., activation and coactivation in specific cortical and subcortical networks). For instance, the conceptual act theory (Barrett, 2014; Lindquist et al., 2012) predicts that emotion categories are characterized by widespread patterns across the brain, including regions that are not specific to emotion at all. Basic emotion theories predict that emotion categories are characterized by differential patterns within regions and networks specific to emotional processes, and that with enough resolution and data quality, there should be brain features (e.g., regions) activated by one and only one emotion category.

Using the Bayesian spatial point process model, the authors were able to identify the emotion category into which each individual study and/or contrast in their database fell, with 66% accuracy on average (range 43–86%, chance = 20%; see Plate 8.3 for classifier maps). This demonstrated that emotion categories can be represented by distinct patterns of activity and coactivity—patterns that are sufficiently robust such that they can be used to classify emotion categories from studies across the meta-analytic database. These representations were, notably, distributed across many regions that (1) are unlikely to have emotion-dedicated neurons; (2) serve a wide variety of basic perceptual, cognitive, and motor functions; and (3) were involved in creating instances of multiple emotion categories. These results are inconsistent with the classical view of emotion, which purports that emotion categories are distinct biological types, or that there are individual brain systems corresponding to specific types of cognitive appraisal (e.g., valence, novelty, coping potential). They are more consistent with constructionist theories, which hypothesize that anger, sadness, fear, disgust, and happiness are not biological types arising from dedicated brain modules, but arise from interactions of anatomically distributed, core systems within the functional architecture of the brain (see also Cunningham, 2013).

It is important to note, however, that these representations of emotion categories do not reflect the "essence" of these emotions. Whereas the patterns identified by Wager et al. (2015) are reliable in the sense that they can predict the emotion category targeted in a study across multiple paradigms and imaging methods, they are not reliable insofar as they could be used to predict what any individual instance of emotion might look like (i.e., a pattern for a category cannot provide any evidence for how each of its instances was computed). In representing the patterns of brain activity associated with different emotion categories, our results do not imply that those categories are homogeneous (i.e., that all instances of "anger," "fear," and so on share all of the category level features we identify). Thus, each activation map correctly classified as representing anger does not have to contain the entire pattern for anger; it only has to contain a set of voxels that is closer to this pattern than to the pattern for any other emotion category. Different instances of anger are likely to contain unique subsets of the category-level pattern that are *sufficient* for anger, without implying that all instances of anger are the same pattern. Rather than capturing a dedicated, obligatory pattern for one emotion category, the category-level maps we identify are *statistical summaries*. This is a basic aspect of population thinking that is the foundation of evolutionary thinking as well (Mayr, 1984). In the same way that no American family consists of 3.13 people (the size of the average American family in 2014), not every instance of an emotion category must involve the pattern that is used to diagnose the category. A statistical summary of a category need not actually exist in nature (Mayr, 1984). For example, one might identify the features of a prototypical chair, but no real chair need have *all* those features to be a chair. Neither does the brain need to have an innate, biologically preprogrammed "chair system." Rather, each instance of the category has some set of features that are sufficient for category membership, but none of them are necessary for category membership, and they don't co-occur anywhere but in the abstract representation that summarizes the category (Posner & Keele, 1968).

This is an important point, and one that is often overlooked: Take, for example, Kassam, Markey, Cherkassky, Loewenstein, and Just (2013). Here, using multivoxel pattern analysis, the authors report that they were successful in distinguishing different types of emotion experience, with average rank accuracies of between .72 and .90 across the different emotions—above the chance level of .51. These results also extended across individuals and across modalities; the authors were able to train classifiers on one set of subjects and word-cued emotion simulations, and use those to classify with accuracy above chance experiences in other individuals and experiences elicited by emotional pictures as well.

These promising results lead to a number of important questions about what the results mean for theories of emotion. Are they reflections of "essences" for each emotion category? Can they be used to identify the category of an emotional response (e.g., Is someone feeling sad?) or category-specific emotional intensity (e.g., How sad does someone feel exactly?)? Kassam et al. (2013) suggest that the neural "signatures" of different emotions—identified in analyses such as the one they conducted—could be used to produce "a generative model that could predict an individual's emotional response to an arbitrary stimulus." Saarimaki, Gotsopoulos, Jääskeläinen, Lampinen, Vuilleumier, et al. (2015) conclude that "basic emotions are encoded in discrete activation patterns" that function as "distinctive fingerprints" (p. 8).[9] Other studies make similar claims. Park, Jang, Chung, and Kim (2013) write about identifying a "core set of features." Yuen et al. (2012) claim that their classifiers represent "important neural signatures corresponding to a cognitive/affective state." Finally, Kragel and LaBar (2014) describe the results of analyses as "emotion specific biomarkers." In each of these cases, the researchers appear to be conceptualizing the patterns identified by classification analyses as essences (a fundamental property that occurs in every instance), when these are, in actuality, a statistical summary of the category (which can be useful in differentiating instances into categories, but which may not appear in any instance at all; Posner & Keele, 1968).

More broadly, the BSPP findings reported by Wager et al. (2015) suggest that understanding the brain basis of emotion will not necessarily be accomplished by searching for emotion-specific modules at ever finer-grained levels of analysis, but instead by understanding the complex interactions among networks during emotional episodes. To this end, these results also highlight some potentially interesting new observations from that meta-analysis. First, there were few differences between emotion categories in terms of their overall level of cortical or subcortical engagement. Emotion categories were furthermore not differentiable based on the frequency with which they activated intrinsic activity networks.[10] Emotion categories *could*, however, be distinguished by their profiles of relative activation *across* networks. For example, anger and fear categories were characterized by relatively greater activation within the limbic, default mode, dorsal attention, visual, and frontoparietal networks. In contrast, the disgust, sadness, and happiness categories were characterized by relatively lesser activation within this group of networks, and greater activation within the salience and somatomotor networks. This is notable, because the grouping of emotion categories these data suggest do not match those that might seem to be obvious, phenomenologically. For example, the happiness and disgust categories differ in valence (one positive, and one negative, respectively)—a feature of phenomenological importance—but are similar in their neural summary pattern. Similarly, the disgust and fear categories differ in terms of their summary neural patterns, but are both designated as “high” in arousal, another phenomenologically based property commonly cited within the emotion literature. It is furthermore notable that the existence of clearly differentiable “summary patterns” of activation across networks for different emotion categories could be seen within subcortical zones as well.

Observations like this are important, because they cause us to rethink the nature of emotion. These results, reported by Wager et al. (2015), lend additional weight to the conclusion that emotion categories may be best characterized by the relative degree to which they recruit networks throughout the brain—rather than by the magnitude of activation within a single, anatomically defined region, or within a single network (see Baucom, Wedell, Wang, Blitzer, & Shinkareva, 2012; Kotz, Kalberlah, Bahlmann, Friederici, & Haynes, 2012, for similar examples). This suggests that rather than indivisible entities, instances of emotion may be more productively conceptualized in terms of the relative degree to which they draw upon different domain-general functions with which these intrinsic networks are associated.

Other studies using similar methods have now started to appear, reaching similar conclusions. Saarimaki et al. (2015), for example, demonstrated in a single set of participants that multivariate pattern analysis could be used to classify six emotion categories, and that the resultant classifiers could be used to identify emotions across different individuals, and different methods of emotion induction (movies vs. mental imagery). The classifiers reported by Saarimaki et al. (2015), like those reported by Wager and colleagues (2015), draw on the pattern of activity across a range of networks performing domain-general functions. Specifically, they found the core nodes of the default mode network (the medial prefrontal cortex [mPFC], precuneus, and posterior cingulate cortex [PCC]; Andrews-Hanna et al., 2014); core nodes of the salience network (e.g., the ACC and amygdala), and the somatosensory, supplementary motor, and premotor regions; as well as the posterior insular (which is the primary interoceptive cortex). The default mode network is associated with many different task domains (Barrett & Satpute, 2013; Lindquist & Barrett, 2012), including self-referential processing (Amodio & Frith, 2006; Northoff et al., 2006; Buckner & Carroll, 2007), as well as the semantic representations that underlie conceptual processing more generally (Binder & Desai, 2011; Binder, 2009; see also Barrett, 2015a; Lindquist, Satpute, & Gendron, 2015). In other works (Barrett, 2009, 2015b), we have proposed the default mode network is one network that is at the core of the active inference process by which the brain perceives and acts in the world. It helps to initiate the construction of all mental events by issuing predictions to the sensory and motor systems. This network is well-known for constructing representations of the past and the future (Buckner, 2012; Schacter, Addis, Hassabis, Martin, Spreng, et al., 2012; Mesulam, 2012), but we have hypothesized that it also helps to construct representations of the present. Think about it this way: A human brain carries around a model of the world. This network is at the core of that model. This network contains the conceptual knowledge needed to categorize and make sense of the sensory inputs in the present moment so a person knows how to act on them. In the process, perception and experience is constructed. This is logic of the active inference framework to understanding the brain (Barrett & Simmons, 2015). The binding of conceptual and body-based representations constitutes a key feature of an emotional category. Although Saarimaki et al. (2015) interpreted these findings as evidence for “basic emotions,” their results showed no evidence that would actually support basic emotion theory (i.e., they were not able to localize each emotion category to a specific, modular brain region that is inheritable and homologous in nonhuman animals). These results are exactly what has been predicted previously by the conceptual act theory, which has posited that the default mode network and regions representing internal states are integral to the experience of emotion (Lindquist et al., 2012; Lindquist & Barrett, 2012; Barrett, 2009).

Emotion Regulation and Emotion Generation

The last question we address in this chapter is the degree to which emotion generation is distinct from emotion *regulation* (Gross & Barrett, 2011)—or the techniques we use to influence what emotions we experience, when we have them, and whether and how we express them (Gross, 1998). For as long as people have been interested in how emotions are generated, they have also been interested in how they are regulated (Gross, 2007, 2010). One reason for this interest is that regulation can have a significant impact on both psychological and physical health. Individual differences in the use of regulation strategies, for example, are predictive of the experience of positive affect, better interpersonal functioning, and general well-being (Gross & John, 2003). Emotion regulation is also integral to the practice of cognitive-behavioral (Beck, 2005), dialectical-behavioral (Lynch, Trost, Salsman, & Linehan, 2007), and psychodynamic (Bateman & Fonagy, 2006; Maroda, 2010; Have-de Labije & Neborsky, 2012) therapies, all of which are widely used in the treatment of mood and anxiety disorders.

The Classical versus Construction Theories of Emotion Regulation

How one defines emotion generation is necessarily dependent on how one defines emotion generation. Here again, the differentiation between the classical and the construction viewpoints is important. From the classical perspective, emotions are indivisible modules of automatic and coordinated responses to specific stimuli. Emotion regulation, in this case, would involve separate processes that either prevent the emotion from being triggered (e.g., situational selection or modification), or that attenuate its expression after it has been realized (Gross & Thompson, 2007). Basic emotion theories, and hypotheses about regulation based on these theories, maintain a clear distinction between generation processes and those that would be required to regulate the emotion produced—at no point are these regulatory processes changing the fundamental nature and action of the affect program that defines the emotion. As a result, one should expect that the neural mechanisms underlying these processes should be independent as well. More specifically, one would expect to see emotion-related activity focused within the subcortical regions (as predicted by the basic emotion theories), and regulatory activity within the cortex (Gross & Barrett, 2011). Causal appraisal models make a similar prediction. These models conceive of appraisals as antecedent to the emotion—necessary evaluations that had to be made, after which the emotion that best fit the appraisal pattern would be produced—in a relatively strict, deterministic form, similar to, but more flexible than, affect programs (Arnold, 1960a, 1960b; Lazarus, 1991; Roseman, 1991). Given the similarity of the emotion production pattern in these early appraisal models to that proposed by basic emotion models, one might expect a similar relationship between this emotion generation and emotion regulation, with the two cast as relatively distinct processes.

In contrast, from the construction standpoint, emotion generation and emotion regulation involve the same processes, and ones that are not limited to either cortical or subcortical tissue alone. For example, constitutive appraisal models define appraisals not as causes, but rather constituents of emotion, along with the bodily changes produced in response to these appraisals, intended to prepare the individual to respond to the eliciting stimulus (Ellsworth & Scherer, 2003; Clore & Ortony, 2008). In these models, emotions are dynamic and can evolve, changing as one's evaluations of one's environment changes. Emotion regulation can take the form not only of situation selection, and modification, but also of cognitive change, or "reappraisal," wherein one changes one's evaluations of the situation in a way that would also change one's emotional response to it. In this case—where regulation could be realized by additional iterations of the same systems that are involved in emotion generation—one should not expect to be able to differentiate emotion generation from emotion regulation, at a neural level, as these processes should draw on the same underlying mechanisms. The same is true for newer construction models (e.g., the conceptual act theory). Whereas appraisal theories conceive of appraisals as evaluations of one's external surroundings, with internal bodily changes occurring in response to the outcomes of these evaluations to prepare the organism to respond to the eliciting stimulus, constructivist theories focus on meaning making based on the internal bodily sensations themselves. Nonetheless, despite the difference in focus, both theories view emotion as being *continually constructed*—meaning that subsequent acts of meaning making ("reappraisals") are part and parcel of the definition of the emotion—not a separable component. Indeed, according to this viewpoint, as with the appraisal theories, regulation is constantly occurring as the emotion evolves. As a result, one would not expect there to be independent neural bases for emotion generation and emotion regulation.

Emotion Generation and Emotion Regulation Share Similar Neural Bases

To date, there has only been a systematic investigation of the brain basis of reappraisal as an emotion regulation strategy. Buhle, Silvers, Wager, Lopez, Onyemekwu, et al. (2014) conducted a meta-analysis of 48 neuroimaging studies involving reappraisal. Comparing their findings with the latest meta-analytic summary of emotional experience (Satpute, Wilson-Mendenhall, Kleckner, & Barrett, 2015; cf. Lindquist et al., 2012; Wager et al., 2008) shows several areas of overlapping activity. As shown in Plate 8.4, these include key regions of the salience and ventral attention networks including the ventrolateral prefrontal cortex, anterior insula, ACC, supplementary motor area, and the posterior superior temporal sulcus. These overlaps suggest that reappraisal and emotional experience share similar underlying mechanisms, consistent with the conceptual act theory. However, there are also differences. Reappraisal reliably engaged a posterior portion of the middle frontal gyrus and intraparietal lobule. These areas are nodes in a dorsal attention network, considered to be important for selecting goal-relevant stimuli from the environment (Corbetta & Shulman, 2002; Corbetta, Patel, & Shulman, 2008). In comparison, emotional experience reliably engaged parts of the default mode network, including the mPFC and PCC. Proponents of a more classical view may point to these areas of nonoverlap as being more selectively important for the regulation or experience of emotion. However, an equally likely account from a constructionist perspective is that these differences are due to differences in the attentional orientation of the task paradigms most frequently used in tasks that elicit regulation or experience. For instance, reappraisal may engage a handful of strategies, including searching a complex graphic image for aspects that feed a reinterpretation or use semantic interoceptive information to retrieve concepts that update an affective state. These strategies may sometimes recruit the dorsal attention network, or the default mode network, respectively. Emotional experience, too, may be elicited in a variety of ways, which have been shown to engage different cortical areas (e.g., Ochsner et al., 2009) that may also recruit these networks to varying degrees.

To the extent that these results suggest that the neural bases for emotion regulation are very similar to those for emotion generation, it also raises an interesting question: Specifically, why are there not more targets for regulation, beyond the amygdala? Buhle et al. (2014) reported strong evidence that reappraisal modulates activity in the bilateral amygdala, but no evidence of similar regulation of other regions integral to the generation of emotion, including the anterior insula, periaqueductal gray, hypothalamus, thalamus, OFC, temporal pole, and rostral and subgenual anterior cingulate. If emotion regulation is realized via iterations of the same mechanisms involved in emotion generation versus a direct attenutation/enhancement of a single node in an emotion-related network, then we should expect modulate to be measurable within the whole of the emotion network, not just the amygdala. Uncovering such modulation, however, may require conducting additional, and different, emotion regulation experiments, using a wider variety of emotion inductions and data analysis. A non-negligible number of the studies within this database furthermore used return on investment (ROI) analyses focused on the amygdala—an approach that would bias any meta-analysis in terms of identifying this region as a particularly important target for regulation relative to others. Finally, is also possible that emotion regulation may be realized not only in terms of the absolute value of the activation of specific regions or networks, but also in the connectivity between them, as has been shown to be important in emotion generation. Future studies should strive to conduct and report both whole-brain analyses that examine the impact of regulation on the full range of regions and networks, and analyses of connectivity—in particular, cortical–subcortical connectivity.

Conclusion

Overall, the meta-analytic studies we review in this chapter make it clear that the brain's "emotion architecture" looks nothing like what our phenomenology, and the classical view of emotion on which it is based, would lead us to expect. First, we addressed the question of whether valence—or that which differentiates positivity from negativity—was encoded within the brain, and if positivity and negativity could be differentiated. Despite having long been treated as a dimension so fundamental and obvious in both nature and importance that these qualities need not be belabored, we reviewed convincing evidence that, across the literature as whole, positivity and negativity did not differ in any substantial way, in their representation within the brain. Second, we applied the same question to emotion: Here the evidence suggests that they can be distinguished (a surprising result, given the lack of discrimination for valence[11]), but, contrary to common assumptions, this discrimination relies not on the absolute value of activity within individual anatomically defined regions but rather on the relative degree to which emotions engage a range of different large-scale networks, and on the *connectivity* of regions and networks throughout the brain. Finally, we turned to the distinction between emotion generation and emotion regulation. Here, despite a more limited literature from which to draw, the data suggest that the generation and regulation of emotion, though experientially dissimilar, likely draw on largely overlapping or self-same neural mechanisms.

Together, these data suggest that emotion's basis within the brain is far more complex than commonly assumed. Yet, scientists still talk and write about the "emotional brain," talk about emotion and cognition "interacting" in the brain, and understand emotion regulation as cortical sites regulating subcortical structures. This is not to say that experientially based differentiations may not be of value subjectively or behaviorally—they may very well be (Barrett, 2009, 2012); nor is it to imply that we should dismantle our phenomenological frameworks when it comes to experimental design and data analysis, either—this may not be possible or desirable. Rather, these results highlight the fact that previous theories on emotion have been *underconstrained* by brain data. The findings presented here constitute a specific set of constraints that may be integrated into future experiments and future models.

Specifically, these data demonstrate the importance of accounting for significant variation within the traditional "folk" categories of emotion. As the meta-analyses described here have demonstrated, there is significant heterogeneity (variability) across instances of both valence and emotion, in terms of how they are represented within the brain. This suggests that there is likely important variability behaviorally and experientially as well. In contrast to indivisible constructs, therefore, it is likely more fruitful to think of positive and negative valence, and emotions, as broad categories within which the characteristics of any given instance are tied to the context in which it is realized. This is important not only for how we think about localizing valence within the brain—as reflected in many and varied neural representations, rather than by the activity of a single region or structure alone—but also how we think about valence from a psychological standpoint. Future research should emphasize and examine the variability within these categories, in order to better understand them. With respect to neuroimaging, this will require approaching representations of emotions in terms of whole-brain states (including not only voxel-level metrics but also measures of network activity, coactivation, distributed representations, and timing), in order to more fully capture their complexity.

In sum, this is an important time for the literature on emotion. We have a developing awareness that its basis within the brain may be more complex than commonly assumed, and we have enough information to start generating more data-driven hypotheses that might never have been possible based on phenomenology alone. We also have new and quickly developing tools that are more sensitive than ever to the complex, multidimensional patterns that may prove to be the best way to test these new hypotheses, and characterize any new constructs they may identify. Together, these developments afford an opportunity for significant progress in further understanding the physical basis of emotion.

Notes

1. An intermediate position between the bipolar and bivalence hypotheses could involve functional selectivity, instead of exclusivity, such that regions or networks respond during both positive and negative valence, but that demonstrate a functional preference during positivity or negativity. A mechanism in which there were two spatially independent sets of neurons/regions/networks supporting positive and negative valence, but where these sets activate reciprocally, would also fall in between a bipolar and bivalent model.
2. Degeneracy is thought to be a ubiquitous biological property, with it becoming increasingly evident that biological functions as a whole cannot be assigned to individual (cellular) components in a one-to-one manner. For example, there are many more DNA codons than there are amino acid residues for which they code, suggesting that many different sequences could produce the same amino acid sequence. As a result, a gene could be inactivated completely, and yet not impact the phenotype of the organism. As applied to the brain basis of emotion, a degenerate architecture would explain the failure heretofore to find consistent and specific fingerprints for valence or emotion categories, insofar as it would suggest that the mechanisms underlying these phenomena may be many, and which is utilized in any given instance may be context dependent.

3. A "brain state" refers to the full set of variables that describe the neural circuits of the brain. Because the neural underpinnings of valence and emotion may be degenerate, is it insufficient to describe them solely in terms of gross anatomical or regional terms; these units are too imprecise. Rather, in order to understand the magnitude of the variability in the brain basis of difference instances of valence or emotion, or the similarity of any two instances, it is necessary to quantify these instances in terms of brain states.
4. Because information about deactivation is typically not included in such analyses, it is possible to only examine whether there is more consistent activation for a positive > negative contrast, relative to a positive > neutral one; the strongest test of the bipolarity hypothesis would require a demonstration of *decreasing* activity during negative affect.
5. Whereas Lindquist et al. (2015), and previous meta-analyses identify regions associated with both positive and negative valence, previous analyses also identified regions of greater specificity. This difference may be attributable to two factors: First, Lindquist et al. were more selective in their selection criteria for study contrasts. Specifically, they included only contrasts where the baseline stimuli were neutral and of the same type as the target stimuli (e.g., angry vs. neutral faces were included; angry faces vs. fixation contrasts were not). They also excluded contrasts from studies that reported only return on investment (ROI) analyses, because the selection of ROIs may reflect experimenter bias. Second, in contrast to previous analyses that analyze all contrasts together, regardless of baseline condition, Lindquist et al. computed Multilevel Kernel Density Analysis (MKDA) maps for different baselines separately.
6. Although Murphy et al. (2003) failed to find any difference in the distribution of activation for positive versus negative emotions generally ("we . . . tested for a difference in the 3-D distributions of neural activity associated with positive and negative emotions, only to confirm the null hypothesis of no difference between the two conditions" [p. 223]), they do claim to identify some specificity for the neural bases of individual emotions within these categories (disgust, fear, and anger), and upon this basis claim to have identified support for "affect program emotion accounts."
7. These neurons are multimodal, and therefore put valence (as interoceptive changes) from different sources on a common scale. In principle, this means that objects and events that differ widely in their sensory properties could be compared according to how they influence a person's positivity or negativity, allowing affect to function like a common currency in decision making (Chikazoe et al., 2014). Similarly, Clithero and Rangel (2013) report a meta-analysis of 81 neuroimaging studies, showing that similar regions are routinely engaged when participants are deciding whether they are willing to work or pay for one item over another (i.e., computing value, or when receiving things they value but not necessarily what they like [affect]). Neuroeconomists propose that neurons in the ventromedial frontal cortex (vmPFC) compare different classes of objects (food, money, trinkets) on a common currency, so that the brain can decide which are preferred.
8. Also, we should add that effects were both relatively weak (they were significant in only one of the regions examined), and they were obtained in a situation where the context was held constant. Indeed, despite the aforementioned changes in modality and individual subjects, all other situational characteristics—that individuals were lying down during a magnetic resonance imaging (MRI), with the same experimenter giving them the exact same instructions, as to how to view the exact same stimuli, and rate them in the exact same task—remained unchanged across the experiment.
9. Strong claims based on current empirical tests, however, drastically underestimate how much context can vary, and how influential contextual variables can be in shaping emotion experiences. Though Kassam et al. (2013) looked at predictive accuracy across individuals and stimulus types, they still used the same experimental set-up, with the same experimenters and the same instructions across conditions. There is little reason for confidence, therefore, that the classifier will prove to be diagnostic outside of this context. Making such a claim would require instead a demonstration that these patterns persisted, despite variation in each one of these task- and context-related variables. A similar observation can be made about the Saarimaki et al. study.
10. As people have been moving away from the once popular "region of interest" analyses in which they focus on a single anatomically defined section of the brain, they have started to adopt a conceptually similar approach, but simply substituting intrinsic connectivity network boundaries for anatomical ones. This suffers from the same limitations as the original ROI analyses did, and here was demonstrated to be insufficient.
11. One reason cited for the failure to discriminate positivity from negativity in the meta-analysis reported by Lindquist et al. (2015) was that the realization of valence may be context dependent, taking different forms in different situations. This highlighted the counterintuitive hypothesis that valence may not be a "thing" but rather a collection of representations—with enough variation between them

such that they may not be measurable across a large and varied database like that used by Lindquist et al. Applied to the results reported by Wager et al. (2015)—in which the authors *were* able to differentiate states based on their neural correlates—this suggests that emotion states, as we typically study them, may be *less* variable than affect (positive/negative) states, despite the common conception of them as more complex.

To this end, it is notable that studies focused on positive versus negative affect are often relatively unconstrained, from the perspective of the participant; many and varied stimuli are presented, with relatively few instructions as to how they should be evaluated. In contrast, experiments designed to measure emotion states are often far more stereotyped, using a smaller range of paradigms and stimuli, and provide significantly more information to the participant, in terms of how he or she is to evaluate and respond to what is provided. Future analyses should strive to account for such differences.

References

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review, 30*, 217–237.

Amodio, D. M., & Frith, C. D. (2006). Meeting of minds: The medial frontal cortex and social cognition. *Nature Reviews: Neuroscience, 7*, 268–277.

Andrews-Hanna, J. R., Smallwood, J., & Spreng, R. N. (2014). The default network and self-generated thought: Component processes, dynamic control, and clinical relevance. *Annals of the New York Academy of Sciences, 1316*(1), 29–52.

Aristotle, C., & Bostock, D. (1994). *Aristotle metaphysics*. Gloucestershire, UK: Clarendon Press.

Arnold, M. B. (1960a). *Emotion and personality: Vol. 1. Psychological aspects*. New York: Columbia University Press.

Arnold, M. B. (1960b). *Emotion and personality: Vol. 2. Physiological aspects*. New York: Columbia University Press.

Barbas, H. (2015). General cortical and special prefrontal connections: Principles from structure to function. *Annual Review of Neuroscience, 38*, 269–289.

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science, 1*, 28–58.

Barrett, L. F. (2009). Variety is the spice of life: A psychological construction approach to understanding variability in emotion. *Cognition and Emotion, 23*, 1284–1306.

Barrett, L. F. (2012). Emotions are real. *Emotion, 12*, 413–429.

Barrett, L. F. (2013). Psychological construction: A Darwinian approach to the science of emotion. *Emotion Review, 5*, 379–389.

Barrett, L. F. (2014). The conceptual act theory: A précis. *Emotion Review, 6*, 292–297.

Barrett, L. F. (2015a). Construction as an integrative framework for the science of emotion. In L. F. Barrett & J. A. Russell (Eds.), *The psychological construction of emotion* (pp. 448–458). New York: Guilford Press.

Barrett, L. F. (2015b). Ten common misconceptions about the psychological construction of emotion. In L. F. Barrett & J. A. Russell (Eds.), *The psychological construction of emotion* (pp. 45–79). New York: Guilford Press.

Barrett, L. F., & Bliss-Moreau, E. (2009). Affect as a psychological primitive. *Advances in Experimental Social Psychology, 41*, 167–218.

Barrett, L. F., Lindquist, K., Bliss-Moreau, E., Duncan, S., Gendron, M., Mize, J., et al. (2007). Of mice and men: Natural kinds of emotion in the mammalian brain? *Perspectives on Psychological Science, 2*, 297–312.

Barrett, L. F., Mesquita, B., Ochsner, K. N., & Gross, J. J. (2007). The experience of emotion. *Annual Review of Psychology, 58*, 373–403.

Barrett, L. F., & Russell, J. A. (1998). Independence and bipolarity in the structure of current affect. *Journal of Personality and Social Psychology, 74*, 967.

Barrett, L. F., & Russell, J. A. (1999). Structure of current affect. *Current Directions in Psychological Science, 8*, 10–14.

Barrett, L. F., & Satpute, A. B. (2013). Large-scale brain networks in affective and social neuroscience: Towards an integrative functional architecture of the brain. *Current Opinion in Neurobiology, 23*, 361–372.

Barrett, L. F., & Simmons, W. K. (2015). Interoceptive predictions in the brain. *Nature Reviews Neuroscience, 16*, 419–429.

Bartra, O., McGuire, J. T., & Kable, J. W. (2013). The valuation system: A coordinate-based meta-analysis of BOLD fMRI experiments examining neural correlates of subjective value. *NeuroImage, 76*, 412–427.

Bateman, A., & Fonagy, P. (2006). *Mentalization-based treatment for borderline personality disorder: A practical guide*. Oxford, UK: Oxford University Press.

Baucom, L. B., Wedell, D. H., Wang, J., Blitzer, D. N., & Shinkareva, S. V. (2012). Decoding the neural representation of affective states. *NeuroImage, 59*, 718–727.

Beck, A. T. (2005). The current state of cognitive therapy: A 40-year retrospective. *Archives of General Psychiatry, 62*, 953–959.

Belova, M. A., Paton, J. J., & Salzman, C. D. (2008). Moment-to-moment tracking of state value in the amygdala. *Journal of Neuroscience, 28*, 10023–10030.

Berntson, G. G., & Cacioppo, J. T. (2008). The neuroevolution of motivation. In J. Y. Shah & W. L. Gardner (Eds.), *Handbook of motivation science* (pp. 188–200). New York: Guilford Press.

Binder, J. R. (2009). fMRI of language systems. In M. Filippi (Ed.), *fMRI techniques and protocols* (pp. 323–351). New York: Springer-Humana Press.

Binder, J. R., & Desai, R. H. (2011). The neurobiology of semantic memory. *Trends in Cognitive Sciences, 15*(11), 527–536.

Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation: I. Defensive and appetitive reactions in picture processing. *Emotion, 1*, 276–298.

Buckner, R. L., & Carroll, D. C. (2007). Self-projection and the brain. *Trends in Cognitive Science, 11*, 49–57.

Buckner, R. L. (2012). The serendipitous discovery of the brain's default network. *NeuroImage, 62*(2), 1137–1145.

Buhle, J. T., Silvers, J. A., Wager, T. D., Lopez, R., Onyemekwu, C., Kober, H., et al. (2014). Cognitive reappraisal of emotion: a meta-analysis of human neuroimaging studies. *Cerebral Cortex, 24*(11), 2981–2990.

Cacioppo, J. T., Crites, S. L., Berntson, G. G., & Coles, M. G. (1993). If attitudes affect how stimuli are processed, should they not affect the event-related brain potential? *Psychological Science, 4*, 108–112.

Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1999). The affect system has parallel and integrative processing components: Form follows function. *Journal of Personality and Social Psychology, 76*, 839–855.

Cacioppo, J. T., Tassinary, L. G., & Berntson, G. G. (2000). Psychophysiological science. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of psychophysiology* (2nd ed., pp. 3–26). New York: Cambridge University Press.

Chang, C., & Lin, C. (2011). LIBSVM: A library for support vector machines. *ACM Transactions on Intelligent Systems and Technology, 2*, 1–27.

Chikazoe, J., Lee, D. H., Kriegeskorte, N., & Anderson, A. K. (2014). Population coding of affect across stimuli, modalities and individuals. *Nature Neuroscience, 17*, 1114–1122.

Clithero, J. A., & Rangel, A. (2013). Informatic parcellation of the network involved in the computation of subjective value. *Social Cognitive and Affective Neuroscience, 9*, 1289–1302.

Clore, G. L., & Ortony, A. (2008). Appraisal theories: How cognition shapes affect into emotion. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 628–642). New York: Guilford Press.

Clore, G. L., & Ortony, A. (2013). Psychological construction in the OCC model of emotion. *Emotion Review, 5*, 335–343.

Corbetta, M., Patel, G., & Shulman, G. L. (2008). The reorienting system of the human brain: From environment to theory of mind. *Neuron, 58*(3), 306–324.

Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience, 3*, 201–215.

Cosmides, L., & Tooby, J. (2004). Social exchange: The evolutionary design of a neurocognitive system. In M. S. Gazzaniga (Ed.), *The cognitive neurosciences* (3rd ed., pp. 1295–1308). Cambridge, MA: MIT Press.

Cunningham, W. A. (2013). Introduction to special section: Psychological constructivism. *Emotion Review, 5*, 333–334.

Edelman, G. M. (1989). *The remembered present: A biological theory of consciousness*. New York: Basic Books.

Edelman, G. M., & Gally, J. A. (2001). Degeneracy and complexity in biological systems. *Proceedings of the National Academy of Sciences USA, 98*, 13763–13768.

Ekman, P. (1972). Universal and cultural differences in facial expressions of emotion. In J. Cole (Ed.), *Nebraska Symposium on Motivation* (Vol. 19, pp. 207–284). Lincoln: University of Nebraska Press.

Ekman, P. (1999). Basic emotions. In T. Dalgleish & T. Power (Eds.), *The handbook of cognition and emotion* (pp. 45–60). New York: Wiley.

Ekman, P. (2004, April). What we become emotional about. In A. S. R. Manstead, N. Frijda, & A. Fischer (Eds.), *Feelings and emotions: The Amsterdam symposium* (pp. 119–135). New York: Cambridge University Press.

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic. *Emotion Review, 3*, 364–370.

Ellsworth, P. C., & Scherer, K. R. (2003). Appraisal processes in emotion. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 572–595). New York: Oxford University Press.

Farroni, T., Menon, E., Rigato, S., & Johnson, M. H. (2007). The perception of facial expressions in newborns. *European Journal of Developmental Psychology, 4*, 2–13.

Feldman, L. A. (1995). Variations in the circumplex structure of mood. *Personality and Social Psychology Bulletin, 21*, 806–817.

Friedman, B. H. (2010). Feelings and the body: The Jamesian perspective on autonomic specificity of emotion. *Biological Psychology, 84*, 383–393.

Frijda, N. H. (1986). *The emotions*. New York: Cambridge University Press.

Friston, K. J., & Price, C. J. (2003). Degeneracy and redundancy in cognitive anatomy. *Trends in Cognitive Sciences, 7*, 151–152.

Gendron, M., Roberson, D., & Barrett, L. F. (2015). Cultural variation in emotion perception is real: A response to Sauter et al. *Psychological Science, 26*, 357–359.

Gendron, M., Roberson, D., van der Vyver, J. M., & Barrett, L. F. (2014a). Cultural relativity in perceiving emotion from vocalizations. *Psychological Science, 25*, 911–920.

Gendron, M., Roberson, D., van der Vyver, J. M., & Barrett, L. F. (2014b). Perceptions of emotion from facial expressions are not culturally universal: Evidence from a remote culture. *Emotion, 14*, 251–262.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*, 271.

Gross, J. J. (Ed.). (2007). *Handbook of emotion regulation*. New York: Guilford Press.

Gross, J. J. (2010). The future's so bright, I gotta wear shades. *Emotion Review, 2*, 212–216.

Gross, J. J., & Barrett, L. F. (2011). Emotion generation and emotion regulation: One or two depends on your point of view. *Emotion Review, 3*, 8–16.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*, 348–362.

Gross, J. J., & Thompson, R. A. (2007). Emotion regulation: Conceptual foundations. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 3–24). New York: Guilford Press.

Guillory, S. A., & Bujarski, K. A. (2014). Exploring emotions using invasive methods: Review of 60 years of human intracranial electrophysiology. *Social Cognitive and Affect Neuroscience, 9*, 1880–1889.

Halgren, E., Walter, R. D., Cherlow, D. G., & Crandall, P. H. (1978). Mental phenomena evoked by electrical stimulation of the human hippocampal formation and amygdala. *Brain, 101*, 83–115.

Have-de Labije, J. T., & Neborsky, R. J. (2012). *Mastering intensive short-term dynamic psychotherapy: A roadmap to the unconscious.* London: Karnac.

Hayes, D. J., Duncan, N. W., Xu, J., & Northoff, G. (2014). A comparison of neural responses to appetitive and aversive stimuli in humans and other mammals. *Neuroscience and Biobehavioral Reviews, 45*, 350–368.

Irwin, M. R., & Cole, S. W. (2011). Reciprocal regulation of the neural and innate immune systems. *Nature Reviews Immunology, 11*, 625–632.

Izard, C. E. (1993). Four systems for emotion activation: Cognitive and noncognitive processes. *Psychological Review, 100*, 68.

Izard, C. E. (2007). Basic emotions, natural kinds, emotion schemas and a new paradigm. *Perspectives on Psychological Science, 2*, 260–280.

Kassam, K. S., Markey, A. R., Cherkassky, V. L., Loewenstein, G., & Just, M. A. (2013). Identifying emotions on the basis of neural activation. *PLoS ONE, 8*, e66032.

Kober, H., Barrett, L. F., Joseph, J., Bliss-Moreau, E., Lindquist, K., & Wager, T. D. (2008). Functional grouping and cortical–subcortical interactions in emotion: A meta-analysis of neuroimaging studies. *NeuroImage, 42*, 998–1031.

Kotsoni, E., de Haan, M., & Johnson, M. H. (2001). Categorical perception of facial expressions by 7-month-old infants. *Perception, 30*, 1115–1126.

Kotz, S. A., Kalberlah, C., Bahlmann, J., Friederici, A. D., & Haynes, J. D. (2012). Predicting vocal emotion expressions from the human brain. *Human Brain Mapping, 34*, 1971–1981.

Kragel, P. A., & LaBar, K. S. (2014). Advancing emotion theory with multivariate pattern classification. *Emotion Review, 6*(2), 160–174.

Kriegeskorte, N., & Kievit, R. A. (2013). Representational geometry: Integrating cognition, computation, and the brain. *Trends in Cognitive Sciences, 17*, 401–412.

Kriegeskorte, N., Mur, M., & Bandettini, P. (2008). Representational similarity analysis: Connecting the branches of systems neuroscience. *Frontiers in Systems Neuroscience, 2*, 4.

Kring, A. M. (2008). Emotion disturbances as transdiagnostic processes in psychopathology. In M . Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 691–705). New York: Guilford Press.

Lammel, S., Ion, D. I., Roeper, J., & Malenka, R. C. (2011). Projection-specific modulation of dopamine neuron synapses by aversive and rewarding stimuli. *Neuron, 70*(5), 855–862.

Lammel, S., Lim, B. K., Ran, C., Huang, K. W., Betley, M. J., Tye, K. M., et al. (2012). Input-specific control of reward and aversion in the ventral tegmental area. *Nature, 491*(7423), 212–217.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual.* Gainesville, FL: University of Florida.

Larsen, J. T., McGraw, A. P., Mellers, B. A., & Cacioppo, J. T. (2004). The agony of victory and the thrill of defeat: Mixed emotional reactions to disappointing wins and relieving losses. *Psychological Science, 15*, 325–330.

Larsen, J. T., McGraw, P., & Cacioppo, J. (2001). Can people feel happy and sad at the same time? *Journal of Personality and Social Psychology, 81*, 684.

Larsen, R. J., & Diener, E. (1992). Promises and problems with the circumplex model of emotion. In M. S. Clark (Ed.), *Review of personality and social psychology: Emotional and social behavior* (Vol. 14, pp. 25–59). Newbury Park, CA: Sage.

Lazarus, R. S. (1991). *Emotion and adaptation.* New York: Oxford University Press.

LeDoux, J. (2012). A neuroscientist's perspective on debates about the nature of emotion. *Emotion Review, 4*, 375–379.

Levenson, R. W. (2011). Basic emotion questions. *Emotion Review, 3*, 379–386.

Levenson, R. W. (2014). The autonomic nervous system and emotion. *Emotion Review,* 6, 100–112.

Lewis, M. (1993). The emergence of human emotions. In M. Lewis & J. M. Haviland-Jones (Eds), *Handbook of emotions* (2nd ed., pp. 253–322). New York: Guilford Press.

Lindquist, K. A., & Barrett, L. F. (2012). A functional architecture of the human brain: Insights from emotion. *Trends in Cognitive Sciences, 16*, 533–540.

Lindquist, K. A., Satpute, A. B., & Gendron, M. (2015). Does language do more than communicate emotion? *Current Directions in Psychological Science, 24*, 99–108.

Lindquist, K. A., Satpute, A. B., Wager, T. D., Weber, J., & Barrett, L. F. (2015, January 28). The brain basis of positive and negative affect: Evidence from a meta-analysis of the human neuroimaging literature. *Cerebral Cortex.*

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavior and Brain Sciences, 35*, 121–143.

Liu, X., Hairston, J., Schrier, M., & Fan, J. (2011). Common and distinct networks underlying reward valence and processing stages: A meta-analysis of functional neuroimaging studies. *Neuroscience and Biobehavioral Reviews, 35*, 1219–1236.

Lynch, T. R., Trost, W. T., Salsman, N., & Linehan, M. M. (2007). Dialectical behavior therapy for borderline personality disorder. *Annual Review of Clinical Psychology, 3*, 181–205.

Maroda, K. J. (2010). *Psychodynamic techniques: Working with emotion in the therapeutic relationship.* New York: Guilford Press.

Mauro, R., Sato, K., & Tucker, J. (1992). The role of appraisal in human emotions: A cross-cultural study. *Journal of Personality and Social Psychology, 62*, 301.

Mayr, E. (1984). Typological versus population thinking. In E. Sober (Ed.), *Conceptual issues in evolutionary biology* (pp. 157–160). Cambridge, MA: MIT Press.

Mesulam, M. (2012). The evolving landscape of human cortical connectivity: Facts and inferences. *NeuroImage, 62*(4), 2182–2189.

Morrison, S. E., & Salzman, C. D. (2009). The convergence of information about rewarding and aversive stimuli in single neurons. *Journal of Neuroscience, 29*, 11471–11483.

Murphy, F. C., Nimmo-Smith, I., & Lawrence, A. D. (2003). Functional neuroanatomy of emotions: A meta-analysis. *Cognitive Affective and Behavoiral Neuroscience, 3*, 207–233.

Namburi, P., Beyeler, A., Yorozu, S., Calhoon, G. G., Halbert, S. A., Wichmann, R., et al. (2015). A circuit mechanism for differentiating positive and negative associations. *Nature, 520*, 675–678.

Norman, G. J., Norris, C. J., Golan, J., Ito, T. A., Hawkley, L. C., Larsen, J. T., et al. (2011). Current emotion research in psychophysiology: The neurobiology of evaluative bivalence. *Emotion Review, 3*, 349–359.

Norris, C. J., Golan, J., Berntson, G. G., & Cacioppo, J. T. (2010). The current status of research on the structure of evaluative space. *Biological Psychology, 84*, 422–436.

Northoff, G., Heinzel, A., de Greck, M., Bermpohl, F., Dobrowolny, H., & Panksepp, J. (2006). Self-referential processing in our brain: A meta-analysis of imaging studies on the self. *NeuroImage, 31*, 440–457.

Ochsner, K. N., Ray, R. R., Hughes, B., McRae, K., Cooper, J. C., Weber, J., et al. (2009). Bottom-up and top-down processes in emotion generation: Common and distinct neural mechanisms. *Psychological Science, 20*(11), 1322–1331.

Olofsson, J. K., Nordin, S., Sequeira, H., & Polich, J. (2008). Affective picture processing: An integrative review of ERP findings. *Biological Psychology, 77*, 247–265.

Oosterwijk, S., Touroutoglou, A., & Lindquist, K. A. (2015). The neuroscience of construction: What neuroimaging can tell us about how the brain creates the mind. In L. F. Barrett & J. A. Russell (Eds.), *The psychological construction of emotion* (pp. 111–143). New York: Guilford Press.

Osgood, C. E. (1952). The nature and measurement of meaning. *Psychological Bulletin, 49*, 197–237.

Osgood, C. E., May, W. H., & Miron, M. S. (1975). *Cross-cultural universals of affective meaning.* Urbana: University of Illinois Press.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions.* New York: Oxford University Press.

Panksepp, J. (2007). Neurologizing the psychology of affects: How appraisal-based constructivism and basic emotion theory can coexist. *Perspectives on Psychological Science, 2*, 281–296.

Panksepp, J., & Watt, D. (2011). What is basic about basic emotions?: Lasting lessons from affective neuroscience. *Emotion Review, 3*, 387–396.

Park, B. J., Jang, E. H., Chung, M. A., & Kim, S. H. (2013). Design of prototype-based emotion recognizer using physiological signals. *ETRI Journal, 35*(5), 869–879.

Parkinson, B. (1996). Emotions are social. *British Journal of Psychology, 87*, 663–683.

Paton, J. J., Belova, M. A., Morrison, S. E., & Salzman, C. D. (2006). The primate amygdala represents the positive and negative value of visual stimuli during learning. *Nature, 439*, 865–870.

Phan, K., Wager, T., Taylor, S., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *NeuroImage, 16*, 331–348.

Posner, M. I., & Keele, S. W. (1968). On the genesis of abstract ideas. *Journal of Experimental Psychology, 77*, 353.

Reynolds, S. M., & Berridge, K. C. (2008). Emotional environments retune the valence of appetitive versus fearful functions in nucleus accumbens. *Nature Neuroscience, 11*, 423–425.

Roseman, I. J. (1991). Appraisal determinants of discrete emotions. *Cognition and Emotion, 5*, 161–200.

Roseman, I. J., & Smith, C. A. (2001). Appraisal theory: Overview, assumptions, varieties, controversies. In K. R. Scherer, A. Schorr, & T. Johnstone (Series Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 3–19). New York: Oxford University Press.

Roy, M., Shohamy, D., & Wager, T. D. (2012). Ventromedial prefrontal–subcortical systems and the generation of affective meaning. *Trends in Cognitive Sciences, 16*, 147–156.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39*, 1161.

Russell, J. A. (1991). Culture and the categorization of emotions. *Psychological Bulletin, 110*, 426.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*, 145.

Russell, J. A., & Carroll, J. M. (1999). On the bipolarity of positive and negative affect. *Psychological Bulletin, 125*, 3–30.

Salzman, C. D., & Fusi, S. (2010). Emotion, cognition, and mental state representation in amygdala and prefrontal cortex. *Annual Review of Neuroscience, 33*, 173–202.

Saarimäki, H., Gotsopoulos, A., Jääskeläinen, I. P., Lampinen, J., Vuilleumier, P., Hari, R., et al. (2015). Discrete neural signatures of basic emotions. *Cerebral Cortex.*

Satpute, A. B., Wilson-Mendenhall, C. D., Kleckner, I. R., & Barrett, L. F. (2015). Emotional experience. In A. W. Toga (Ed.), *Brain mapping: An encyclopedic reference* (pp. 65–72). Waltham, MA: Academic Press.

Sauter, D. A., Eisner, F., Ekman, P., & Scott, S. K. (2010). Cross-cultural recognition of basic emotions through nonverbal emotional vocalizations. *Proceedings of the National Academy of Sciences USA, 107*, 2408–2412.

Sauter, D. A., Eisner, F., Ekman, P., & Scott, S. K. (2015). Emotional vocalizations are recognized across cultures regardless of the valence of distractors. *Psychological Science, 26*, 354–356.

Schacter, D. L., Addis, D. R., Hassabis, D., Martin, V. C., Spreng, R. N., & Szpunar, K. K. (2012). The future of

memory: Remembering, imagining, and the brain. *Neuron, 76*(4), 677–694.
Scherer, K. R. (1984). Emotion as a multicomponent process: A model and some cross-cultural data. In P. Shaver (Ed.), *Review of personality and social psychology* (Vol. 5, pp. 37–63). Beverly Hills, CA: Sage.
Scherer, K. R. (1993). Neuroscience projections to current debates in emotion psychology. *Cognition and Emotion, 7*, 1–41.
Scherer, K. R. (2001). Appraisal considered as a process of multilevel sequential checking. *Appraisal Processes in Emotion: Theory, Methods, Research, 92*, 120.
Seeley, W. W., Menon, V., Schatzberg, A. F., Keller, J., Glover, G. H., Kenna, H., et al. (2007). Dissociable intrinsic connectivity networks for salience processing and executive control. *Journal of Neuroscience, 27*, 2349–2356.
Shenhav, A., Botvinick, M. M., & Cohen, J. D. (2013). The expected value of control: An integrative theory of anterior cingulate cortex function. *Neuron, 79*, 217–240.
Siegel, E. H., Sands, M. K., Condon, P., Chang Y., Dy, J., Quigley, K. S., et al. (2015). *Emotion fingerprints or emotion populations?: A meta-analytic investigation of autonomic features of emotion categories*. Manuscript submitted for publication.
Smith, C. A. (1989). Dimensions of appraisal and physiological response in emotion. *Journal of Personality and Social Psychology, 56*, 339.
Smith, C. A., & Ellsworth, P. C. (1985). Patterns of cognitive appraisal in emotion. *Journal of Personality and Social Psychology, 48*, 813–838.
Stemmler, G. (1989). The autonomic differentiation of emotions revisited: Convergent and discriminant validation. *Psychophysiology, 26*, 617–632.
Thagard, P., & Schröder, T. (2013). Emotions as semantic pointers: Constructive neural mechanisms. In L. F. Barrett & J. A. Russell (Eds.), *The psychological construction of emotions* (pp. 144–167). New York: Guilford Press.
Tomkins, S. S. (1962). *Affect, imagery, consciousness: The positive affects*. New York: Springer.
Tomkins, S. S. (1963). *Affect, imagery, consciousness: The negative affects*. New York: Springer.
Tovote, P., Fadok, J. P., & Luthi, A. (2015). Neuronal circuits for fear and anxiety. *Nature Reviews Neuroscience, 16*, 317–331.
Touroutoglou, A., Lindquist, K. A., Dickerson B. C., & Barrett, L. F. (2015). Intrinsic connectivity in the human brain does not reveal networks for "basic" emotions. *Social Cognitive and Affective Neuroscience*.
Tracy, J. L., & Randles, D. (2011). Four models of basic emotions: A review of Ekman and Cordaro, Izard, Levenson, and Panksepp and Watt. *Emotion Review, 3*, 397–405.
Tsunozaki, M., Chalasani, S. H., & Bargmann, C. I. (2008). A behavioral switch: cGMP and PKC signaling in olfactory neurons reverses odor preference in C. elegans. *Neuron, 59*, 959–971.
Tye, K. M., & Deisseroth, K. (2012). Optogenetic investigation of neural circuits underlying brain disease in animal models. *Nature Reviews Neuroscience, 13*, 251–266.
van den Heuvel, M. P., & Sporns, O. (2013). Network hubs in the human brain. *Trends in Cognitive Sciences, 17*, 683–696.
Vytal, K., & Hamann, S. (2010). Neuroimaging support for discrete neural correlates of basic emotions: A voxel-based meta-analysis. *Journal of Cognitive Neuroscience, 22*, 2864–2885.
Wager, T. D., Barrett, L. F., Bliss-Moreau, E., Lindquist, K., Duncan, S., Kober, H., et al. (2008). The neuroimaging of emotion. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *The handbook of emotions* (3rd ed., pp. 249–271). New York: Guilford Press.
Wager, T. D., Kang, J., Johnson, T. D., Nichols, T. E., Satpute, A. B., & Barrett, L. F. (2015). A Bayesian model of category-specific emotional brain responses. *PLoS Computational Biology, 11*, 1–27.
Wager, T. D., Phan, K. L., Liberzon, I., & Taylor, S. F. (2003). Valence, gender, and lateralization of functional brain anatomy in emotion: A meta-analysis of findings from neuroimaging. *NeuroImage, 19*, 513–531.
Watson, D., & Clark, L. A. (1997). The measurement and mismeasurement of mood: Recurrent and emergent issues. *Journal of Personality Assessment, 86*, 267–296.
Watson, D., & Tellegen, A. (1985). Toward a consensual structure of mood. *Psychological Bulletin, 98*, 219–235.
Widen, S., & Russell, J. A. (2008). Young children's understanding of others' emotions. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 348–363). New York: Guilford Press.
Wierzbicka, A. (1992). *Semantics, culture, and cognition: Universal human concepts in culture-specific configurations*. New York: Oxford University Press.
Wilson-Mendenhall, C. D., Barrett, L. F., & Barsalou, L. W. (2014). Variety in emotional life: Within-category typicality of emotional experiences is associated with neural activity in large-scale brain networks. *Social Cognitive and Affective Neuroscience, 10*, 62–71.
Wundt W. (1998). *Outlines of psychology*. Bristol, UK: Thoemmes Press. (Original work published 1897)
Yarkoni, T., Poldrack, R. A., Nichols, T. E., Van Essen, D. C., & Wager, T. D. (2011). Large-scale automated synthesis of human functional neuroimaging data. *Nature Methods, 8*, 665–670.
Yuen, K. S. L., Johnston, S. J., De Martino, F., Sorger, B., Formisano, E., Linden, D. E. J., et al. (2012). Pattern classification predicts individuals' responses to affective stimuli. *Translational Neuroscience, 3*, 278–287.
Zautra, A. J., Potter, P. T., & Reich, J. W. (1997). The independence of affects is context-dependent: An integrative model of the relationship between positive and negative affect. In M. P. Lawton & K. W. Schaie (Eds.), *Annual review of gerontology and geriatrics* (pp. 75–103). New York: Springer.

CHAPTER 9

EMOTION AND THE AUTONOMIC NERVOUS SYSTEM

Wendy Berry Mendes

A glance at some of the classic review papers and chapters on emotion and autonomic nervous system (ANS) physiology reveals a common thread—evoking William James's (1884) quote on the essential conditions for what should be considered an emotion: "the only emotions I propose expressly to consider here are those that have a distinct bodily expression" (p. 189). It is no wonder that emotion researchers and theorists who consider the biological underpinnings of emotion use this quote as justification for looking "under the skin" at bodily responses as a window into affective and emotional states.

James's perspective is but one of many factors that sets the stage for examining how ANS responses change during emotion states. ANS responses and emotion reactions share similar temporal features; emotion responses are described as short-lived, experiences that, on average, last seconds to a couple of minutes. This temporal window aligns well with typical ANS changes as opposed to neural activation often measured in milliseconds or neuroendocrine and immunological changes measured over hours or days. Additionally, emotion responses are perceived as being "felt" in the body and folk language implicates bodily changes in these processes. Feeling sick to your stomach when experiencing disgust; a racing heart when walking down a dark, deserted street; or hot, sweaty palms when furious seem to effortlessly couple the emotional state and the bodily change. Given this apparent natural coupling it is not surprising that a large literature has amassed examining the relation between emotion experiences and ANS changes.

There are, however, many factors that modulate the *emotion–physiology link* limiting the straightforward conclusion that a discrete emotion experience is reliably and universally associated with specific changes in ANS responses. Rather than viewing the many factors that moderate the emotion–ANS link as obstacles, it may be more useful to consider the moderators as opportunities to understand how emotions are manifested in the brain and body, and how contextual factors extend our knowledge about emotion. In this chapter, I provide an overview of research examining the links between emotion and peripheral physiology, ignoring neuroendocrine and immune responses, which are covered in Chapter 37 (see Prather, this volume) and neural activation, covered in Chapter 8 (see Clark-Polner, Wager, & Barrett, this volume). First, I review research that examines relations between emotion and peripheral physiology, and then address the moderators that can alter the emotion–physiology link, specifically, context, developmental factors, and sociocultural environments. Due to space constraints, the literature reviewed is illustrative rather than comprehensive. The chapter begins with a primer on psychophysiological theory and ANS functioning that serves to both orient the reader to the most commonly measured physiological systems used in the study of emotion, and identifies some of the limitations inherent in examining physiological responses to understand emotion and emotion processes.

Peripheral Physiological Systems

A number of biological systems have been implicated in emotional experiences, including sympathetic and parasympathetic nervous systems, hemodynamic, enteric, neuroendocrine, immune, and neural. A common feature of these biological systems is that their *primary* functions have little, if anything, to do with emotions. The sympathetic nervous system (SNS) is designed to provide oxygenated blood to the brain and body to support movement; the parasympathetic system can coregulate SNS responses and supports homeostasis during sleep; the gastrointestinal system breaks down food for energy and excretes waste. These biological systems can change during emotion experiences, providing the foundation for these systems to be examined in emotion research, but the presence of changes in any of these systems does not indicate that an emotional experience occurred, and the reverse is true as well—a lack of response does not indicate the emotion did not occur.

As described in the first chapter of the *Handbook of Psychophysiology* (Cacioppo, Tassinary, & Berntson, 2000, 2007), inferring mental states from physiological changes poses several challenges, including the idea that *many* mental states can influence specific physiological changes and that a specific mental state is related to *many* physiological responses. In adopting a biological systems approach to understanding emotions, the literature is clear that one-to-one invariants of emotional states and physiological changes that exist across contexts and people are rare, if not nonexistent (e.g., Cacioppo et al., 2007; Kreibig, 2010; Siegel et al., 2016). The pursuit of unearthing invariants between emotion and psychophysiology might be a noble one—the entire field would benefit if a single channel of physiological responses changed predictably and precisely with the presence of an emotional state, regardless of context, culture, or character—but it is also likely misguided. Patterned physiological responses, looking across a variety of physiological changes, linked to emotion states provides a step in the right direction (e.g., Friedman, 2010; Kreibig, 2010; Levenson, 2014; Stemmler, Heldmann, Pauls, & Scherer, 2001), particularly if the panel of physiological responses are not strongly correlated with one another. In addition to looking across a variety of physiological responses, a deep understanding of the individual differences and cultural and contextual factors that influence emotion, along with an appreciation of the developmental, physical, and environmental factors that affect physiology, can enable researchers to augment their understanding of the emotion–physiology relationship.

At the broadest level, relations between peripheral physiology and emotion can be construed in terms of their *sensitivity* and *specificity.* Sensitivity is the extent to which the physiological responses reliably change as a function of shifts in emotion states with the idea that subtle shifts would affect highly *sensitive* measures, but measures that are lower in sensitivity would take more intense emotion states to observe changes. Skin conductance (SC), for example, is highly sensitive because very subtle and low-level changes in emotion can affect SC levels. In contrast, blood pressure (BP) changes are less sensitive given that the emotional experience needs to be fairly intense to alter BP levels (Mendes, 2009).

Specificity refers to how physiological responses are related to discrete mental states, with low specificity indicating that a physiological response is related to many mental states and high specificity indicating that a physiological response is related to fewer or (possibly) a single mental state. Using SC again as an example, though it is highly sensitive, it is not specific. Many affective states, even emotions with different valence like anger and enthusiasm, can engender SC increases (e.g., Kreibig, 2010; Shiota, Neufeld, Yeung, Moser, & Perea, 2011).

The constructs of sensitivity and specificity are crucial to understanding and predicting associations between emotions and peripheral physiological responses, though these relationships can be modified by context. Staying with the example of SC, if the context is constrained such that a smaller array of emotions are likely to be experienced, then one might be on firmer ground to conclude that the physiological response is a reasonable measure of the emotional experience. For example, the threat of experiencing an electric shock reliably increases SC, and while some people might interpret the increased SC as synonymous with the experience of *fear*, others might conclude that SC responses are tracking threat detection, general arousal, or intensity (e.g., LeDoux, 2014). Importantly, it is unlikely that increased SC in the electric shock context indicates an emotion like happiness or disgust. Thus constraining the context can improve the specificity of the emotion–

physiology relationship by limiting the number of likely emotional states that can be experienced.

Autonomic Nervous System

The ANS comprises two major branches: the SNS and the parasympathetic nervous system (PNS), both of which are commonly examined in studies on emotion and physiology, and many measures represent hybrid responses that are influenced by both systems simultaneously. Indeed, the division of the systems is more didactic than functional given the vast number of bodily changes influenced by the *combination* of these systems and the extent to which the SNS and PNS influence each other, which can be reciprocal, coinhibited, coactivated, or orthogonal (Berntson, Cacioppo, & Quigley, 1993).

The SNS functions, in part, to mobilize oxygenated blood from the heart to peripheral sites such as arms, hands, legs, feet, and the brain. The greatest change in SNS responding occurs with physical exertion, like sprinting or intense aerobic exercise. But this system also activates in *nonmetabolically demanding* situations, ones that do not by necessity require an increase in oxygenated blood. Measures that tap aspects of SNS that are commonly used in emotion research include heart rate (HR)/interbeat interval, SC, finger pulse transit time, BP, skin temperature, preejection period (PEP), stroke volume/cardiac output, and local/global blood flow measures (pulse amplitude, total peripheral resistance). Most of these measures tend to be highly correlated with one another, suggesting that studies that examine multiple SNS measures to look at patterns of physiological responses might be unwittingly inflating Type 1 errors if they are not accounting for the common variance in the measures.

The PNS is typically assessed with heart rate variability (HRV) measures such as cardiac vagal responses. Initially, HRV—the time interval between each heart beat—was believed to be a measurement artifact or nuisance, but further exploration into spontaneous changes in the timing of the heart cycle proved to be psychologically and physiologically meaningful. Though there are still disagreements on the specifics related to measurement, quantification, and psychological meaningfulness of HRV, these measures are often used by emotion psychophysiologists, given their putative sensitivity to valence and links to social engagement processes (Larsen, Berntson, Poehlmann, Ito, & Cacioppo, 2008; Porges, 2007).

Porges's (e.g., 2007) polyvagal theory is commonly evoked in studies examining emotional states associated with HRV/vagal changes. Polyvagal theory argues that primates uniquely have vagal nerve modulation (but see Grossman & Taylor, 2007), which has evolved as part of the *social engagement system*. Thus one of the primary postulates of polyvagal theory is that social factors (affiliation, social engagement), personality factors (optimism, bonding, attachment), and emotional states (positive emotions, compassion) can modulate cardiac vagal responses. Thus, higher resting vagal tone is suggested to serve as an index of adaptive regulation and responsiveness to the social environment.

The vast majority of studies examining peripheral physiological responses and emotion focus on one, some, or all of these responses identified above. To a lesser extent emotion researchers have examined responses like electrogastrography (EGG), respiration, or muscle tension. Some of the less commonly examined responses will be reviewed below.

Debate on ANS Specificity of Emotion

Even though peripheral physiological responses are widely integrated in emotion theories, there remain hotly debated theoretical perspectives on how best to conceive of emotions and consequent physiological responses. These arguments include whether there exists a specific identifiable physiological pattern that underlies distinct, "basic" emotions; if physiological patterning maps onto the more dimensional aspects of emotion, like approach–avoid tendencies and positive–negative valence; if subtypes of discrete emotions have patterned physiology; and whether contexts trigger core psychological states (i.e., "ingredients") that engender physiological reactions that are then labeled with emotion words (e.g., Barrett, 2006; Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000; Kreibig, 2010; Levenson, 2014; Quigley & Barrett, 2014).

One of the enduring perspectives argues that "basic emotions" have a specific patterning of physiological responses that differentiates anger, fear, disgust, sadness, and happiness (e.g., Ekman, Levenson, & Friesen, 1983). The strong version of this argument suggests that patterned physiological responses related to the experience of discrete emotions occur across human and nonhuman animals, persists across the lifespan, and are unmodified by context (Ekman, 1993). Over the past few decades, much has been written in support of and against this strong version of autonomic specificity of emotions (see Lang, 2014; Levenson, 2014; Norman, Berntson, & Cacioppo, 2014, for recent discussions).

Evidence in favor of the strong view of autonomic specificity of emotions comes from cross-cultural studies and literature reviews (e.g., Levenson, 2003). For example, Levenson (1992) and colleagues traveled to West Sumatra, a large island in Indonesia, and measured a panel of physiological responses from the Minangkabau during the "directed facial action" task. The task requires the movement of facial muscles to create a configuration tied to a discrete emotion while seven peripheral physiological responses were obtained: HR, finger transit time, finger temperature and SC, finger amplitude, respiration period, and respiration depth. They also obtained measures from a U.S. sample using the same paradigm. Although the mean responses for HR, finger temperature, and finger pulse transit time were greater in the U.S. sample than the Minangkabau for all five emotions examined, the patterning of the responses were similar—for example, HR and finger temperature were higher during experiences of anger compared with disgust. The authors concluded that the two cultures "evidenced patterns of emotion-specific ANS activity that were similar," though they followed this with the point that these data did "not [establish] universality" (p. 983).

More recently, Kreibig (2010) identified 134 studies utilizing ANS measures and concluded that there was "considerable ANS response specificity in emotion when considering subtypes of distinct emotions" (p. 394) but also pointed to the need to incorporate ANS measures beyond ones that are the easiest to obtain (e.g., HR and SC). Echoing this point, Levenson identified rarely studied physiological responses in emotion research that might be more reliably related to emotions such as visible changes in coloration, moisture and secretion, protrusions, and appearance of eyes, which are all ANS mediated (Levenson, 2003, 2014). In sum, claims that specific emotions show ANS patterning come from (1) cross-cultural research showing similar patterned responses to basic emotions, and (2) narrative reviews supporting similar directional changes in physiology as a function of the emotion experienced. Finally, it may be the case that emotion psychophysiologists have simply fallen prey to focusing on responses that are the easiest to measure (Levenson, 2003)—akin to looking for lost keys under the light, rather than where they were dropped.

Evidence against the strong view of patterned physiological responses mapping onto discrete emotions comes from meta-analytic approaches that suggest that physiological patterning might relate to more basic *ingredients* of emotions (e.g., Barrett, 2006). For example, in the meta-analyses that appeared in two editions of the *Handbook of Emotion* (Cacioppo, Berntson, et al., 2000; Larsen et al., 2008), the authors concluded that motivational tendencies embedded within emotional states show some consistent ANS patterning. Specifically, approach-oriented emotional states in which there is an expectation for the need to mobilize energy are more likely to activate the SNS than emotional states in which there is no expectation of energy reserves. This is consistent with the biopsychosocial model of challenge and threat, which relies on cardiovascular reactivity to differentiate general *approach* (or challenge) orientation from *avoidance* (or threat) orientation (Blascovich & Mendes, 2010; Mendes & Park, 2014). Also aligned with this perspective is the overlap between fear and defensive/threat responding. LeDoux's (2014) animal work on how the brain detects threats and the consequent identification of neural "fear systems" was called "a mistake that has led to much confusion" by LeDoux himself (p. 2871). Instead, LeDoux argues that animal research shows reflexive motivational responses linked to threat detection more akin to defensive responding than "fear" as an emotional state.

In a more recent meta-analysis of over 300 articles neither traditional meta-analytic techniques nor multivariate pattern classification revealed consistent evidence for autonomic signatures of discrete emotions (Siegel et al., 2016). Based on their results, the authors made two observations about autonomic patterning. First, that there was pervasive variability in autonomic responses during instances of discrete emotions and second, that autonomic patterning was tied to experimental context in which it was induced, though the authors acknowledged that the extant literature was biased in such a way that context and emotion were often confounded. These meta-analytic findings are consistent with the perspective that the *context* in which emotions are examined can alter the physiological responses more than the specific emotion experienced (Lang, Bradley, & Cuthbert, 1997).

Underscoring the heterogeneity of physiological responses that has been observed when examining discrete emotions, some studies have shown different patterns of physiological responses to presumably the same emotion category. Shenhav and Mendes (2014) examined gastrointestinal, SNS, and PNS changes during different types of disgust experiences. Participants were randomly assigned to watch one of three different collections of videos: one condition showed individuals suffering painful injuries and accidents in which legs and arms were contorted beyond natural mobility, but no breaking of the body envelope occurred (e.g., no spilling of bodily fluids or blood); a second condition showed individuals with breaking of the body envelope with emissions of blood, puss, and vomit, and people consuming disgusting things; the third collection consisted of neutral stimuli, landscapes, landmarks, animals, and people in rural and urban areas. Participants in the first two conditions labeled the emotion they were feeling as "disgust" more than any other emotion label provided and showed greater activation of the levator labii (i.e., the muscle region surrounding the nose previously linked to *disgust*) relative to participants viewing neutral stimuli. However, participants watching breaking of the body envelope videos showed decreases in gastrointestinal activity and HR acceleration, whereas viewing painful injuries was associated with no changes in gastrointestinal responses, HR deceleration, and HRV increases. Thus two instantiations of the same emotion, disgust, using the same medium (watching videos) produced similar self-reported and facial expressions, but different physiological patterning of the SNS, PNS, and the enteric nervous system. Together these perspectives suggest greater variability in physiological patterns within the same emotion category, and provide support for a perspective on the "ingredients" of emotions or core motivational properties more likely to share similar physiological patterning—with body envelope breakage engendering more avoidance responses and others' pain experiences engendering more approach-oriented responses (Barrett, 2006; Mendes & Park, 2014).

Emotion researchers often ask "What type of data would be needed to resolve the debate of ANS-specificity of emotional states?" Researchers have suggested organization of peripheral responding along evolved neural circuitry might provide a stronger basis for examining emotion–physiology relations (Lang, 2014). Other researchers have noted the paucity of work examining ANS-mediated changes in bodily expressions that might be more closely tied to emotion experiences that manifest in observable bodily changes. For example, responses like piloerections (goosebumps), blushing, sweating, salivating, tearing, and bulging or twinkling eyes (Levenson, 2014), might reveal distinctions across discrete emotions not previously observed with the typically examined ANS responses, like HR and SCR. Still others have urged researchers to take seriously the social and cultural context, individual differences, and developmental factors that alter how emotions are manifested in the body (Barrett, 2006; Mendes, 2010; Mendes & Park, 2014). Whether any of these approaches resolve this debate remains to be seen, but it is likely that most emotion physiologists would agree that multiple measures—which are not dually regulated—and attention to temporal, contextual, and developmental factors are more likely to lead to better insight into the nature of emotion–physiology relations.

Effects of Emotion on Peripheral Psychophysiology

Previous articles and chapters have reviewed the literature examining physiological responses stemming from emotion states (e.g., Cacioppo, Berntson, et al., 2000; Larsen et al., 2008; Kreibig, 2010). To provide added value here, I use a different organizing principle than what is typically used—where the organizing feature focuses at the level of the emotion category. Instead, the review here is organized by physiological systems. The intention is to show how easy it is to overinfer emotion states as having a distinct physiological signature if the organizing principle is at the level of the specific emotion. Instead, if the organizational structure is sorted by physiological responses, it becomes apparent how multiple mental states—not just emotional states, but also stress, cognition, and motivation—can trigger the same physiological response.

Sympathetic Nervous System

SNS increases have been linked to a variety of emotional states, including ones that differ in valence, and other mental states including effort, motivation, cognition, salience, and stress. Changes in SNS can be assessed in a variety of ways with the most common measures being SC, HR/interbeat interval, pulse transit time, and PEP. These aforementioned responses are not perfect proxies for one another, with each one characterized by different underlying physiological processes (e.g., SC increases are innervated by acetylcholine, whereas cardiac increases by epinephrine). These responses also differ in the extent to which they are dually innervated by the SNS and PNS versus solely influenced by SNS. PEP, for example, is a chronotropic measure based on the time from the left ventricle contracting to the opening of the aortic valve. As such, it is one of the few nondually innervated measures representing solely SNS activation. However, measurement of PEP, most typically assessed using impedance cardiography, tends to be more difficult to obtain than other responses like SC or electrocardiography, and is more costly and requires considerable expertise.

HR and SC changes are the most commonly used peripheral measures in emotion research. As described earlier it is not surprising that these measures are ubiquitous given these responses are sensitive to a variety of internal and external information, and have a predictable, short-lived response that mirrors common emotional reactions. Emotions as varied as fear, amusement, anger, sadness, and disgust reliably bring about HR and SC changes (Kreibig, 2010; Larsen et al., 2008), but so do mental states like effort (Wright & Kirby, 2001), acute stress (Dickerson & Kemeny, 2004; Fredrickson & Matthews, 1990; Jacobs Friedman, Parker, Tofler, Jimenez, et al., 1994), mind wandering (Smallwood, O'Connor, Sudbery, & Obonsawin, 2007), active coping (Obrist, 1976), attention (Pribram & McGuinness, 1975), and rumination (Brosschot, Gerin, & Thayer, 2006; see Figure 9.1). Because these measures are sensitive to many mental states, it is best to conceive of these responses as primarily indicating larger categories of mental states such as mental demand, saliency, general arousal, or effort (Dawson, Schell, & Filion, 2000). This leaves emotion researchers in a difficult position because if the hypothesis is, for example, that an HR response is larger in one discrete emotion than a different emotion, the onus is on the researcher to equate the intensity of the emotion experiences from the different contexts used to induce the emotion. That is, if one wanted to compare HR responses in fear to anger, one would have to resolve the problem of equating the intensity of the emotional stimuli. Would the fear

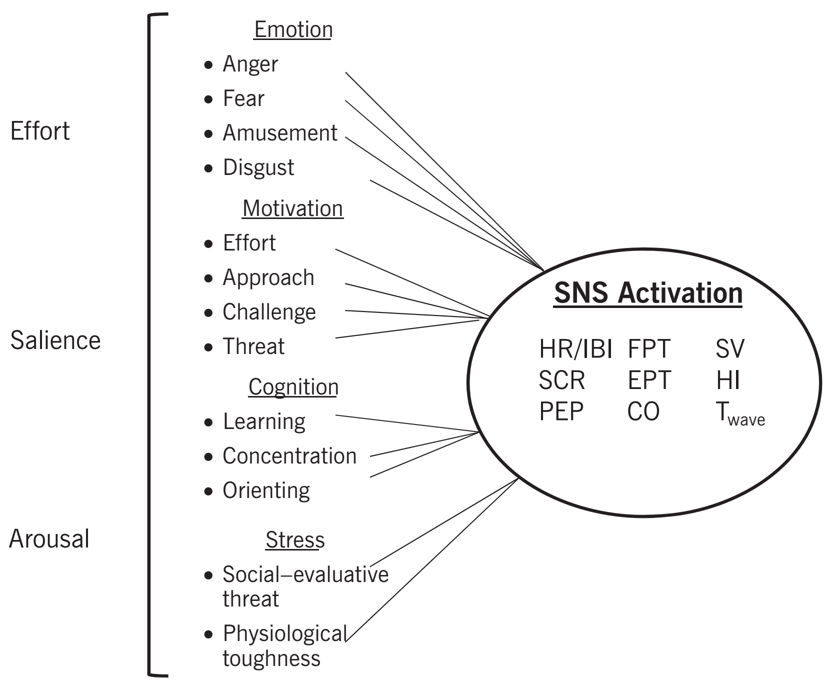

FIGURE 9.1. Sympathetic nervous system (SNS) activation associated with multiple mental states: emotional, motivational, cognitive, and acute stress. HR: heart rate; IBI: interbeat interval; FPT: finger pulse transit time; SV: stroke volume; SCR: skin conductance response; EPT: ear pulse transit time; HI: heather index; PEP: preejection period; CO: cardiac output; Twave: amplitude of T segment.

of a spider presented to someone with arachnophobia be as intense as a derogatory racist insult leveled at a marginalized minority? Because the variety of contexts that engender emotions varies greatly and those contexts differ in many ways, the question of which emotion elicits greater HR or SC can be a frustrating and nonfruitful endeavor.

Does moving to a measure of SNS that is solely innervated solve this problem? Changes in PEP (shorter PEP indicates greater SNS activation) have been observed during anger inductions (Herrald & Tomaka, 2002; Mauss, Cook, Cheng, & Gross, 2007; Mendes, Major, McCoy, & Blascovich, 2008) relative to emotions like shame or motivational states like threat. Though PEP decreases have also been associated with emotions like joy, disgust, and embarrassment (Kreibig, 2010). Considering other mental states, PEP decreases are associated with active coping (Obrist, 1976), and motivational states of threat *and* challenge (Blascovich & Mendes, 2010; Mendes, 2009; Seery, 2013). Much less work includes measurements obtained from impedance cardiography so it is unclear whether this type of measurement will reveal more emotion specificity than measures that are dually innervated (see Norman et al., 2014, for a discussion on why these "purer" measures might reveal more reliable associations).

Though I have treated these SNS measures as separate entities, it is not uncommon to combine these measures to form a composite index (Cole et al., 2001; Murphy, Steele, & Gross, 2007; Roberts, Levenson, & Gross, 2008). The value of doing so is to optimize the common signal across measures and minimize the noise inherent in each measure. On the one hand, this approach can be useful because it might reduce *researcher degrees of freedom* that might be exploited if one collected many measures and then reported just the one(s) that was significant (Simmons, Nelson, & Simonsohn, 2011). On the negative side of the ledger many of the measures have distinct underlying physiological processes, and by combining the measures we might end up learning less about the underlying physiological responses. Composite measures also make it difficult to conduct meaningful meta-analyses since there are not agreed-upon standards of what determines the composite measure.

Parasympathetic Nervous System

There are several measures of the PNS that can be reliably obtained using fairly inexpensive technology and without a lot of experimenter or participant burden (see Allen, 2002). One of the most common measures of PNS used by emotion researchers is high-frequency heart rate variability (HF/HRV), also commonly referred to as respiratory sinus arrhythmia (RSA). It is not surprising that emotion researchers rely on RSA given its putative links to relevant affective states like attachment and social engagement. Cardiac vagal tone (or resting HRV) has been associated with dispositional emotional styles (Demaree & Everhart, 2004; Oveis et al., 2009; Sloan et al., 2001). For example, individuals with greater hostile tendencies have lower cardiac vagal tone at baseline, during an emotional induction task, and at recovery than those lower in hostility (Demaree & Everhart, 2004; Sloan et al., 2001). On the brighter side, Oveis and colleagues (2009) found that those higher in optimism had higher vagal tone. Accumulating evidence suggests that vagal tone might be a reasonable physiological response to index general positive and negative affect with the caveat that particularly high levels of vagal tone might be detrimental; Kogan and colleagues (2014) observed a quadratic relationship between cardiac vagal activity and prosocial behavior such that extremely high levels of vagal tone were associated with fewer prosocial emotions and traits.

A variety of emotions have been associated with HRV decreases and increases that show some valence differences: negative emotions are more likely linked to decreases in HRV, whereas positive emotions might be linked with increases in HRV (Figure 9.2). In support of a valence interpretation of HRV, in a study examining the benefits of implicit goal setting, students were interviewed about their grades while HRV was obtained. Those who exaggerated their obtained grade point average (GPA) during the interview subsequently earned a higher GPA in a later semester. Critical HRV changes mediated the relationship between exaggeration and improvement such that the greater the HRV decreases the *less* students improved and this effect was corroborated by behavioral coding supporting the idea that participants with greater HRV decreases appeared *more* anxious during the interview (Gramzow, Willard, & Mendes, 2008). Evidence showing that HRV increases can be linked with positive outcomes include a recent study that showed that induced compassion, compared with other positive emotion inductions (like pride or inspiration), was associated with higher levels of HRV (Stellar, Cohen, Oveis, & Keltner, 2015). But again, the directional HRV effects associated with valence is far from invariant. For ex-

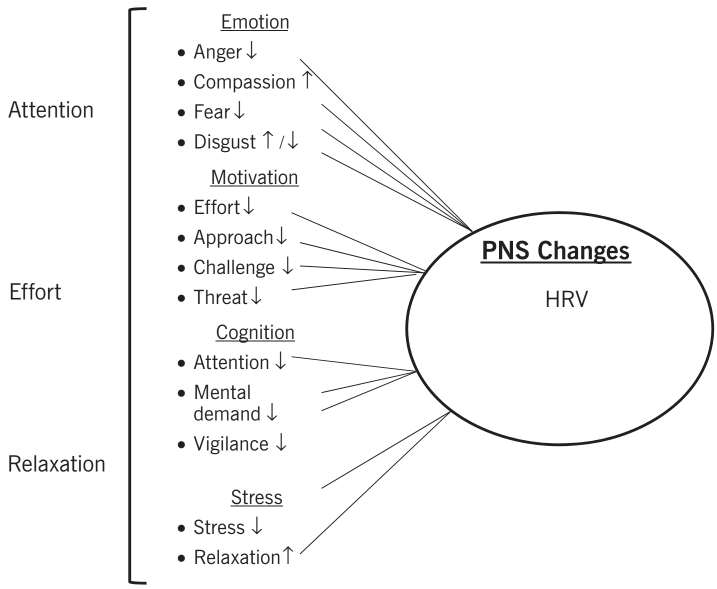

FIGURE 9.2. Parasympathetic nervous system (PNS) changes are associated with multiple mental states: emotional, motivational, cognitive, and acute stress. Arrows indicate the direction of the PNS activation. HRV: heart rate variability.

ample, in the Shenhav and Mendes (2014) study looking at different types of disgust, the condition in which participants watched videos of individuals suffering injuries and experiencing twisted limbs was associated with an *increase* in HRV relative to those watching videos with body envelope breakage. Interestingly, there are commonalities in the stimuli across the "compassion" study and the "disgust" study. In the Stellar et al. (2015) paper, the stimuli included photos of starving children, homeless individuals, and injured animals (Study 2), which shares many features with the disgust condition from Shenhav and Mendes (2014), which used stimuli of people also suffering and potentially experiencing grave and unfortunate outcomes like falling off buildings and extreme sports accidents. Thus HRV reactivity might be associated with fundamental features of the emotion experience that are not best described by the emotion categories (disgust, compassion, anxiety) but instead by interest, attention, and motivational states, like approach and avoid.

Like SNS activation, PNS changes have been linked to mental states that are viewed as part of the stress response or are more cognitive or motivational. Indeed, cognitive psychophysiologists use HRV decreases to index attention and mental effort (Tattersall & Hockey, 1995), and Porges (e.g., 2007) uses the example of target shooting as a reliable task that is associated with HRV decreases. In one study relying on this interpretation, Kassam, Koslov, and Mendes (2009) examined HRV decreases during a judgment and decision-making task and found that greater HRV decreases were associated with more accurate performance, specifically, more accurate responding on an anchoring and adjustment task. Following this logic, HRV on average decreases reliably during a visual tracking task (Cavanagh & Alvarez, 2005), and individual differences in the amount of HRV decreases predicts social perception accuracy and social sensitivity (Muhtadie, Koslov, Akinola, & Mendes, 2015).

Some studies have used emotional and cognitive interpretations to explain the same effect. In a stereotype threat study, Croizet et al. (2004) examined changes in HRV and found that participants primed with threatening stereotypes of their group showed decreases in HRV during a test of "intellectual diagnosticity" and poorer performance than those in the nonstereotyped threat group, and the greater the decrease in HRV, the worse participants performed on the test. However, in the nonstereotyped group, HRV also decreased during the "intellectual test" but the greater the decrease in HRV, the *better* participants performed on the test (though this path was short of significance), which was interpreted as indicated more effort. This work underscores how presumably different mental states (distress compared with mental effort) are associated with a similar physiological response (decrease in HRV) but can have different influences on behavior and performance.

Hemodynamic Responses

BP and precursors of BP, like total peripheral resistance (TPR), have been used by health psychologists for decades given their putative role in disease etiology like essential hypertension and cardiovascular disease. Given this link, BP is probably more closely identified with acute *stress* than emotional states. Hemodynamic changes are slower to respond than SNS activation and can be more challenging to measure continuously, which might also prevent emotion researchers from including these measures in their protocols (Mendes, 2009). Even with less accumulated evidence, reviews report increased BP across a variety of emotions and not necessarily tied to only negative emotional states—such as anger and fear—but also happiness and amusement (Kreibig, 2010; Siegel et al., 2016).

Research stemming from motivational theories often examines changes in BP. Wright and colleagues offer their effort mobilization theory, which relies on BP changes (typically systolic blood pressure [SBP]) and HR increases to index motivational effort (e.g., Wright & Kirby, 2001; Wright et al., 2007). In this perspective, SBP increases linearly with effort, which is consistent with the broader interpretation of SNS activation. Offering a nuanced perspective of motivational states is the *challenge and threat* theory (Blascovich & Tomaka, 1996; Blascovich & Mendes, 2010), which proposes that in active, goal-relevant contexts, appraisals of demands and resources interact to produce either general approach motivation (challenge), or avoidance orientation (threat). One of the physiological changes that best differentiates these psychological states is TPR. In threat states TPR increases, which represents a tightening of the arterioles so blood travel to peripheral sites is impaired, whereas challenge states are associated with increased blood flow to peripheral sites (Mendes, 2009).

In the broader stress literature, there tends to be little nuance in terms of what increases in BP indicates at a psychological level, and instead the broadest, catchall label "stress" is applied to increased BP responses (e.g., Matthews, Woodall, & Allen, 1993; Guyll, Matthews, & Bromberger, 2001). If emotion research can be characterized for forcing too many distinctions between discrete/specific emotions (i.e., *splitting*), stress research suffers from the opposite error of collapsing across possibly distinct mental states (i.e., *lumping*). The differences between emotion and stress research is most obvious when comparing experimental protocols using many of the measures reviewed here from papers claiming to be studying *stress* compared with those studying *emotion*. In many cases the paradigms are similar, even if the interpretations of the mental states are different, likely leading to the common expression "Stress is what is studied in medical schools; emotion is what is studied in psychology departments."

Moderators of the Emotion–Physiology Link

The previous sections may present what seems like an unwieldy literature on ANS responses to emotional states, but a different way to interpret these data is to consider the moderators that may reliably explain the variance in physiological responding across different studies. Thus far, the review of physiological responses associated with emotional states show that these relations are far from invariant. Adopting an approach that relaxes strong essentialist constraints provides a view of emotion that is flexible in terms of how emotions states are manifested in the brain and body. Attending to these moderators may be as important, or even more important, than the emotion category itself. Here, I outline key moderators that can alter the association between emotion and its physiological concomitants. Specifically, moderators such as context; including environment and bodily states (positioning of the body); cognitive states like labeling; developmental factors; and sociocultural factors can affect how emotions are manifested in the body. These factors can influence emotional experience, physiological responses to emotion, and the consequent behavior and feeling states that occur, which underscores the perspective that the emotion–physiology link is flexible and can be altered by top-down *and* bottom-up influences.

Context

Psychological science is replete with examples of how subtle features in the environment or minor tweaks of perspective can alter an emotional state. From holding a pen with one's teeth versus lips leading to more humorous reactions to comic strips (Strack, Martin, & Stepper, 1998) to clutching a warm cup of coffee influencing judgments of others' endearing personalities (Williams & Bargh, 2008), there are many demonstrations that bottom-up influences can alter emotion states, often without conscious awareness.

Bottom-up influences that directly affect the body and/or change the interpretation of the event can alter physiological responses of emotional states. An extensive body of nonhuman animal research work has explored "defensive" responses using rats that were classically conditioned to experience "fear" using acoustic responses and shocks. In one study, Iwata and LeDoux (1988) placed rats in either a cage where they were unrestrained, which allowed free movement, or restrained, which forced immobility. When exposed to an aversive signal, rats that were restrained had a different profile of physiological responses than rats that were unrestrained. Specifically, rats that were unrestrained showed greater HR acceleration relative to restrained rats. This study elegantly demonstrates the influence of context in modulating physiological outcomes to the (presumably) same emotion/affective state. If "fear-conditioned" rats have different physiological responses based on the *context* rather than the specific emotional state, then it is difficult to argue that fear invariably leads to a predictable physiological response. Instead, this finding shows that the context in which an emotion or affective state is experienced can shape the physiological pattern. One interpretation is that when rats' behavioral options are interpreted in terms of their potential to escape or not, the physiological responses provide functional support. When escape is possible, an increase in cardiac responses would allow for more oxygenated blood to innervate peripheral muscles, whereas when no escape is possible a reduction in sympathetic responses facilitates freezing and, in the case of a predator attack, the lower SNS reaction would reduce blood loss if attacked.

Context and body positioning interact in humans as well. In one study using electroencephalographic (EEG) responses, participants were seated either upright or supine while they experienced insults from a confederate, intended to engender an anger state (Harmon-Jones & Peterson, 2009). Those who were upright showed a shift in left-frontal cortical activation that occurs during anger and general *approach-oriented* states, whereas those who were supine did not show a shift in left-frontal cortical activity. Self-reported anger *did not differ* by body position, underscoring that physiological changes are often subtle and may be below conscious awareness. Importantly, like Iwata and LeDoux's (1998) restrained rats, putatively the same emotional state experienced in different contexts—in this example, in different body positions—have a different profile of physiological responses. Because anger is typically conceived as an approach-oriented emotion (Carver & Harmon-Jones, 2009), the conclusion was that an incongruent body position, leaning back when feeling angry, blunts a physiological response that co-occurs with the emotional state.

We recently extended this question by exploring if a body position could *potentiate* an affective state and, as a consequence, influence moral judgments. In a recent study, we examined whether manipulated body positions would interact with experienced affective states to influence moral judgments (Park & Mendes, 2016). Participants were randomly assigned to experience anger or shame and were orthogonally assigned to one of three body positions: leaning forward, leaning away, and upright/control. When participants were induced to experience anger and were in an approach (leaning forward) body position, they were more likely to endorse utilitarian judgments—pushing a person out of a sinking lifeboat to save more lives. Similar to the EEG study above, this study demonstrates that emotional states are malleable and can be altered by body positions.

Cognitive Factors

How one identifies or cognitively interprets an emotion experience provides insight into how top-down influences shape emotion–physiology relations. Self-disclosure or expressive writing has long been suggested to be associated with better health, conceivably due to its ability to make sense of a traumatic event by reducing negative cognitive processes like rumination and preservative thinking (Frattaroli, 2006; Pennebaker, 1997). Following this line of reasoning, *labeling* experienced emotions has been linked to reduced amygdala responding to frightening or aversive stimuli (Lieberman et al., 2007). However, if labeling or disclosure occurs soon after the event, it might cement associations that bond the aversive label with the event. For example, Seery and colleagues (2008) used a nationally representative sample (more than 2,000 respondents) and queried them about their feelings and thoughts regarding September 11, 2001, within 24 hours of the attacks, and then followed them for several years to assess their physical and mental health trajectories (Seery et al., 2008). Those who expressed their thoughts and feeling immediately after the attacks had *worse* health outcomes than those who did not. Thus, reflection and cognitive activity around emotions may create more maladaptive binding of the cognitive components of the emotion and the downstream consequences.

To test the idea that immediate reporting of an emotional experience could change a subsequent physiological response, Kassam and Mendes (2013) randomly assigned participants to an emotion task designed to induce either external negative emotions (anger) or internal negative emotions (shame) and measured cardiovascular reactivity throughout the task (specifically, PEP, cardiac output, and total peripheral resistance). In addition to the emotion manipulation, participants were assigned to either a *reporting* condition or *no-reporting* condition. Quite simply, this manipulation consisted of participants in the reporting condition to self-report their experienced emotion throughout the study. Indeed, this condition mimicked most lab-based emotion studies that rely on self-reported emotions as the primary outcome variable. In contrast, the no-reporting condition did not have participants report on their emotions at any time during the study, and instead used self-reports of technology use as the instruments replacing self-reported emotions. If the act of self-reporting on an emotion state changes the experience of an emotion, then the physiological response might differ between the reporting and no-reporting conditions. Consistent with this prediction, emotion reporting changed physiological reactivity, but only when participants were assigned to the *anger* induction. When reporting on emotions and assigned to the anger induction, participants on average showed greater hemodynamic changes—increased peripheral resistance/increased BP—whereas participants who did not report on their emotional state showed greater cardiac increases and lower hemodynamic responses. Thus, the simple act of reporting on an emotional state changed the pattern of physiological responses even though the emotional induction did not differ. In contrast, among participants in the shame condition, reporting or not on emotional states did not differentially influence physiological reactions—shame was associated with increased cardiac reactivity and increased vascular resistance regardless of the reporting condition. The conclusion of this work was that self-conscious emotions, like shame, are not modified by deliberate and conscious appraisal of the emotional state, but emotions that might be highly contextualized, like anger, might be more modifiable by conscious processes.

Developmental Factors

Much of modern psychophysiological research assumes reliable mind–body connections—changes in emotional states influence bodily responses and the biological milieu can shape experienced emotions. However, connections between mental states and physiological changes are not static across the life course; at different developmental periods processes like *interoception*, *proprioception*, and *reactivity* can alter how emotions are experienced in the body.

As we age cognitive declines such as deterioration in short-term memory, reaction times, and attention occur even in the absence of neurological diseases (e.g., Levy, 1994). In the body, loss of muscle mass, deficiencies of growth hormones, hardening of the vasculature, and blunted activation reduces the flexibility of responding to different environmental demands (e.g., Epel, Burke, & Wolkowitz, 2007; Matthews, 2005). These bodily changes can alter how emotions are experienced. Most critically for understanding the role of the ANS in emotions is that aging bodies have greater difficulty mounting larger SNS increases, which may alter the emotional experience.

Consider the roles of proprioception and interoception in emotion experience and across the lifespan. Proprioception, the awareness of *external* body position during static and dynamic movement, and interoception, the awareness of *internal* bodily changes, both decline with older adulthood. Khalsa and colleagues (2009) examined interoception using a heartbeat detection paradigm with participants ranging in age from 22 to 63; older subjects showed poorer detection of their heart beats than younger and middle-age adults, and the overall bivariate correlation between age and accurate heart beat detection across two time points was approximately $r = -.47$. Similarly, proprioceptive impairments with age occur along varied dimensions of static and dynamic body positions (see Goble et al., 2009, for a review).

Declines in interoception and proprioception are not the only physiological changes that occur in aging that is relevant to emotional states. As people age there is a degrading and loss of flexibility of key physiological systems, like the SNS. For example, Levenson and colleagues found lower HR responses for anger, fear, and sadness in older adults compared with younger adults during a directed facial action task. In some cases younger adults had twice as large SNS increases as older adults (a finding that mirrors physical exercise).

Importantly, in research with older adults, high arousal emotions, like anger, did not engender increases in skin temperature that has been observed in younger adults (Levenson et al., 1991). Changes in the flexibility of the vasculature especially in the peripheral regions—arms and hands, legs and feet—are typically affected by neuropathy that occurs with aging and the extremities tend to be affected first. The lack of skin temperature increase during anger is especially interesting given that anger is characterized as having an approach orientation (Carver & Harmon-Jones, 2009) and has been associated with greater dilation of the arterioles allowing more blood to get to the effector muscles and periphery, which is one of the likely physiological changes that increases skin temperature during anger (Mendes et al., 2008). However, it is important to note that the flexibility of the vasculature is compromised in an asymmetrical manner with age—vessels can still constrict easily but are harder to dilate. Therefore, emotional states that have approach functions may be compromised before states of emotions with withdrawal or avoidance feature, which might become the default response in older age.

Evidence of declines in sensory perception of the body with age and how this decline can interrupt the mind–body connection has been used as evidence of *maturational dualism*, a phenomenon that suggests that the bodily changes that often co-occur with the aging process can influence the experience of affective states in specific ways (Mendes, 2009). Thus, for older adults, intentions, motivations, and emotions may be experienced in the mind (and brain) but not be embodied in the same way as they are in younger adults. The weakening of the mind–body connection in older adulthood is primarily due to a loss of peripheral perception and blunted physiological reactivity and may blunt the ability to use internal states to guide decisions and behavior.

The consequence for this loss in mind–body connections with age has implications for emotion–physiology relations. In a study examining the somatic marker hypothesis, older adults used bodily information to a lesser extent than younger adults (Denburg, Tranel, & Bechara, 2005). In previous papers, the somatic marker hypothesis posited that bodily states outside of conscious awareness can influence behavior (Bechara, Damasio, Tranel, & Damasio, 1997). To test this hypothesis, participants (brain damaged and control) were presented with four decks of cards with various gains and losses associated with the cards. Two of the decks resulted in overall losses—large gains, but large losses as well—whereas the other two decks resulted in smaller gains, but also smaller losses. They found that as participants turned over cards from the various decks, changes in SC co-occurred with choices from the riskier decks. Importantly, these bodily changes *preceded* conscious reporting of which decks were risky by approximately 40 trials. Thus, the somatic marker hypothesis claims that bodily changes can indicate psychological or mental states prior to conscious reporting. In the original article, normal participants were compared with patients with ventral medial lesions. While normal participants consciously reported which decks were risky by about the 40th trial, patients with lesions were not able to learn this pattern.

In the extension of this earlier study, older adults (56–85 years old) did not show preferences for the advantageous decks (Denburg et al., 2005). When examining individual responses, the authors reported that among the younger group, 37 out of 40 participants eventually picked from the advantaged deck; among the older group, only 15 out of 40 showed this same "unimpaired" pattern. The remaining older participants either showed more preference for the disadvantaged deck or no preference. It is unclear whether older participants had blunted physiological responses during the task, which limited their ability to sense internal states, or the physiological response was intact and as strong as that experienced by younger participants, but the ability to sense the bodily changes—interoceptive awareness—was diminished (Khalsa et al., 2009), or there was some neural impairment.

An implication of the loss in mind–body connections is that older individuals might have to rely more on the external environment to determine their internal states, and possibly their emotional experience. This is consistent with Cartensen's socioemotional selectivity theory, which describes a positivity effect in older adults including a shifting away from negative stimuli toward more positive stimuli (Carstensen, 2006). Another implication is that older participants would be more susceptible to suggestions of an emotional state since they might have to rely more on their external world to provide information about their internal states. Although theory and evidence suggest that environmental cues can strongly influence affective states and meaning (Barrett, 2006), the loss of the ability to detect internal states might make older participants more susceptible to environmental cues. Future studies exploring these ideas would be imperative to determine boundary conditions of mind–body relations.

Sociocultural Factors

The shaping of emotion via cultural displays and norms is a vibrant area of inquiry and several thorough reviews highlight critical features in how emotion is experienced and displayed across cultures (see Shweder, Haidt, Horton, & Joseph, 2007). Among many things, culture provides rules of appropriate and inappropriate expression (i.e., display rules) and this cultural context can shape how the body responds to emotional experiences. For example, expressions of anger may have different meanings in different cultures. In a Western culture, anger expression might indicate blocked goals and be aligned with feelings of frustration (e.g., Berkowitz, 1989). In East Asian cultures there is a strong normative prohibition to expressions of anger and tends to be reserved for those in high status or dominant positions (Park, Kitayama, Markus, Coe, Miyamoto, et al., 2013). Recently, Kitayama and colleagues (2015) examined two large related datasets from the United States and from Japan to compare anger expression and consequent physiological and biological health responses with the idea that because anger has different cultural rules around its expression, bodily changes associated with anger expression in the United States would be more detrimental than anger expression in the Japanese context. Relying on more than 1,000 U.S. participants and more than 500 Japanese participants, Kitayama and colleagues found that the interaction between anger expression and culture was significant in predicting physiological outcomes. Specifically, anger expression among Japanese was associated with better biological health, including lower resting BP, whereas in the U.S. context anger expression was associated with poorer health and higher BP.

Summary

The goal of this chapter was to review literature and theory relating to emotion and peripheral psychophysiology. If one adopted an essentialist, natural origin perspective on emotion, emotions would be predictable across the lifespan, resistant to ephemeral changes in the environment, sturdy to differences in language and labeling, and not modifiable by something as subtle as body positioning. However, across different research programs employing multiple methods there is evidence that emotions are manifested in the body in ways that do not respect boundaries around discrete emotions. Taken together, these data suggest that any emotion category for which common language applies—such as *anger*, *sadness*, or *shame*—result in a wide variety of physiological and behavioral consequences. Importantly, one should not conclude that emotion labels at this level of understanding are useless, they certainly are not, but rather that there are critical cognitive, bodily, and developmental moderators that influence the link from emotion to physiological responses. Attending to these moderatos may be as important, or even more important, than the emotion category itself.

References

Allen, J. J. (2002). Calculating metrics of cardiac chronotropy: A pragmatic overview. *Psychophysiology, 39*, S18.

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science, 1*, 28–58.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science, 275*(5304), 1293–1295.

Berkowitz, L. (1989). Frustration–aggression hypothesis: Examination and reformulation. *Psychological Bulletin, 106*(1), 59.

Berntson, G. G., Cacioppo, J. T., & Quigley, K. S. (1993). Respiratory sinus arrhythmia: Autonomic origins, physiological mechanisms, and psychophysiological implications. *Psychophysiology, 30*(2), 183–196.

Blascovich, J., & Mendes, W. B. (2010). Social psychophysiology and embodiment. In S. T. Fiske, D. T. Gilbert, & G. Lindzey (Eds.), *The handbook of social psychology,* (5th ed., pp. 194–227). New York: Wiley.

Blascovich, J., & Tomaka, J. (1996). The biopsychosocial model of arousal regulation. *Advances in Experimental Social Psychology, 28*, 1–51.

Brosschot, J. F., Gerin, W., & Thayer, J. F. (2006). The perseverative cognition hypothesis: A review of worry, prolonged stress-related physiological activation, and health. *Journal of Psychosomatic Research, 60*(2), 113–124.

Cacioppo, J. T., Berntson, G. G., Larsen, J. T., Poehlmann, K. M., & Ito, T. A. (2000). The psychophysiology of emotion. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed., pp. 173–191). New York: Guilford Press.

Cacioppo, J. T., Tassinary, L. G., & Berntson, G. G. (2000). *Handbook of psychophysiology, second edition*. New York: Cambridge University Press.

Cacioppo, J. T., Tassinary, L. G., & Berntson, G. (Eds.). (2007). *Handbook of psychophysiology*. New York: Cambridge University Press.

Carstensen, L. L. (2006). The influence of a sense of time on human development. *Science, 312*(5782), 1913–1915.

Carver, C. S., & Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological Bulletin, 135*(2), 183.

Cavanagh, P., & Alvarez, G. A. (2005). Tracking multiple targets with multifocal attention. *Trends in Cognitive Sciences, 9*(7), 349–354.

Cole, S. W., Naliboff, B. D., Kemeny, M. E., Griswold, M. P., Fahey, J. L., & Zack, J. A. (2001). Impaired response to HAART in HIV-infected individuals with high autonomic nervous system activity. *Proceedings of the National Academy of Sciences USA, 98*(22), 12695–12700.

Croizet, J. C., Després, G., Gauzins, M. E., Huguet, P., Leyens, J. P., & Méot, A. (2004). Stereotype threat undermines intellectual performance by triggering a disruptive mental load. *Personality and Social Psychology Bulletin, 30*(6), 721–731.

Dawson, M. E., Schell, A. M., & Filion, D. L. (2007). The electrodermal system. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of psychophysiology* (3rd ed., pp. 159–181). Cambridge, UK: Cambridge University Press.

Demaree, H. A., & Everhart, D. E. (2004). Healthy high-hostiles: Reduced parasympathetic activity and decreased sympathovagal flexibility during negative emotional processing. *Personality and Individual Differences, 36*(2), 457–469.

Denburg, N. L., Tranel, D., & Bechara, A. (2005). The ability to decide advantageously declines prematurely in some normal older persons. *Neuropsychologia, 43*(7), 1099–1106.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin, 130*(3), 355.

Ekman, P. (1993). Facial expression and emotion. *American Psychologist, 48*(4), 384.

Ekman, P., Levenson, R. W., & Friesen, W. V. (1983). Autonomic nervous system activity distinguishes among emotions. *Science, 221*(4616), 1208–1210.

Epel, E. S., Burke, H. M., & Wolkowitz, O. M. (2007). The psychoneuroendocrinology of aging: Anabolic and catabolic hormones. In C. M. Aldwin, C. L. Park, & A. Sprio III (Eds.), *Handbook of health psychology and aging* (pp. 119–141). New York: Guilford Press.

Frattaroli, J. (2006). Experimental disclosure and its moderators: a meta-analysis. *Psychological Bulletin, 132*(6), 823–865.

Fredrikson, M., & Matthews, K. A. (1990). Cardiovascular responses to behavioral stress and hypertension: A meta-analytic review. *Annals of Behavioral Medicine, 12*(1), 17–39.

Friedman, B. H. (2010). Feelings and the body: The Jamesian perspective on autonomic specificity of emotion. *Biological Psychology, 84*(3), 383–393.

Goble, D. J., Coxon, J. P., Wenderoth, N., Van Impe, A., & Swinnen, S. P. (2009). Proprioceptive sensibility in the elderly: degeneration, functional consequences and plastic-adaptive processes. *Neuroscience and Biobehavioral Reviews, 33*(3), 271–278.

Gramzow, R. H., Willard, G., & Mendes, W. B. (2008). Big tales and cool heads: Academic exaggeration is related to cardiac vagal reactivity. *Emotion, 8*(1), 138.

Grossman, P., & Taylor, E. W. (2007). Toward understanding respiratory sinus arrhythmia: Relations to cardiac vagal tone, evolution and biobehavioral functions. *Biological Psychology, 74*(2), 263–285.

Guyll, M., Matthews, K. A., & Bromberger, J. T. (2001). Discrimination and unfair treatment: Relationship to cardiovascular reactivity among African American and European American women. *Health Psychology, 20*(5), 315.

Harmon-Jones, E., & Peterson, C. K. (2009). Supine body position reduces neural response to anger evocation. *Psychological Science, 20*(10), 1209–1210.

Herrald, M. M., & Tomaka, J. (2002). Patterns of emotion-specific appraisal, coping, and cardiovascular reactivity during an ongoing emotional episode. *Journal of Personality and Social Psychology, 83*(2), 434.

Iwata, J., & LeDoux, J. E. (1988). Dissociation of associative and nonassociative concomitants of classical fear conditioning in the freely behaving rat. *Behavioral Neuroscience, 102*(1), 66.

Jacobs, S. C., Friedman, R., Parker, J. D., Tofler, G. H., Jimenez, A. H., Muller, J. E., et al. (1994). Use of skin conductance changes during mental stress testing as an index of autonomic arousal in cardiovascular research. *American Heart Journal, 128*(6), 1170–1177.

James, W. (1884). What is an emotion? *Mind, 34*, 188–205.

Kassam, K., Koslov, K., & Mendes, W. B. (2009). Decisions under distress: Stress profiles influence anchoring and adjustment. *Psychological Science, 20*, 1394–1399.

Kassam, K. S., & Mendes, W. B. (2013). The effects of measuring emotion: Physiological reactions to emotional situations depend on whether someone is asking. *PLoS ONE, 8*, e64959.

Khalsa, S. S., Rudrauf, D., Feinstein, J. S., & Tranel, D. (2009). The pathways of interoceptive awareness. *Nature Neuroscience, 12*(12), 1494–1496.

Kitayama, S., Park, J., Boylan, J. M., Miyamoto, Y., Levine, C. S., Markus, H. R., et al. (2015). Expression of anger and ill health in two cultures: An examination of inflammation and cardiovascular risk. *Psychological Science, 26*(2), 211–220.

Kogan, A., Oveis, C., Carr, E. W., Gruber, J., Mauss, I. B., Shallcross, A., et al. (2014). Vagal activity is quadratically related to prosocial traits, prosocial emotions, and observer perceptions of prosociality. *Journal of Personality and Social Psychology, 107*(6), 1051–1063.

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology, 84*, 394–421.

Lang, P. J. (2014). Emotion's response patterns: The brain and the autonomic nervous system. *Emotion Review*, 6, 93–99.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). Motivated attention: Affect, activation, and action. In P. J. Lang, R. F. Simons, & M. T. Balaban (Eds.), *Attention and orienting: Sensory and motivational processes* (pp. 97–135). Hillsdale, NJ: Erlbaum.

Larsen, J. T., Berntson, G. G., Poehlmann, K. M., Ito, T. A., & Cacioppo, J. T. (2008). The psychophysiology of emotion. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 180–195). New York: Guilford Press.

LeDoux, J. E. (2014). Coming to terms with fear. *Proceedings of National Academy of Science USA, 111*, 2871–2878.

Levenson, R. W. (1992). Autonomic nervous system differences among emotions. *Psychological Science, 3*(1), 23–27.

Levenson, R. W. (2003). Blood, sweat, and fears. *Annals of the New York Academy of Sciences, 1000*(1), 348–366.

Levenson, R. W. (2014). The autonomic nervous system and emotion. *Emotion Review,* 6, 100–112.

Levenson, R. W., Carstensen, L. L., Friesen, W. V., & Ekman, P. (1991). Emotion, physiology, and expression in old age. *Psychology and Aging,* 6(1), 28.

Levy, R. (1994). Aging-associated cognitive decline. *International Psychogeriatrics,* 6(01), 63–68.

Lieberman, M. D., Eisenberger, N. I., Crockett, M. J., Tom, S. M., Pfeifer, J. H., & Way, B. M. (2007). Putting feelings into words: Affect labeling disrupts amygdala activity in response to affective stimuli. *Psychological Science, 18*(5), 421–428.

Matthews, K. A. (2005). Psychological perspectives on the development of coronary heart disease. *American Psychologist,* 60(8), 783.

Matthews, K. A., Woodall, K. L., & Allen, M. T. (1993). Cardiovascular reactivity to stress predicts future blood pressure status. *Hypertension, 22*(4), 479–485.

Mauss, I. B., Cook, C. L., Cheng, J. Y., & Gross, J. J. (2007). Individual differences in cognitive reappraisal: Experiential and physiological responses to an anger provocation. *International Journal of Psychophysiology,* 66(2), 116–124.

Mendes, W. B. (2009). Assessing the autonomic nervous system. In E. Harmon-Jones & J. S. Beer (Eds.), *Methods in social neuroscience* (pp. 118–147). New York: Guilford Press.

Mendes, W. B. (2010). Weakened links between mind and body in older age: The case for maturational dualism in the experience of emotion. *Emotion Review, 2*, 240–244.

Mendes, W. B., Major, B., McCoy, S., & Blascovich, J. (2008). How attributional ambiguity shapes physiological and emotional responses to social rejection and acceptance. *Journal of Personality and Social Psychology, 94*, 278–291.

Mendes, W. B., & Park, J. (2014). Neurobiological concomitants of motivation states. In A. J. Elliot (Ed.), *Advances in motivation science* (pp. 233–270). Waltham, MA: Academic Press.

Muhtadie, L., Koslov, K., Akinola, M., & Mendes, W. B. (2015). Vagal flexibility: A physiological predictor of social sensitivity. *Journal of Personality and Social Psychology, 109*(1), 106–120.

Murphy, M. C., Steele, C. M., & Gross, J. J. (2007). Signaling threat: How situational cues affect women in math, science, and engineering settings. *Psychological Science, 18*(10), 879–885.

Norman, G. J., Berntson, G. G., & Cacioppo, J. T. (2014). Emotion, somatovisceral afference, and autonomic regulation. *Emotion Review,* 6(2), 113–123.

Obrist, P. A. (1976). The cardiovascular–behavioral interaction—as it appears today. *Psychophysiology, 13*(2), 95–107.

Oveis, C., Cohen, A. B., Gruber, J., Shiota, M. N., Haidt, J., & Keltner, D. (2009). Resting respiratory sinus arrhythmia is associated with tonic positive emotionality. *Emotion,* 9(2), 265.

Park, J., Kitayama, S., Markus, H. R., Coe, C. L., Miyamoto, Y., Karasawa, M., et al. (2013). Social status and anger expression: The cultural moderation hypothesis. *Emotion, 13*(6), 1122–1131.

Park, J., & Mendes, W. B. (2016). *Body positioning potentiates emotional responses on moral decision making.* Manuscript in preparation.

Pennebaker, J. W. (1997). Writing about emotional experiences as a therapeutic process. *Psychological Science,* 8(3), 162–166.

Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology, 74*(2), 116–143.

Pribram, K. H., & McGuinness, D. (1975). Arousal, activation, and effort in the control of attention. *Psychological Review, 82*(2), 116.

Quigley, K. S., Barrett, L. F. (2014). Is there consistency and specificity of autonomic changes during emotional episodes? Guidance from the conceptual act theory and psychophysiology. *Biological Psychology,* 98, 82–94.

Roberts, N. A., Levenson, R. W., & Gross, J. J. (2008). Cardiovascular costs of emotion suppression cross ethnic lines. *International Journal of Psychophysiology, 70*(1), 82–87.

Seery, M. D. (2013). The biopsychosocial model of challenge and threat: Using the heart to measure the mind. *Social and Personality Psychology Compass, 7*(9), 637–653.

Seery, M. D., Silver, R. C., Holman, E. A., Ence, W. A., & Chu, T. Q. (2008). Expressing thoughts and feelings following a collective trauma: Immediate responses to 9/11 predict negative outcomes in a national sample. *Journal of Consulting and Clinical Psychology, 76*(4), 657–667.

Shenhav, A., & Mendes, W. B. (2014). Aiming for the stomach and hitting the heart: Dissociable triggers and sources for disgust reactions. *Emotion, 14*, 301–309.

Shiota, M. N., Neufeld, S. L., Yeung, W. H., Moser, S. E., & Perea, E. F. (2011). Feeling good: Autonomic nervous system responding in five positive emotions. *Emotion, 11*(6), 1368.

Shweder, R. A., Haidt, J., Horton, R., & Joseph, C. (2007). The cultural psychology of the emotions: Ancient and renewed. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 409–427). New York: Guilford Press.

Siegel, E. H., Cannon, M., Condon, P., Chang, Y., Dy, J., Quigley, K. S., et al. (2016). *A meta-analytic search for autonomic signatures of emotion.*

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science, 22*(11), 1359–1366.

Sloan, R. P., Bagiella, E., Shapiro, P. A., Kuhl, J. P., Chernikhova, D., Berg, J., et al. (2001). Hostility, gender, and cardiac autonomic control. *Psychosomatic Medicine, 63*(3), 434–440.

Smallwood, J., O'Connor, R. C., Sudbery, M. V., & Obonsawin, M. (2007). Mind-wandering and dysphoria. *Cognition and Emotion, 21*(4), 816–842.

Stellar, J. E., Cohen, A., Oveis, C., & Keltner, D. (2015). Affective and physiological responses to the suffering of others: Compassion and vagal activity. *Journal of Personality and Social Psychology, 108*(4), 572–585.

Stemmler, G., Heldmann, M., Pauls, C. A., & Scherer, T. (2001). Constraints for emotion specificity in fear and anger: The context counts. *Psychophysiology, 38*(2), 275–291.

Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: A nonobtrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology, 54*(5), 768.

Tattersall, A. J., & Hockey, G. R. J. (1995). Level of operator control and changes in heart rate variability during simulated flight maintenance. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 37*(4), 682–698.

Williams, L. E., & Bargh, J. A. (2008). Experiencing physical warmth promotes interpersonal warmth. *Science, 322*(5901), 606–607.

Wright, R. A., Junious, T. R., Neal, C., Avello, A., Graham, C., Herrmann, L., et al. (2007). Mental fatigue influence on effort-related cardiovascular response: Difficulty effects and extension across cognitive performance domains. *Motivation and Emotion, 31*(3), 219–231.

Wright, R. A., & Kirby, L. D. (2001). Effort determination of cardiovascular response: An integrative analysis with applications in social psychology. *Advances in Experimental Social Psychology, 33*, 255–307.

CHAPTER 10

Genetic Contributions to Affect and Emotion

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As reviewed elsewhere in this volume, the expression and processing of human emotion relies on highly conserved and increasingly well-characterized biological machinery, which has been incrementally revealed using a variety of experimental methodologies, most notably functional magnetic resonance imaging (fMRI). As our understanding of the shared biological machinery of human emotion has developed, so too has our appreciation of considerable interindividual variability in its operating parameters (Hamann & Canli, 2004). Importantly, this biological variability is reflected in the wide range of expressed dispositional affective traits such as neuroticism and extraversion, which are in turn predictive of psychopathology risk (Bienvenu, Hettema, Neale, Prescott, & Kendler, 2007; Kendler, Kuhn, & Prescott, 2004). These advances and insights have led to growing interest in deepening our mechanistic understanding of individual differences in emotional brain function and related risk for psychopathology. This interest has fueled the development of large-scale neuroimaging studies that afford necessary power to reliably map individual differences in the biological machinery of human emotion (Bogdan, Perlis, Fagerness, & Pizzagalli, 2010; Carre, Hyde, Neumann, Viding, & Hariri, 2013; Stein et al., 2012). Parallel advances in molecular genetics have allowed for the further mapping of this variability onto common genetic variation.

A focus on relatively well-characterized neural circuits and molecular signaling pathways has proven to be particularly useful in the endophenotypic dissection of complex human affective traits, which has in turn provided more tractable substrates for genetic association studies. Thus, drawing on extensive cross-species functional neuroanatomy research, a large portion of the work examining genetic contributions to human emotion has focused on behavioral and neural phenomena pertaining to reward and threat processing. These basic behavioral and neural phenomena are largely subserved by the increasingly well-understood corticostriatal (CSC) and corticolimbic circuitries (CLC), respectively, and represent crucial component processes of more complex human affective and personality traits. Among those, most prominently, various facets of extraversion and positive emotionality have been mapped onto relatively increased signaling within the CSC (Cohen, Young, Baek, Kessler, & Ranganath, 2005; Hermes, Hagemann, Naumann, & Walter, 2011). Similarly, various facets of neuroticism and negative emotionality, including trait anxiety, have been mapped onto relatively higher levels of threat-related reactivity of the CLC (Cunningham, Arbuckle, Jahn, Mowrer, & Abduljalil, 2011; Fakra et al., 2009).

Despite the well-characterized nature of these circuits, the task of mapping the variability in their functioning onto common genetic variation is immensely challenging and, unsurprisingly, as of now, incomplete. The seeming complexity of this endeavor stems from the hypothesized contribution of multiple, perhaps thousands, of genetic variants within a multitude of biological systems, alongside environmental factors, to shaping those circuits as well as the way they give rise to emotion. Nonetheless, initial efforts have yielded promising insights into the basis of individual differences in the functioning of those circuits, and thus also more broadly into the biology of human affect and emotion.

There are currently two major approaches to identifying genetic contributions to variability in these and other phenotypes: (1) the historically older candidate gene approach, which examines the impact of individual genetic variants or biological systems known to be implicated in a particular trait of interest based on prior research; and (2) genomewide association studies (GWAS), which, thanks to recent technological advances, have afforded the examination of variants occurring throughout the genome and their potential contribution to a particular trait without the prioritization of any particular pathway or variant.

Each of these approaches has distinct advantages and disadvantages in an empirical setting. The candidate gene approach is more biologically informed and can successfully be used to explain variability in neural traits of interest even when using relatively small experimental groups. It is, however, limited in its dependence on prior empirical and theoretical work, which may not always be complete or accurate. In addition, it is limited in its relative inability to capture genetic variability occurring across multiple genes and systems, which are likely to simultaneously contribute to the complex neural and psychological traits pertaining to human emotion more broadly, as well as the functioning of the CSC and CLC specifically.

The GWAS approach is better suited to assess polygenic contributions to traits of interest, especially across multiple biological systems. However, GWASs require larger experimental groups (on the order of thousands or tens of thousands of individuals) in order to ensure adequate power to detect significant effects in the context of the multiple statistical tests being conducted. Given the high cost of fMRI, the approach has only been applied in a very limited way to studying the functioning of the CSC and CLC (Ousdal et al., 2012; Stein et al., 2011). In addition, while results from GWAS analyses can serve as powerful hypothesis generators, they are frequently difficult to interpret biologically without mechanistic follow-up by more targeted psychological or neuroscientific investigations, which frequently bear a striking resemblance to candidate gene studies. Thus, ultimately, candidate gene studies and GWAS represent complementary approaches, which can inform and fuel each other.

The current chapter focuses on the candidate gene perspective, not only because it has been adopted by the majority of studies on the genetics of emotion and its underlying circuitry to date, but also because it represents an approach more proximal to the biology of the phenotypes of interest, and thus also a medium through which basic research from the fields of molecular genetics and complex *in vivo* psychology and neuroscience work can be bridged. The biological pathways considered here are largely deemed most representative as regulators of each system or circuit on the basis of the current literature. However, it should be noted that additional pathways not extensively reviewed here may be implicated in the regulation of these and other affect-related phenotypes, and that the reviewed pathways may in turn regulate other non-affect-specific phenotypes as well.

Rather than discussing genetic contributions to behaviorally assessed emotion and affect in humans, this chapter reviews the genetic variants that have been most reliably mapped onto differences in the functioning of the CSC and CLC. The first section discusses genetic contributions to reward-related ventral striatum (VS) reactivity, broadly implicated in positive emotion and impulsivity. Next, we discuss genetic contributions to threat-related amygdala reactivity, broadly implicated in anxiety, neuroticism, and negative affect. The third section focuses on genetic contributions to the cognitive control of emotion. While the chapter focuses on the candidate gene approach, at the ends of the first two sections we also briefly present ways in which this approach has been modified and extended in recent years to incorporate technological and conceptual advances and overcome some of its limitations. Consistent with these recent advances, we also briefly outline future directions for this approach at the end of the chapter.

Genetic Contributions to Reward Processing and Positive Emotion

Reward processing and motivation are crucial for the adaptive engagement in goal-directed behavior and represent a pivotal component of positive affect and emotionality. Imaging genetics studies of positive emotion and reward processing have typically focused on the reactivity of the VS, which serves as a neural hub within the CSC, as well as the neurotransmitter dopamine (DA), because of the central role it plays in regulating reward-related and motivational processing, particularly in the VS.

The blood-oxygenation-level-dependent (BOLD) fMRI signal recorded in the VS during reward processing paradigms is widely thought to reflect increases in phasic DA activity, occurring upon the receipt of unexpected primary rewards or in response to a conditioned stimulus previously paired with reward. Lending support to this notion, multimodal neuroimaging research combining positron emission tomography (PET) and BOLD fMRI has shown that the magnitude of the VS response to monetary reward directly correlates with the amount of DA released in the same region following pharmacological challenge (Buckholtz et al., 2010). Thus, functional polymorphisms within genes involved in regulating each individual step of DA synthesis, signaling, and synaptic clearance are apt to create individual variability in CSC reactivity and reward processing as well as positive emotion on the behavioral level. Several commonly studied functional genetic polymorphisms affecting CSC function by modulating various steps of the DA signaling cascade are reviewed below.

The Dopamine Transporter

The dopamine transporter (DAT), encoded by the gene *SLC6A3*, is a protein with a key role in regulating DA neurotransmission. DAT binds DA after its release into the synaptic cleft and facilitates reuptake of the neurotransmitter into the presynaptic neuron. Thus, DAT helps regulate the duration and intensity of postsynaptic responses to dopaminergic inputs as well as the available presynaptic pool of DA (via recycling). DAT is expressed predominantly in the striatum, including the VS, where it plays a crucial role in modulating dopaminergic inputs from the ventral tegmental area (VTA)—the major source of DA in the CSC (Lewis et al., 2001; Sesack, Hawrylak, Matus, Guido, & Levey, 1998; Wayment, Schenk, & Sorg, 2001).

A variable number tandem repeat (VNTR) polymorphism termed "DAT1" occurs within a regulatory region near *SLC6A3* and results in several different variants (i.e., alleles) of the gene. The alleles range in length and can have anywhere between three and 13 repeats of the same small stretch of DNA, with the 9- and 10-repeat alleles being most frequent in the majority of world populations studied (Doucette-Stamm, Blakely, Tian, Mockus, & Mao, 1995; Kang, Palmatier, & Kidd, 1999; Mitchell et al., 2000). Although not all studies have found an effect of the DAT1 genotype on DAT expression levels (Martinez et al., 2001; Mill, Asherson, Craig, & D'Souza, 2005), several studies have linked the 9-repeat allele to reduced DAT availability (Arinami, Gao, Hamaguchi, & Toru, 1997; Cheon, Ryu, Kim, & Cho, 2005; Heinz et al., 2000; VanNess, Owens, & Kilts, 2005). The presence of the 9-repeat allele would then presumably lead to reduced DAT function, less efficient DA reuptake, and, ultimately, heightened CSC reactivity through increased synaptic levels of DA. Consistent with this notion, individuals carrying at least one copy of the low-expressing 9-repeat allele have been shown to have increased VS reactivity to positive feedback in a number-guessing BOLD fMRI paradigm, relative to individuals homozygous for the 10-repeat allele (Forbes et al., 2009).

Dopamine Receptors

In addition to reuptake mechanisms, DA signaling is also critically dependent on the properties of DA receptors. There are two major classes of DA receptors: D_1-like receptors, which have primarily excitatory functions and include DA receptors D_1 and D_5; and D_2-like receptors, which inhibit DA signaling (via either pre- or postsynaptic mechanisms) and include DA receptors D_2, D_3, and D_4 (Beaulieu & Gainetdinov, 2011).

The D_1 and D_5 DA receptors are encoded by the genes *DRD1* and *DRD5*, respectively. Partially due to the simpler structure and relatively conserved nature of those genes, few association studies have investigated the effects of D_1-like receptor variants on neural function. The molecular, cellular, neural, and behavioral effects of common polymorphisms within the D_2-like family have been studied much more extensively. Thus, the rest of the current DA signaling overview focuses on this class of receptors.

DA D_2 receptors, encoded by the *DRD2* gene, are most densely expressed in the VS, where they are located both pre- and postsynaptically (Beaulieu & Gainetdinov, 2011). Consistent with the inhibitory effect of D_2 receptor signaling on DA neurotransmission, imaging genetics studies have linked polymorphisms resulting in relatively reduced *DRD2* expression to heightened VS reactivity. Specifically, the deletion (Del) allele of a 1-point insertion (Ins)/Del polymorphism (rs1799732) occurring within the 5′ UTR of *DRD2*, frequently termed "*DRD2*-141C Ins/Del," has been associated with up to 78% reduction in striatal *DRD2* expression *in vitro* (Arinami et al., 1997) and increased VS reactivity to positive feedback in a BOLD fMRI number-guessing paradigm (Forbes et al., 2009).

Another commonly studied *DRD2* polymorphic locus is the *DRD2* Taq1A (rs1800497), which is a single nucleotide polymorphism (SNP) located in the adjacent ankyrin repeat and kynase domain containing one (*ANKK1*) gene and probably affects *DRD2* function only indirectly. Its two alleles T (A1) and C (A2) have been linked to relatively decreased and increased D_2 receptor availability, respectively (Jonsson et al., 1999; Pohjalainen et al., 1998). However, the C allele has been associated with increased striatal glucose metabolism (Noble, Gottschalk, Fallon, Ritchie, & Wu, 1997) and reactivity to reward (Stice, Spoor, Bohon, & Small, 2008). This pattern may reflect a specific effect of the *DRD2* Taq1A polymorphism on postsynaptic D_2 receptors localized on inhibitory gamma-aminobutyric acid (GABA) interneurons, which modulate striatal function by in turn inhibiting GABAergic medium spiny neurons, which are the predominant neuronal type in the human striatum. Thus, the C allele may result in increased DA-mediated inhibition of GABAergic interneurons leading to disinhibition of medium spiny neurons and thus, ultimately, increased VS reactivity measured with fMRI.

The DA D_4 receptor, encoded by the *DRD4* gene, mediates postsynaptic inhibition of DA signaling. Unlike *DRD2*, however, *DRD4* exhibits relatively low expression in the striatum (Jaber, Robinson, Missale, & Caron, 1996) and the lowest expression levels in the human brain of all DA receptors (Beaulieu & Gainetdinov, 2011; Rondou, Haegeman, & Van Craenenbroeck, 2010). Nonetheless, preliminary data suggest that the D_4 receptor is expressed at low levels postsynaptically on striatal neurons, as well as presynaptically on glutamatergic afferents from the prefrontal cortex (PFC) to the striatum (Jaber et al., 1996; Missale, Nash, Robinson, Jaber, & Caron, 1998; Tarazi, Campbell, Yeghiayan, & Baldessarini, 1998). Thus, D_4 receptor stimulation can inhibit striatal function either directly or indirectly, via one or both of these independent mechanisms. Based on these localization data, genetic variants associated with higher levels of D_4 function are likely to result in greater DA-mediated inhibition of postsynaptic target neurons and reduced striatal reactivity.

A common VNTR within the coding region of *DRD4* results in alleles of different length (ranging from two to 11 repeats), associated with differential gene transcription and protein function (Asghari et al., 1995). Specifically, the 7-repeat allele has been linked to reduced D_4 receptor sensitivity and reduced postsynaptic inhibition (Asghari et al., 1995). Consistent with the inhibitory role of D_4 receptors on striatal DA, the 7-repeat allele has also been linked to higher VS reactivity to positive feedback (Forbes et al., 2009). Finally, in line with its putative neurochemical effects, the same allele has been associated with increased approach to reward on the behavioral level (Roussos, Giakoumaki, & Bitsios, 2010). Taken together, these findings demonstrate that, despite its relatively low expression levels in the striatum, *DRD4* may play an important role in regulating the reactivity of the CSC and its associated behaviors.

Other Variants

Additional polymorphisms implicated in the regulation of DA signaling in the VS and CSC include the catechol-O-methyltransferase (*COMT*) gene Val158Met (rs4680) SNP (Dreher, Kohn, Kolachana, Weinberger, & Berman, 2009; Yacubian et al., 2007), and the monoamine oxidase A (*MAOA*) rs12843268 SNP (Nymberg et al., 2013). Both of these likely exert their effects on DA signaling through modulating the rate and efficiency of DA enzymatic degradation. In addition, COMT Val158Met may play a role in the cognitive control of emotion, as reviewed in the section "Genetic Contributions to the Cognitive Control of Emotion." Variants that modulate DA signaling more distally have also been implicated in the regulation of VS signaling. Notable examples include the C385A (rs324420) SNP in the fatty amino acid hydroxylase gene (*FAAH*), involved in the enzymatic degradation of endogenous cannabinoid neuromodulators (Hariri et al., 2009), A118G (rs1799971) in the mu-opioid receptor (*OPRM1*; Ramchandani et al., 2011), as well as rs2513281 within the *GAL* gene encoding the hypothalamic neuropeptide galanin (Nikolova, Singhi, Drabant, & Hariri, 2013). The effects and properties of these and other variants (e.g., Ramchandani et al., 2011) found to modulate human CSC function are summarized in Table 10.1.

TABLE 10.1. Genetic Variants Associated with Differences in CSC Reactivity.

Pathway	Molecule	Function	Gene	Polymorphism	Effect on gene/protein function	Neural effect	Seminal report
Dopamine	Dopamine transporter	Synaptic reuptake	*SLC6A3*	3' UTR VNTR	9-repeat allele associated with reduced transcription	Increased VS reactivity in 9-repeat allele carriers	Forbes et al. (2009)
	D2 receptor	Pre- and postsynaptic signaling	*DRD2*	rs1799732	-141C Del allele associated with reduced gene expression	Increased VS reactivity in -141C Del allele carriers	Forbes et al. (2009)
	D4 receptor	Postsynaptic signaling	*DRD4*	3' UTR VNTR	7-repeat allele associated with reduced postsynaptic inhibition	Increased VS reactivity in 7-repeat allele carriers	Forbes et al. (2009)
	Catechol-O-methyltransferase	Synaptic degradation	*COMT*	Val158Met	158Met allele associated with reduced activity of COMT enzyme	Increased VS reactivity during reward anticipation in 158Met allele homozygotes	Yacubian et al. (2007)
Endocannabinoid	Fatty acid amide hydrolase	Enzymatic degradation	*FAAH*	rs324220	A allele associated with decreased degradation of anandamide	Decreased amygdala reactivity in A allele carriers	Hariri et al. (2009)
Galanin, dopamine	Galanin neuropeptide	Intercellular signaling; neuromodulator	*GAL*	GAL 5.1 haplotype: rs2513280, rs2513281	GG haplotype predicts greater GAL expression	Increased VS reactivity in GG haplotype homozygotes	Nikolova et al. (2013)
Opioid	Mu-opioid receptor	Pre- and postsynaptic signaling	*OPRM1*	rs1799971 (A118G)	Unknown	Increased VS response to alcohol in G allele carriers	Ramchandani et al. (2011)

Beyond the Candidate Gene Approach: Multilocus Strategies

Although most genetic studies of reward processing conducted to date and surveyed herein focus on single genes or polymorphisms, like other complex behavioral phenomena, reward processing is shaped by a multitude of genetic influences, which act in concert to create specific neural and, ultimately, behavioral phenotypes. While several studies have investigated interactions between two genetic loci and their effects on reward-related neural processes (Dreher et al., 2009; Yacubian et al., 2007), reward-related brain function is likely to be shaped by the simultaneous impact of many more genetic variants. In support of this notion, a recent study has demonstrated that a biologically founded genetic profile for dopamine signaling based on five of the polymorphic loci reviewed herein (*COMT* Val158Met, DAT1 40-bp VNTR, *DRD4* 48-bp VNTR, *DRD2* -141C Ins/Del, and *DRD2* Taq1A) explains nearly 11% of variability in VS reactivity, while none of the loci taken individually explains any VS reactivity variance, after appropriate correction for multiple testing (Nikolova, Ferrell, Manuck, & Hariri, 2011). This finding underscores the importance of taking the simultaneous impact of multiple loci into account when investigating the genetic correlates of complex neural and behavioral phenotypes. Similar profile scores can be compiled to include additional variants within and beyond the DA system to more extensively capture variability in reward-related neural function and any component of emotion and affect subserved by this circuitry.

Genetic Contributions to Threat Processing and Negative Emotion

As reviewed extensively in other chapters of this volume, the neural system, which plays a pivotal role in the detection and response to threat in the environment, is the brain's CLC. The CLC comprises a distributed network of cortical and subcortical (i.e., limbic) regions, within which the amygdala, a small structure in the anterior medial temporal lobe, serves as a circuit hub. The physiological changes orchestrated by the amygdala in response to both conditioned and unconditioned stimuli are primarily associated with increased vigilance and arousal and are neither directly equivalent to the conscious experience of fear, nor in fact sufficient to produce this affective state in humans (LeDoux, 2014) . Nonetheless, they are a necessary and indispensable part of the biological basis of fear and negative affect (Ochsner et al., 2004; Schaefer et al., 2002). Consistent with this notion, variability in the functioning of the amygdala has been associated with pathological, as well as normal-range, negative affective states and traits in humans (Etkin & Wager, 2007; Hariri, 2009).

While DA clearly plays a central role in reward processing and learning, there is not a single neurotransmitter molecule that plays a similar role in the context of threat processing and fear conditioning in the amygdala and the CLC. Instead, multiple systems and neuromodulators contribute to variability in the functioning of the circuit. Signaling within and by the amygdala relies primarily on the brain's major excitatory and inhibitory neurotransmitters glutamate and GABA, respectively. However, the relative sensitivity of the amygdala to glutamatergic and GABAergic inputs from additional nodes of the CLC can be modulated by monoaminergic projections originating in the brainstem.

Monoaminergic modulation of amygdala function is mediated by serotonin (5-hydroxytryptamine [5-HT]), DA, and norepinephrine (NE), which are synthesized and secreted by neurons residing in the dorsal raphe nucleus (DRN), VTA, and locus ceruleus (LC), respectively. Functional neuroanatomy research in animal models and human pharmacological challenge studies converge to suggest all three monoamines are involved in regulating the activity of the amygdala (Bigos et al., 2008; Hariri, Mattay, Tessitore, Fera, et al., 2002; Hurlemann et al., 2010; Sadikot & Parent, 1990). However, the modulator whose contribution appears most prominent is 5-HT (Sadikot & Parent, 1990). Thus, the vast majority of studies that have identified genetic markers of CLC function have focused on genes involved in the regulation of 5-HT signaling.

The Serotonin Transporter

The serotonin transporter (5-HTT) is a presynaptic transmembrane protein, which is instrumental in the reuptake of 5-HT following its release into the synaptic cleft. Similarly to DAT for DA, 5-HTT is an important regulator of both the duration and the intensity of the postsynaptic responses elicited by 5-HT signaling in the CLC. A common VNTR polymorphism occurs in the promoter region of the 5-HTT gene (*SLC6A4*). This polymorphism, referred to as the serotonin transporter-linked polymorphic region (5-HTTLPR), results in a short (S) and a long (L) allele of the gene, which have divergent functional properties. Critically, the S allele has been associated with reduced *SLC6A4* transcription and reduced capacity for 5-HT reuptake *in vitro* (Lesch et al., 1996). Consistent with these early findings, numerous imaging genetics studies have also linked the S allele to relatively heightened amygdala reactivity *in vivo* (Hariri, Mattay, Tessitore, Kolachana, et al., 2002; Munafo, Brown, & Hariri, 2008; Murphy et al., 2013). Notably, the latter finding constitutes the most widely replicated association in imaging genetics. The link between reduced 5-HT reuptake capacity and amygdala hyperresponsivity is also corroborated by studies demonstrating that threat-related amygdala response is potentiated in individuals with lower DRN 5-HTT binding (Rhodes, Murthy, Dresner, Selvaraj, Stavrakakis, et al., 2007) or following the acute administration of a selective serotonin reuptake inhibitor (SSRI; Bigos et al., 2008).

Consistent with animal studies demonstrating that stress results in local increases in amygdala 5-HT signaling (Amat, Matus-Amat, Watkins, & Maier, 1998), additional BOLD fMRI research in humans indicates that the relationship between 5-HT reuptake capacity and amygdala reactivity may be potentiated by environmental adversity. Specifically, carriers of the S allele show larger increases in amygdala reactivity under acute threat (Drabant et al., 2012), as well as stronger fear conditioning, particularly in the context of recently experienced stressful life events (Klucken et al., 2013). This synergistic effect of exposure to environmental challenge and genetically driven variability in 5-HT reuptake capacity is also consistent with extensive epidemiological evidence linking the S allele to increased vulnerability to major depressive disorder (MDD), particularly in the wake of life adversity (Caspi et al., 2003; Karg, Burmeister, Shedden, & Sen, 2011).

The 5-HT$_{1A}$ Receptor

The 5-HT$_{1A}$ receptor, encoded by the *HTR1A* gene, is another key element in the regulation of 5-HT signaling in the CLC. 5-HT$_{1A}$ receptors are found in DRN projection target areas, where they mediate postsynaptic inhibition, as well as on DRN neurons, where they function as autoreceptors mediating negative feedback inhibition of 5-HT release. Multimodal PET–fMRI imaging studies have shown that there is an inverse correlation between DRN 5-HT$_{1A}$ receptor binding and threat-related amygdala reactivity, consistent with a reduced capacity for autoreceptor regulation of 5-HT signaling in this region (Fisher et al., 2006).

A common functional SNP (rs6295) resulting in a C / G substitution, occurs in the promoter region of the human *HTR1A* gene. The G allele is associated with impaired transcriptional repression and consequently relatively increased levels of 5-HT$_{1A}$ receptor as well as enhanced capacity for autoreceptor-mediated negative feedback (Lemonde et al., 2003). Consistent with these *in vitro* findings, the same allele has been associated with relatively decreased threat-related amygdala reactivity *in vivo* as well as reduced levels of trait anxiety (Fakra et al., 2009).

Other Variants

Additional variants impacting 5-HT signaling through divergent biochemical mechanisms have also been associated with individual differences in amygdala reactivity. Those include the tryptophan hydroxylase 2 (*TPH2*) rs4570625 SNP (Brown et al., 2005; Canli, Congdon, Gutknecht, Constable, & Lesch, 2005), which likely modulates 5-HT synthesis; and the *MAOA* upstream VNTR (u-VNTR; Buckholtz et al., 2008), which impacts 5-HT enzymatic degradation. Additional genetic variants in systems more distally involved in the regulation of neurotransmission within the amygdala include the brain-derived neurotrophic factor (*BDNF*) rs6265 (Montag, Reuter, Newport, Elger, & Weber, 2008), and haplotypes in neuropeptide Y (*NPY*; Zhou, Xu, & Jiang, 2008), as well as rs1064448 within the adenylate cyclase 7 (*ADCY7*; Joeyen-Waldorf et al., 2012). In recent years, small genomewide association studies of amygdala reactivity (Brown et al., 2012; Ousdal et al., 2012) have identified additional candidates of unknown functionality, whose relevance has yet to be verified through replication in independent samples. A summary of variants found to modulate human CLC function (e.g., Bogdan, Williamson, & Hariri, 2012; Brown et al., 2005; Lohoff et al., 2014; Meyer-Lindenberg et al., 2006; White et al., 2012; Zhou et al., 2008) is provided in Table 10.2.

Beyond the Candidate Gene Approach: Multilocus Strategies and Epigenetic Effects on Threat Processing

As with VS reactivity, each individual polymorphic locus is likely to account for only a relatively small fraction of variability in amygdala reactivity. While no study to date has investigated the effects of a multilocus genetic profile for 5-HT signaling on amygdala reactivity, a profile score comprising 5-HTTLPR and variants in the 5-HT_{1A} and $_{2A}$ receptor genes has been found to moderate the effects of mood reactivity on attentional bias—a process likely mediated at least in part by differences in amygdala reactivity (Disner, McGeary, Wells, Ellis, & Beevers, 2014). Thus, multilocus genetic profiles reflecting 5-HT and other monoaminergic signaling are likely to enhance statistical power to account for genetically driven variability in CLC function.

While genetic factors are apt to account for a large proportion of the measurable variability in brain function, especially when cumulative effects across genes and systems are considered, they are nevertheless unlikely to account for all such variability for two interrelated reasons: (1) there are multiple intervening steps between the assembly of a DNA sequence and its expression as a functional protein, all of which are subject to intricate non-DNA-sequence-based regulation; and (2) environmental factors may moderate the effects on genetic variation on many behaviorally relevant neural phenotypes (Klucken et al., 2013). Epigenetic modifications of DNA and chromatin may help account for both sources of variability, as these modifications are not only involved in regulating gene expression without altering the basic DNA sequence, but are also heritable and subject to environmental modulation (Goldberg, Allis, & Bernstein, 2007). Thus, the study of the epigenetic landscape may yield much needed insight into the mechanisms that link genetic variation to complex phenotypes.

In strong support of this notion, it has recently been demonstrated that relatively high levels of methylation in the proximal promoter region of *SLC6A4* predict greater amygdala reactivity in two independent samples. Providing additional cues as to the molecular mechanisms underlying this effect, methylation in the same region was associated with reduced gene expression in postmortem amygdala tissue. Critically, all of these effects persist even after accounting for the 5-HTTLPR genotype (Nikolova et al., 2014).

These findings critically implicate epigenetic modifications in the regulation of brain function and suggest their effects may in fact override those of functional DNA-sequence-based variation. Thus, epigenetics should ideally be considered in all studies aiming to identify genetic influences on neural functioning, particularly in cases of suspected or established environmental moderation. With the increasing availability of methods for assaying the human epigenome in its entirety and reasonable, though far from perfect, convergence between methylation patterns in the brain and in peripheral tissues (Tylee, Kawaguchi, & Glatt, 2013), such considerations would hopefully become increasingly easy to meet.

Genetic Contributions to the Cognitive Control of Emotion

While the first two sections of this chapter focused primarily on genetic influences modulating bottom-up processes pertaining to emotion processing and reactivity, in this section we discuss genetic contributions to the top-down control of affect and emotion. Specifically, this section focuses on a common functional polymorphism that influences the efficiency of the PFC in responding to positive and negative stimuli in the environment, and thus has effects on emotional experience, reactions to stress, and vulnerability to psychopathology. Due to reciprocal interactions with subcortical systems, variation in this gene also indirectly impacts bottom-up signaling and can therefore impact the demand on prefrontal regulatory resources.

The relationship between prefrontal functioning and DA has been hypothesized to have the shape of an inverted-*U*, where peak PFC functioning occurs at intermediate levels of prefrontal DA availability and D_1 receptor activation (Goldman-Rakic, Muly, & Williams, 2000). Dopaminergic tone and signaling in the PFC is primarily regulated by the catabolic action of the COMT enzyme (Karoum, Chrapusta, & Egan, 1994; Lundstrom et al., 1995; Mannisto & Kaakkola, 1999). A common functional polymorphism in the gene that encodes COMT, referred to as *COMT* Val158Met or rs4680, affects the thermostability of the COMT enzyme and thus its functionality. Met/Met homozygotes have a 40% reduction in enzymatic activity compared with Val/Val homozygotes (Chen et al., 2004), and therefore, there is a relative increase in DA availability with an increasing number of Met alleles. At baseline, Met/Met homozygotes are hypothesized to have close to an optimal level of prefrontal DA and thus their cognitive functioning is at a peak (Mattay et al., 2003). Consistent with this theory, several studies have found cognitive advantages associated with the Met/Met genotype, including both performance indices and evidence of prefrontal efficiency (e.g., Blasi et al., 2005; Bruder et al., 2005; Egan et al., 2001; Farrell, Tunbridge, Braeutigam, & Harrison, 2012; Fossella et al., 2002; Goldberg et al., 2003; Green, Kraemer,

TABLE 10.2. Genetic Variants Associated in the Differences in CLC Reactivity

Pathway	Molecule	Function	Gene	Polymorphism	Effect on gene/protein function	Neural effect	Seminal report
Serotonin	Tryptophan hydroxylase 2	Serotonin biosynthesis	*TPH2*	rs4570625	Unknown	Increased amygdala reactivity in T allele carriers	Brown et al. (2005)
	Serotonin transporter	Synaptic reuptake	*SLC6A4*	5-HTTLPR	Short allele associated with decreased transcription	Increased amygdala reactivity in short allele carriers	Hariri et al. (2002)
	5-HT_{1A} autoreceptor	Negative feedback	*HTR1A*	rs6296	G allele associated with more efficient transcription	Increased amygdala reactivity in G allele homozygotes	Fakra et al. (2009)
	Monoamine oxidase A	Enzymatic degradation	*MAOA*	u-VNTR	3- and 5-repeat alleles associated with decreased transcription	Increased amygdala reactivity in 3- and 5-repeat allele carriers	Meyer-Lindenberg et al. (2006)
Neuropeptide Y	Neuropeptide Y	Intercellular signaling; neuromodulator	*NPY*	Haplotypes at rs17149106, rs3037354, rs16147, rs16139, rs5573, rs5574, rs16475	rs16147 in promoter region alters NPY expression *in vitro*	Increased amygdala reactivity in lower NPY expression diplotypes	Zhou et al. (2008)
Monoamines	Vesicular monoamine transporter	Presynaptic signaling	*VMAT1 SLC18A1*	rs1390938	Ile allele leads to increased monoamine transport into presynaptic vesicles	Increased amygdala reactivity in Ile allele carriers	Lohoff et al. (2014)

Endocannabinoid	Fatty acid amide hydrolase	Enzymatic degradation	*FAAH*	rs324220	A allele associated with decreased degradation of anandamide	Decreased amygdala reactivity in A allele carriers	Hariri et al. (2009)
Serotonin	Adenylate cyclase 7 enzyme	Intracellular signaling	*ADCY7*	rs1064448	Unknown	Increased amygdala reactivity in T allele carriers	Joeyen-Waldorf et al. (2012)
Glucocorticoid	FK506 binding protein 5	Transcriptional regulation of HPA axis	*FKBP5*	Haplotypes at rs7748266, rs1360780, rs9296158, rs3800373, rs9470080, rs9394309	Unknown	Increased amygdala reactivity in the context of emotional neglect in haplotypes with risk alleles	White et al. (2012)
	Mineralocorticoid receptor	HPA axis response onset regulation	*NR3C2*	rs5522	Val allele associated with decreased cortisol-related transactivation *in vitro*	Increased amygdala reactivity in val allele carriers	Bogdan et al. (2012)
Testosterone	Androgen receptor	Postsynaptic signaling	*AR*	Trinucleotide (CAG) repeat polymorphism	Unknown	CAG length inversely correlated with amygdala reactivity to angry and fearful faces when controlling for variation in testosterone	Manuck et al. (2010)
Acetylcholine	Choline transporter	Acetylcholine reuptake	*SLC5A7*	rs333229	GG presumed to have impaired choline transport and subsequent reduced acetylcholine availability for neurotransmission	Increased amygdala reactivity in GG allele homozygotes	Neumann et al. (2006)

Deyoung, Fossella, & Gray, 2013; Malhotra et al., 2002; Mattay et al., 2003; see also Mier, Kirsch, & Meyer-Lindenberg, 2010).

In positive or low-stress emotional contexts, Met/Met individuals thrive and succeed. For example, real-life pleasant experiences elicit a greater positive affective response for individuals with increasing numbers of Met alleles. Wichers et al. (2008) used an experience sampling method to capture affective responses in the moment. They found that events rated as equally pleasant across *COMT* genotype groups produced higher positive affective ratings in Met carriers, and the same number of pleasant events elicited a greater mood increase with more Met alleles. Another example comes from a gene-by-environment study that investigated the impact of socioeconomic adversity and educational attainment on cognitive performance (Enoch, Waheed, Harris, Albaugh, & Goldman, 2009). Under favorable conditions, Met/Met individuals exhibited superior performance on subtests of the Wechsler Adult Intelligence Scale—Revised (WAIS-R) (Wechsler, 1981).

However, the Met-allele cognitive advantage has been shown to be reversed under conditions of stress or negative stimuli. With more socioeconomic adversity, fewer years of education, and presumably more emotionally difficult circumstances, the Met/Met individuals' WAIS-R performance was significantly worse than that of Val/Val individuals (Enoch et al., 2009). Consistent evidence was found in a laboratory study where Met/Met individuals exhibited poorer working memory task performance after an acute psychosocial stress manipulation (Buckert, Kudielka, Reuter, & Fiebach, 2012). Several researchers have hypothesized that the effects of stress result in an increase in dopamine availability that pushes Met/Met homozygotes past the peak point of the inverted-*U* curve and into a position of supraoptimal DA and worse cognitive performance (Bishop, Cohen, Fossella, Casey, & Farah, 2006; Buckert et al., 2012; Mattay et al., 2003).

The Met-associated cognitive advantages have been couched as a tradeoff coupled with affective vulnerability. Termed the "warrior/worrier model" (Goldman, Oroszi, & Ducci, 2005; Mier et al., 2010; Stein, Newman, Savitz, & Ramesar, 2006), this theory states that the Met variant, or "worrier," is advantageous for cognitive tasks requiring memory and attention, but is susceptible to affective dysregulation under stress. Stress not only shifts the Met/Met position on the inverted-*U* curve beyond the optimal range, but the effects of negative stimuli and negative affect are more potentiated in Met/Met individuals. By contrast, the Val variant provides an advantage in processing aversive stimuli and adapting under stressful circumstances—the "warrior strategy." The cognitive inefficiency seen in Val/Val homozygotes becomes protective when the environmental context is stressful or stimuli are aversive.

The advantages associated with the superior maintenance of information in working memory in Met/Met individuals is coupled with a disadvantage in that working memory cannot easily be reset or shifted away from processing a particular stimulus. This pattern of working memory maintenance occurs at a D_1-receptor-dominated state, as described by the dual-state theory of prefrontal DA function (Durstewitz & Seamans, 2008). The D_1 state allows for mental representations to be sustained over delay periods, supporting working memory and protecting from distractors. However, because of the high threshold to change the signaling pattern, this stability is associated with inflexible information processing and perseveration. By contrast, Val/Val individuals are characterized by a preferential activation of D_2 receptors within the synaptic cleft, due to the rapid clearance of extrasynaptic DA by the high-functioning COMT enzyme. The D_2 state facilitates switching between different activity patterns, which supports flexible problem solving and the incorporation of new information. However, this flexibility is associated with increased distractibility and failure to maintain working memory processes (Durstewitz & Seamans, 2008).

In summary, the Met-related DA signaling profile favors D_1 receptor activation, maintenance of a current working memory representation, tonic DA signaling, and resistance to distractors, while the Val-related DA signaling profile favors D_2 receptor activation, set shifting, phasic DA signaling, and responsiveness to distractors (Bilder, Volavka, Lachman, & Grace, 2004). When it comes to processing affectively laden, and particularly, negative information, the more flexible information processing style seen in Val/Val homozygotes is actually advantageous. There is evidence that Val carriers can more readily disengage from processing negative information, reallocate attentional resources away, and thus show attenuated neural and self-reported responsiveness to negative emotional stimuli. Val carriers thus show more "efficient" neural processing of affective stimuli, manifest as decreased ventrolateral PFC activation on emotion processing tasks (Mier et al., 2010). By contrast, Met carriers show relatively greater prefrontal activation in response to emotional stimuli, particularly those that are negative.

Met-carriers' increased reactivity to negative stimuli may contribute to affective vulnerability, possibly due to a persisting attentional bias toward negative stimuli and therefore a heightened demand on regulatory resources. Several research groups have found evidence of increased amygdala activation in Met carriers during processing of negative pictures or negative emotional faces (Lonsdorf et al., 2011; Rasch et al., 2010; Williams et al., 2010). Consistent event-related potential (ERP) evidence shows Met carriers' heightened neural responsiveness to negative stimuli (Herrmann et al., 2009), and they have higher fear-potentiated startle responses after being primed with aversive pictures (Montag, Buckholtz, et al., 2008). Met/Met individuals also have increased pain responsiveness and higher pain sensitivity (Diatchenko et al., 2005; Zubieta et al., 2003), and report more negative affect in response to pain. They are also more sensitive to stress (Hernaus et al., 2013), including stressful life events that can lead to psychopathology such as PTSD (Kolassa, Kolassa, Ertl, Papassotiropoulos, & De Quervain, 2010; Valente et al., 2011). Although not all results are consistent with this pattern (e.g., Domschke et al., 2008, 2012; Kempton et al., 2009; Lelli-Chiesa et al., 2011), the majority are consistent with the theory that increased DA in the limbic system can lead to disinhibition of the amygdala and potentiation of amygdala responsiveness (Hariri, Mattay, Tessitore, Fera, et al., 2002; Rosenkranz & Grace, 2001; Tessitore et al., 2002). Catecholamine release triggered by negative stimuli could result in potentiated signaling in Met carriers, whose lower COMT activity results in a slower return to baseline (Bishop et al., 2006; Canli, Ferri, & Duman, 2009).

The relatively stronger (and possibly more persisting) bottom-up signal seen in Met carriers triggers a greater need for top-down regulation. In healthy individuals, increased prefrontal activation in response to negative stimuli is likely effective in mitigating the negativity bias. However, excessive activation of those regulatory pathways could lead to susceptibility to anxiety and dysphoria over time and/or under emotionally demanding conditions (Heinz & Smolka, 2006). Met/Met homozygotes may show perseveration on negative stimuli and impaired regulation of negative emotionality, for example, as evidenced by a deficit in extinguishing conditioned fear (Lonsdorf et al., 2009). The connectivity between prefrontal regulatory regions and limbic regions during the processing of emotional stimuli has been shown to be increased in Met carriers and associated with inflexible personality traits and more negative ratings of stimulus images (Drabant et al., 2006; Rasch et al., 2010).

The Met-related vulnerability for inflexible processing of affective information could manifest as increased or potentiated negative affect, rumination, and even difficulty disengaging from ineffective behavioral strategies or maladaptive personal goals. These tendencies may lead to dysfunctional self-regulation and psychopathology (Baumeister & Heatherton, 1996; Bilder et al., 2004; Davis & Nolen-Hoeksema, 2000; Nolen-Hoeksema, 2000). However, in many instances Met carriers' superior attentional control may be effectively applied to reduce perseveration on negative emotional content, as the behavioral differences across genotype groups are often subtle. Environmental context, stress, and history of negative experiences are all relevant to whether these underlying tendencies will impact behavior and mood and how persistent those effects will be, thus further underscoring the role of the environment in modulating genetic effects on emotion processing.

Conclusions

In summary, advances in human neuroimaging and molecular genetics over the past two decades have allowed for some of the interindividual variability that occurs in complex affective traits and states to be mapped onto variability in neural function, which has in turn been at least partially explained by differences in genetic and epigenetic background. This mapping has been particularly successful when focusing on well-characterized circuits mediating the processing of reward and threat, their adaptive integration, and their associated affective traits. While variants impacting neurotransmission in multiple systems and pathways have been implicated in regulating neural phenotypes pertaining to these processes, the main emerging themes in the literature indicate that genetic variants leading to relatively increased DA signaling are associated with a relative increase in reward-related VS reactivity, along with its affective and behavioral consequences. Similarly, those associated with relatively increased 5-HT signaling are generally predictive of increased amygdala reactivity and relatively heightened sensitivity to threat. A genetic variant modulating DA signaling in the PFC has been implicated in differences in the cognitive control of emotion processing in a more complex, context-dependent manner. Future studies integrating multilocus genetic and epigenetic data with current and novel neuroimaging approaches to these and other increasingly well-understood circuits of emotion processing are particularly likely to yield further insight into the origins of the vast interindividual variability characterizing human emotion processing and complex affective traits.

References

Amat, J., Matus-Amat, P., Watkins, L. R., & Maier, S. F. (1998). Escapable and inescapable stress differentially alter extracellular levels of 5-HT in the basolateral amygdala of the rat. *Brain Research, 812*(1–2), 113–120.

Arinami, T., Gao, M., Hamaguchi, H., & Toru, M. (1997). A functional polymorphism in the promoter region of the dopamine D2 receptor gene is associated with schizophrenia. *Human Molecular Genetics, 6*(4), 577–582.

Asghari, V., Sanyal, S., Buchwaldt, S., Paterson, A., Jovanovic, V., & Van Tol, H. H. (1995). Modulation of intracellular cyclic AMP levels by different human dopamine D4 receptor variants. *Journal of Neurochemistry, 65*(3), 1157–1165.

Baumeister, R. F., & Heatherton, T. F. (1996). Self-regulation failure: An overview. *Psychological Inquiry, 7*(1), 1–15.

Beaulieu, J. M., & Gainetdinov, R. R. (2011). The physiology, signaling, and pharmacology of dopamine receptors. *Pharmacological Reviews, 63*(1), 182–217.

Bienvenu, O. J., Hettema, J. M., Neale, M. C., Prescott, C. A., & Kendler, K. S. (2007). Low extraversion and high neuroticism as indices of genetic and environmental risk for social phobia, agoraphobia, and animal phobia. *American Journal of Psychiatry, 164*(11), 1714–1721.

Bigos, K. L., Pollock, B. G., Aizenstein, H. J., Fisher, P. M., Bies, R. R., & Hariri, A. R. (2008). Acute 5-HT reuptake blockade potentiates human amygdala reactivity. *Neuropsychopharmacology, 33*(13), 3221–3225.

Bilder, R. M., Volavka, J., Lachman, H. M., & Grace, A. A. (2004). The catechol-O-methyltransferase polymorphism: Relations to the tonic-phasic dopamine hypothesis and neuropsychiatric phenotypes. *Neuropsychopharmacology, 29*(11), 1943–1961.

Bishop, S. J., Cohen, J. D., Fossella, J., Casey, B. J., & Farah, M. J. (2006). COMT genotype influences prefrontal response to emotional distraction. *Cognitive, Affective, and Behavioral Neuroscience, 6*(1), 62–70.

Blasi, G., Mattay, V. S., Bertolino, A., Elvevag, B., Callicott, J. H., Das, S., et al. (2005). Effect of catechol-O-methyltransferase val158met genotype on attentional control. *Journal of Neuroscience, 25*(20), 5038–5045.

Bogdan, R., Perlis, R. H., Fagerness, J., & Pizzagalli, D. A. (2010). The impact of mineralocorticoid receptor iso/val genotype (rs5522) and stress on reward learning. *Genes, Brain and Behavior, 9*(6), 658–667.

Bogdan, R., Williamson, D. E., & Hariri, A. R. (2012). Mineralocorticoid receptor Iso/Val (rs5522) genotype moderates the association between previous childhood emotional neglect and amygdala reactivity. *American Journal of Psychiatry, 169*(5), 515–522.

Brown, A. A., Jensen, J., Nikolova, Y. S., Djurovic, S., Agartz, I., Server, A., et al. (2012). Genetic variants affecting the neural processing of human facial expressions: Evidence using a genome-wide functional imaging approach. *Translational Psychiatry, 2*, e143.

Brown, S. M., Peet, E., Manuck, S. B., Williamson, D. E., Dahl, R. E., Ferrell, R. E., et al. (2005). A regulatory variant of the human tryptophan hydroxylase-2 gene biases amygdala reactivity. *Molecular Psychiatry, 10*(9), 805, 884–888.

Bruder, G. E., Keilp, J. G., Xu, H., Shikhman, M., Schori, E., Gorman, J. M., et al. (2005). catechol-O-methyltransferase (COMT) genotypes and working memory: Associations with differing cognitive operations. *Biological Psychiatry, 58*(11), 901–907.

Buckert, M., Kudielka, B. M., Reuter, M., & Fiebach, C. J. (2012). The COMT val158met polymorphism modulates working memory performance under acute stress. *Psychoneuroendocrinology, 37*(11), 1810–1821.

Buckholtz, J. W., Callicott, J. H., Kolachana, B., Hariri, A. R., Goldberg, T. E., Genderson, M., et al. (2008). Genetic variation in MAOA modulates ventromedial prefrontal circuitry mediating individual differences in human personality. *Molecular Psychiatry, 13*(3), 313–324.

Buckholtz, J. W., Treadway, M. T., Cowan, R. L., Woodward, N. D., Benning, S. D., Li, R., et al. (2010). Mesolimbic dopamine reward system hypersensitivity in individuals with psychopathic traits. *Nature Neuroscience, 13*(4), 419–421.

Canli, T., Congdon, E., Gutknecht, L., Constable, R. T., & Lesch, K. P. (2005). Amygdala responsiveness is modulated by tryptophan hydroxylase-2 gene variation. *Journal of Neural Transmission, 112*(11), 1479–1485.

Canli, T., Ferri, J., & Duman, E. A. (2009). Genetics of emotion regulation. *Neuroscience, 164*(1), 43–54.

Carre, J. M., Hyde, L. W., Neumann, C. S., Viding, E., & Hariri, A. R. (2013). The neural signatures of distinct psychopathic traits. *Society for Neuroscience, 8*(2), 122–135.

Caspi, A., Sugden, K., Moffitt, T. E., Taylor, A., Craig, I. W., Harrington, H., et al. (2003). Influence of life stress on depression: Moderation by a polymorphism in the 5-HTT gene. *Science, 301*(5631), 386–389.

Chen, J., Lipska, B. K., Halim, N., Ma, Q. D., Matsumoto, M., Melhem, S., et al. (2004). Functional analysis of genetic variation in catechol-O-methyltransferase (COMT): Effects on mRNA, protein, and enzyme activity in postmortem human brain. *American Journal of Human Genetics, 75*(5), 807–821.

Cheon, K. A., Ryu, Y. H., Kim, J. W., & Cho, D. Y. (2005). The homozygosity for 10-repeat allele at dopamine transporter gene and dopamine transporter density in Korean children with attention deficit hyperactivity dis-

order: Relating to treatment response to methylphenidate. *European Neuropsychopharmacology, 15*(1), 95–101.
Cohen, M. X., Young, J., Baek, J. M., Kessler, C., & Ranganath, C. (2005). Individual differences in extraversion and dopamine genetics predict neural reward responses. *Cognitive Brain Research, 25*(3), 851–861.
Cunningham, W. A., Arbuckle, N. L., Jahn, A., Mowrer, S. M., & Abduljalil, A. M. (2011). Aspects of neuroticism and the amygdala: Chronic tuning from motivational styles. *Neuropsychologia, 49*(4), 657–662.
Davis, R. N., & Nolen-Hoeksema, S. (2000). Cognitive inflexibility among ruminators and nonruminators. *Cognitive Therapy and Research, 24*, 699–711.
Diatchenko, L., Slade, G. D., Nackley, A. G., Bhalang, K., Sigurdsson, A., Belfer, I., et al. (2005). Genetic basis for individual variations in pain perception and the development of a chronic pain condition. *Human Molecular Genetics, 14*(1), 135–143.
Disner, S. G., McGeary, J. E., Wells, T. T., Ellis, A. J., & Beevers, C. G. (2014). 5-HTTLPR, HTR1A, and HTR2A cumulative genetic score interacts with mood reactivity to predict mood-congruent gaze bias. *Cognitive, Affective, and Behavioral Neuroscience, 14*(4), 1259–1270.
Domschke, K., Baune, B. T., Havlik, L., Stuhrmann, A., Suslow, T., Kugel, H., et al. (2012). catechol-O-methyltransferase gene variation: Impact on amygdala response to aversive stimuli. *NeuroImage, 60*(4), 2222–2229.
Domschke, K., Ohrmann, P., Braun, M., Suslow, T., Bauer, J., Hohoff, C., et al. (2008). Influence of the catechol-O-methyltransferase val158met genotype on amygdala and prefrontal cortex emotional processing in panic disorder. *Psychiatry Research, 163*(1), 13–20.
Doucette-Stamm, L. A., Blakely, D. J., Tian, J., Mockus, S., & Mao, J. I. (1995). Population genetic study of the human dopamine transporter gene (DAT1). *Genetic Epidemiology, 12*(3), 303–308.
Drabant, E. M., Hariri, A. R., Meyer-Lindenberg, A., Munoz, K. E., Mattay, V. S., Kolachana, B. S., et al. (2006). catechol-O-methyltransferase val158met genotype and neural mechanisms related to affective arousal and regulation. *Archives of General Psychiatry, 63*(12), 1396–1406.
Drabant, E. M., Ramel, W., Edge, M. D., Hyde, L. W., Kuo, J. R., Goldin, P. R., et al. (2012). Neural mechanisms underlying 5-HTTLPR-related sensitivity to acute stress. *American Journal of Psychiatry, 169*(4), 397–405.
Dreher, J. C., Kohn, P., Kolachana, B., Weinberger, D. R., & Berman, K. F. (2009). Variation in dopamine genes influences responsivity of the human reward system. *Proceedings of the National Academy of Sciences USA, 106*(2), 617–622.
Durstewitz, D., & Seamans, J. K. (2008). The dual-state theory of prefrontal cortex dopamine function with relevance to catechol-O-methyltransferase genotypes and schizophrenia. *Biological Psychiatry, 64*(9), 739–749.
Egan, M. F., Goldberg, T. E., Kolachana, B. S., Callicott, J. H., Mazzanti, C. M., Straub, R. E., et al. (2001). Effect of COMT val108/158met genotype on frontal lobe function and risk for schizophrenia. *Proceedings of the National Academy of Sciences USA, 98*(12), 6917–6922.
Enoch, M. A., Waheed, J. F., Harris, C. R., Albaugh, B., & Goldman, D. (2009). COMT val158met and cognition: Main effects and interaction with educational attainment. *Genes, Brain and Behavior, 8*(1), 36–42.
Etkin, A., & Wager, T. D. (2007). Functional neuroimaging of anxiety: A meta-analysis of emotional processing in PTSD, social anxiety disorder, and specific phobia. *American Journal of Psychiatry, 164*(10), 1476–1488.
Fakra, E., Hyde, L. W., Gorka, A., Fisher, P. M., Munoz, K. E., Kimak, M., et al. (2009). Effects of HTR1A C(-1019) G on amygdala reactivity and trait anxiety. *Archives of General Psychiatry, 66*(1), 33–40.
Farrell, S. M., Tunbridge, E. M., Braeutigam, S., & Harrison, P. J. (2012). COMT val(158)met genotype determines the direction of cognitive effects produced by catechol-O-methyltransferase inhibition. *Biological Psychiatry, 71*(6), 538–544.
Fisher, P. M., Meltzer, C. C., Ziolko, S. K., Price, J. C., Moses-Kolko, E. L., Berga, S. L., et al. (2006). Capacity for 5-HT1A-mediated autoregulation predicts amygdala reactivity. *Nature Neuroscience, 9*(11), 1362–1363.
Forbes, E. E., Brown, S. M., Kimak, M., Ferrell, R. E., Manuck, S. B., & Hariri, A. R. (2009). Genetic variation in components of dopamine neurotransmission impacts ventral striatal reactivity associated with impulsivity. *Molecular Psychiatry, 14*(1), 60–70.
Fossella, J., Sommer, T., Fan, J., Wu, Y., Swanson, J. M., Pfaff, D. W., et al. (2002). Assessing the molecular genetics of attention networks. *BMC Neuroscience, 3*, 14.
Goldberg, A. D., Allis, C. D., & Bernstein, E. (2007). Epigenetics: A landscape takes shape. *Cell, 128*(4), 635–638.
Goldberg, T. E., Egan, M. F., Gscheidle, T., Coppola, R., Weickert, T., Kolachana, B. S., et al. (2003). Executive subprocesses in working memory: Relationship to catechol-O-methyltransferase val158met genotype and schizophrenia. *Archives of General Psychiatry, 60*(9), 889–896.
Goldman, D., Oroszi, G., & Ducci, F. (2005). The genetics of addictions: Uncovering the genes. *Nature Reviews Genetics, 6*(7), 521–532.
Goldman-Rakic, P. S., Muly, E. C., 3rd, & Williams, G. V. (2000). D(1) receptors in prefrontal cells and circuits. *Brain Research Reviews, 31*(2–3), 295–301.
Green, A. E., Kraemer, D. J., Deyoung, C. G., Fossella, J. A., & Gray, J. R. (2013). A gene–brain–cognition pathway: Prefrontal activity mediates the effect of COMT on cognitive control and IQ. *Cerebral Cortex, 23*(3), 552–559.
Hamann, S., & Canli, T. (2004). Individual differences in emotion processing. *Current Opinion in Neurobiology, 14*(2), 233–238.
Hariri, A. R. (2009). The neurobiology of individual differences in complex behavioral traits. *Annual Review of Neuroscience, 32*, 225–247.
Hariri, A. R., Gorka, A., Hyde, L. W., Kimak, M., Halder, I., Ducci, F., et al. (2009). Divergent effects of genetic variation in endocannabinoid signaling on human threat- and reward-related brain function. *Biological Psychiatry, 66*(1), 9–16.
Hariri, A. R., Mattay, V. S., Tessitore, A., Fera, F., Smith,

W. G., & Weinberger, D. R. (2002). Dextroamphetamine modulates the response of the human amygdala. *Neuropsychopharmacology, 27*(6), 1036–1040.

Hariri, A. R., Mattay, V. S., Tessitore, A., Kolachana, B., Fera, F., Goldman, D., et al. (2002). Serotonin transporter genetic variation and the response of the human amygdala. *Science, 297*(5580), 400–403.

Heinz, A., Goldman, D., Jones, D. W., Palmour, R., Hommer, D., Gorey, J. G., et al. (2000). Genotype influences *in vivo* dopamine transporter availability in human striatum. *Neuropsychopharmacology, 22*(2), 133–139.

Heinz, A., & Smolka, M. N. (2006). The effects of catechol-O-methyltransferase genotype on brain activation elicited by affective stimuli and cognitive tasks. *Reviews in the Neurosciences, 17*(3), 359–367.

Hermes, M., Hagemann, D., Naumann, E., & Walter, C. (2011). Extraversion and its positive emotional core: Further evidence from neuroscience. *Emotion, 11*(2), 367–378.

Hernaus, D., Collip, D., Lataster, J., Ceccarini, J., Kenis, G., Booij, L., et al. (2013). COMT val158met genotype selectively alters prefrontal [18f]fallypride displacement and subjective feelings of stress in response to a psychosocial stress challenge. *PLoS ONE, 8*(6), e65662.

Herrmann, M. J., Wurflein, H., Schreppel, T., Koehler, S., Muhlberger, A., Reif, A., (2009). catechol-O-methyltransferase val158met genotype affects neural correlates of aversive stimuli processing. *Cognitive, Affective, and Behavioral Neuroscience, 9*(2), 168–172.

Hurlemann, R., Walter, H., Rehme, A. K., Kukolja, J., Santoro, S. C., Schmidt, C., et al. (2010). Human amygdala reactivity is diminished by the beta-noradrenergic antagonist propranolol. *Psychological Medicine, 40*(11), 1839–1848.

Jaber, M., Robinson, S. W., Missale, C., & Caron, M. G. (1996). Dopamine receptors and brain function. *Neuropharmacology, 35*(11), 1503–1519.

Joeyen-Waldorf, J., Nikolova, Y. S., Edgar, N., Walsh, C., Kota, R., Lewis, D. A., et al. (2012). Adenylate cyclase 7 is implicated in the biology of depression and modulation of affective neural circuitry. *Biological Psychiatry, 71*(7), 627–632.

Jonsson, E. G., Nothen, M. M., Grunhage, F., Farde, L., Nakashima, Y., Propping, P., et al. (1999). Polymorphisms in the dopamine D2 receptor gene and their relationships to striatal dopamine receptor density of healthy volunteers. *Molecular Psychiatry, 4*(3), 290–296.

Kang, A. M., Palmatier, M. A., & Kidd, K. K. (1999). Global variation of a 40-bp VNTR in the 3'-untranslated region of the dopamine transporter gene (SLC6A3). *Biological Psychiatry, 46*(2), 151–160.

Karg, K., Burmeister, M., Shedden, K., & Sen, S. (2011). The serotonin transporter promoter variant (5-HTTLPR), stress, and depression meta-analysis revisited: Evidence of genetic moderation. *Archives of General Psychiatry, 68*(5), 444–454.

Karoum, F., Chrapusta, S. J., & Egan, M. F. (1994). 3-methoxytyramine is the major metabolite of released dopamine in the rat frontal cortex: Reassessment of the effects of antipsychotics on the dynamics of dopamine release and metabolism in the frontal cortex, nucleus accumbens, and striatum by a simple two pool model. *Journal of Neurochemistry, 63*(3), 972–979.

Kempton, M. J., Haldane, M., Jogia, J., Christodoulou, T., Powell, J., Collier, D., et al. (2009). The effects of gender and COMT val158met polymorphism on fearful facial affect recognition: A fMRI study. *International Journal of Neuropsychopharmacology, 12*(3), 371–381.

Kendler, K. S., Kuhn, J., & Prescott, C. A. (2004). The interrelationship of neuroticism, sex, and stressful life events in the prediction of episodes of major depression. *American Journal of Psychiatry, 161*(4), 631–636.

Klucken, T., Alexander, N., Schweckendiek, J., Merz, C. J., Kagerer, S., Osinsky, R., et al. (2013). Individual differences in neural correlates of fear conditioning as a function of 5-HTTLPR and stressful life events. *Social Cognitive and Affective Neuroscience, 8*(3), 318–325.

Kolassa, I. T., Kolassa, S., Ertl, V., Papassotiropoulos, A., & De Quervain, D. J. (2010). The risk of posttraumatic stress disorder after trauma depends on traumatic load and the catechol-O-methyltransferase val(158)met polymorphism. *Biological Psychiatry, 67*(4), 304–308.

LeDoux, J. E. (2014). Coming to terms with fear. *Proceedings of the National Academy of Sciences USA, 111*(8), 2871–2878.

Lelli-Chiesa, G., Kempton, M. J., Jogia, J., Tatarelli, R., Girardi, P., Powell, J., et al. (2011). The impact of the val158met catechol-O-methyltransferase genotype on neural correlates of sad facial affect processing in patients with bipolar disorder and their relatives. *Psychological Medicine, 41*(4), 779–788.

Lemonde, S., Turecki, G., Bakish, D., Du, L., Hrdina, P. D., Bown, C. D., et al. (2003). Impaired repression at a 5-hydroxytryptamine 1A receptor gene polymorphism associated with major depression and suicide. *Journal of Neuroscience, 23*(25), 8788–8799.

Lesch, K. P., Bengel, D., Heils, A., Sabol, S. Z., Greenberg, B. D., Petri, S., (1996). Association of anxiety-related traits with a polymorphism in the serotonin transporter gene regulatory region. *Science, 274*(5292), 1527–1531.

Lewis, D. A., Melchitzky, D. S., Sesack, S. R., Whitehead, R. E., Auh, S., & Sampson, A. (2001). Dopamine transporter immunoreactivity in monkey cerebral cortex: Regional, laminar, and ultrastructural localization. *Journal of Comparative Neurology, 432*(1), 119–136.

Lohoff, F. W., Hodge, R., Narasimhan, S., Nall, A., Ferraro, T. N., Mickey, B. J., et al. (2014). Functional genetic variants in the vesicular monoamine transporter 1 modulate emotion processing. *Molecular Psychiatry, 19*(1), 129–139.

Lonsdorf, T. B., Golkar, A., Lindstom, K. M., Fransson, P., Schalling, M., Ohman, A., et al. (2011). 5-HTTLPR and COMT val158met genotype gate amygdala reactivity and habituation. *Biological Psychology, 87*(1), 106–112.

Lonsdorf, T. B., Weike, A. I., Nikamo, P., Schalling, M., Hamm, A. O., & Ohman, A. (2009). Genetic gating of human fear learning and extinction: Possible implications for gene–environment interaction in anxiety disorder. *Psychological Science, 20*(2), 198–206.

Lundstrom, K., Tenhunen, J., Tilgmann, C., Karhunen, T., Panula, P., & Ulmanen, I. (1995). Cloning, expression and structure of catechol-O-methyltransferase. *Biochimica et Biophysica Acta, 1251*(1), 1–10.

Malhotra, A. K., Kestler, L. J., Mazzanti, C., Bates, J. A., Goldberg, T., & Goldman, D. (2002). A functional polymorphism in the COMT gene and performance on a test of prefrontal cognition. *American Journal of Psychiatry, 159*(4), 652–654.

Mannisto, P. T., & Kaakkola, S. (1999). catechol-O-methyltransferase (COMT): Biochemistry, molecular biology, pharmacology, and clinical efficacy of the new selective COMT inhibitors. *Pharmacological Reviews, 51*(4), 593–628.

Manuck, S. B., Marsland, A. L., Flory, J. D., Gorka, A., Ferrell, R. E., & Hariri, A. R. (2010). Salivary testosterone and a trinucleotide (CAG) length polymorphism in the androgen receptor gene predict amygdala reactivity in men. *Psychoneuroendocrinology, 35*, 94–104.

Martinez, D., Gelernter, J., Abi-Dargham, A., van Dyck, C. H., Kegeles, L., Innis, R. B., et al. (2001). The variable number of tandem repeats polymorphism of the dopamine transporter gene is not associated with significant change in dopamine transporter phenotype in humans. *Neuropsychopharmacology, 24*(5), 553–560.

Mattay, V. S., Goldberg, T. E., Fera, F., Hariri, A. R., Tessitore, A., Egan, M. F., et al. (2003). catechol-O-methyltransferase val158-met genotype and individual variation in the brain response to amphetamine. *Proceedings of the National Academy of Sciences USA, 100*(10), 6186–6191.

Meyer-Lindenberg, A., Buckholtz, J. W., Kolachana, B., Hariri, A. R., Pezawas, L., Blasi, G., et al. (2006). Neural mechanisms of genetic risk for impulsivity and violence in humans. *Proceedings of the National Academy of Sciences USA, 103*(16), 6269–6274.

Mier, D., Kirsch, P., & Meyer-Lindenberg, A. (2010). Neural substrates of pleiotropic action of genetic variation in COMT: A meta-analysis. *Molecular Psychiatry, 15*(9), 918–927.

Mill, J., Asherson, P., Craig, I., & D'Souza, U. M. (2005). Transient expression analysis of allelic variants of a VNTR in the dopamine transporter gene (DAT1). *BMC Genetics, 6*, 3.

Missale, C., Nash, S. R., Robinson, S. W., Jaber, M., & Caron, M. G. (1998). Dopamine receptors: From structure to function. *Physiological Reviews, 78*(1), 189–225.

Mitchell, R. J., Howlett, S., Earl, L., White, N. G., McComb, J., Schanfield, M. S., et al. (2000). Distribution of the 3' VNTR polymorphism in the human dopamine transporter gene in world populations. *Human Biology, 72*(2), 295–304.

Montag, C., Buckholtz, J. W., Hartmann, P., Merz, M., Burk, C., Hennig, J., et al. (2008). COMT genetic variation affects fear processing: Psychophysiological evidence. *Behavioral Neuroscience, 122*(4), 901–909.

Montag, C., Reuter, M., Newport, B., Elger, C., & Weber, B. (2008). The BDNF val66met polymorphism affects amygdala activity in response to emotional stimuli: Evidence from a genetic imaging study. *NeuroImage, 42*(4), 1554–1559.

Munafo, M. R., Brown, S. M., & Hariri, A. R. (2008). Serotonin transporter (5-HTTLPR) genotype and amygdala activation: A meta-analysis. *Biological Psychiatry, 63*(9), 852–857.

Murphy, S. E., Norbury, R., Godlewska, B. R., Cowen, P. J., Mannie, Z. M., Harmer, C. J., et al. (2013). The effect of the serotonin transporter polymorphism (5-HTTLPR) on amygdala function: A meta-analysis. *Molecular Psychiatry, 18*(4), 512–520.

Neumann, S. A., Brown, S. M. Ferrell, R. E., Flory, J. D., Manuck, S. B., & Hariri, A. R. (2006). Human choline transporter gene variation is associated with corticolimbic reactivity and autonomic–cholinergic function. *Biological Psychiatry, 60*, 1155–1162.

Nikolova, Y. S., Ferrell, R. E., Manuck, S. B., & Hariri, A. R. (2011). Multilocus genetic profile for dopamine signaling predicts ventral striatum reactivity. *Neuropsychopharmacology, 36*(9), 1940–1947.

Nikolova, Y. S., Koenen, K. C., Galea, S., Wang, C. M., Seney, M. L., Sibille, E., et al. (2014). Beyond genotype: Serotonin transporter epigenetic modification predicts human brain function. *Nature Neuroscience, 17*(9), 1153–1155.

Nikolova, Y. S., Singhi, E. K., Drabant, E. M., & Hariri, A. R. (2013). Reward-related ventral striatum reactivity mediates gender-specific effects of a galanin remote enhancer haplotype on problem drinking. *Genes, Brain and Behavior, 12*(5), 516–524.

Noble, E. P., Gottschalk, L. A., Fallon, J. H., Ritchie, T. L., & Wu, J. C. (1997). D2 dopamine receptor polymorphism and brain regional glucose metabolism. *American Journal of Medical Genetics, 74*(2), 162–166.

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology, 109*(3), 504–511.

Nymberg, C., Jia, T., Lubbe, S., Ruggeri, B., Desrivieres, S., Barker, G., et al. (2013). Neural mechanisms of attention-deficit/hyperactivity disorder symptoms are stratified by MAOA genotype. *Biological Psychiatry, 74*(8), 607–614.

Ochsner, K. N., Ray, R. D., Cooper, J. C., Robertson, E. R., Chopra, S., Gabrieli, J. D., et al. (2004). For better or for worse: Neural systems supporting the cognitive down- and up-regulation of negative emotion. *NeuroImage, 23*(2), 483–499.

Ousdal, O. T., Anand Brown, A., Jensen, J., Nakstad, P. H., Melle, I., Agartz, I., et al. (2012). Associations between variants near a monoaminergic pathways gene (PHOX2B) and amygdala reactivity: A genome-wide functional imaging study. *Twin Research and Human Genetics, 15*(3), 273–285.

Pohjalainen, T., Rinne, J. O., Nagren, K., Lehikoinen, P., Anttila, K., Syvalahti, E. K., et al. (1998). The A1 allele of the human D2 dopamine receptor gene predicts low D2 receptor availability in healthy volunteers. *Molecular Psychiatry, 3*(3), 256–260.

Ramchandani, V. A., Umhau, J., Pavon, F. J., Ruiz-Velasco, V., Margas, W., Sun, H., et al. (2011). A genetic determinant of the striatal dopamine response to alcohol in men. *Molecular Psychiatry, 16*(8), 809–817.

Rasch, B., Spalek, K., Buholzer, S., Luechinger, R., Boesiger, P., de Quervain, D. J.-F., et al. (2010). Aversive stimuli lead to differential amygdala activation and connectivity patterns depending on catechol-O-methyltransferase val158met genotype. *NeuroImage, 52*(4), 1712–1719.

Rhodes, R. A., Murthy, N. V., Dresner, M. A., Selvaraj, S., Stavrakakis, N., Babar, S., et al. (2007). Human 5-HT transporter availability predicts amygdala reactivity in vivo. *Journal of Neuroscience, 27*, 9233–9237.

Rondou, P., Haegeman, G., & Van Craenenbroeck, K. (2010). The dopamine D4 receptor: Biochemical and signalling properties. *Cellular and Molecular Life Sciences, 67*(12), 1971–1986.

Rosenkranz, J. A., & Grace, A. A. (2001). Dopamine attenuates prefrontal cortical suppression of sensory inputs to the basolateral amygdala of rats. *Journal of Neuroscience, 21*(11), 4090–4103.

Roussos, P., Giakoumaki, S. G., & Bitsios, P. (2010). Cognitive and emotional processing associated with the season of birth and dopamine D4 receptor gene. *Neuropsychologia, 48*(13), 3926–3933.

Sadikot, A. F., & Parent, A. (1990). The monoaminergic innervation of the amygdala in the squirrel monkey: An immunohistochemical study. *Neuroscience, 36*(2), 431–447.

Schaefer, S. M., Jackson, D. C., Davidson, R. J., Aguirre, G. K., Kimberg, D. Y., & Thompson-Schill, S. L. (2002). Modulation of amygdalar activity by the conscious regulation of negative emotion. *Journal of Cognitive Neuroscience, 14*(6), 913–921.

Sesack, S. R., Hawrylak, V. A., Matus, C., Guido, M. A., & Levey, A. I. (1998). Dopamine axon varicosities in the prelimbic division of the rat prefrontal cortex exhibit sparse immunoreactivity for the dopamine transporter. *Journal of Neuroscience, 18*(7), 2697–2708.

Stein, D. J., Newman, T. K., Savitz, J., & Ramesar, R. (2006). Warriors versus worriers: The role of COMT gene variants. *CNS Spectrums, 11*(10), 745–748.

Stein, J. L., Hibar, D. P., Madsen, S. K., Khamis, M., McMahon, K. L., de Zubicaray, G. I., et al. (2011). Discovery and replication of dopamine-related gene effects on caudate volume in young and elderly populations (N = 1198) using genome-wide search. *Molecular Psychiatry, 16*(9), 927–937, 881.

Stein, J. L., Medland, S. E., Vasquez, A. A., Hibar, D. P., Senstad, R. E., Winkler, A. M., et al. (2012). Identification of common variants associated with human hippocampal and intracranial volumes. *Nature Genetics, 44*(5), 552–561.

Stice, E., Spoor, S., Bohon, C., & Small, D. M. (2008). Relation between obesity and blunted striatal response to food is moderated by TaqIA A1 allele. *Science, 322*(5900), 449–452.

Tarazi, F. I., Campbell, A., Yeghiayan, S. K., & Baldessarini, R. J. (1998). Localization of dopamine receptor subtypes in corpus striatum and nucleus accumbens septi of rat brain: Comparison of D1-, D2-, and D4-like receptors. *Neuroscience, 83*(1), 169–176.

Tessitore, A., Hariri, A. R., Fera, F., Smith, W. G., Chase, T. N., Hyde, T. M., et al. (2002). Dopamine modulates the response of the human amygdala: A study in Parkinson's disease. *Journal of Neuroscience, 22*(20), 9099–9103.

Tylee, D. S., Kawaguchi, D. M., & Glatt, S. J. (2013). On the outside, looking in: A review and evaluation of the comparability of blood and brain "-omes." *American Journal of Medical Genetics Part B Neuropsychiatric Genetics, 162B*(7), 595–603.

Valente, N. L., Vallada, H., Cordeiro, Q., Bressan, R. A., Andreoli, S. B., Mari, J. J., et al. (2011). catechol-O-methyltransferase (COMT) val158met polymorphism as a risk factor for PTSD after urban violence. *Journal of Molecular Neuroscience, 43*(3), 516–523.

VanNess, S. H., Owens, M. J., & Kilts, C. D. (2005). The variable number of tandem repeats element in DAT1 regulates in vitro dopamine transporter density. *BMC Genetics, 6*, 55.

Wayment, H. K., Schenk, J. O., & Sorg, B. A. (2001). Characterization of extracellular dopamine clearance in the medial prefrontal cortex: Role of monoamine uptake and monoamine oxidase inhibition. *Journal of Neuroscience, 21*(1), 35–44.

Wechsler, D. (1981). *WAIS-R Manual: Wechsler Adult Intelligence Scale—Revised*. New York: Psychological Corporation.

White, M. G., Bogdan, R., Fisher, P. M., Munoz, K. E., Williamson, D. E., & Hariri, A. R. (2012). FKBP5 and emotional neglect interact to predict individual differences in amygdala reactivity. *Genes, Brain and Behavior, 11*(7), 869–878.

Wichers, M., Aguilera, M., Kenis, G., Krabbendam, L., Myin-Germeys, I., Jacobs, N., et al. (2008). The catechol-O-methyl transferase val158met polymorphism and experience of reward in the flow of daily life. *Neuropsychopharmacology, 33*(13), 3030–3036.

Williams, L. M., Gatt, J. M., Grieve, S. M., Dobson-Stone, C., Paul, R. H., Gordon, E., et al. (2010). COMT val(108/158)met polymorphism effects on emotional brain function and negativity bias. *NeuroImage, 53*(3), 918–925.

Yacubian, J., Sommer, T., Schroeder, K., Glascher, J., Kalisch, R., & Leuenberger, B., (2007). Gene–gene interaction associated with neural reward sensitivity. *Proceedings of the National Academy of Sciences USA, 104*(19), 8125–8130.

Zhou, J. R., Xu, Z., & Jiang, C. L. (2008). Neuropeptide Y promotes TGF-beta1 production in RAW264.7 cells by activating PI3K pathway via Y1 receptor. *Neuroscience Bulletin, 24*(3), 155–159.

Zubieta, J. K., Heitzeg, M. M., Smith, Y. R., Bueller, J. A., Xu, K., Xu, Y., et al. (2003). COMT val158met genotype affects mu-opioid neurotransmitter responses to a pain stressor. *Science, 299*(5610), 1240–1243.

CHAPTER 11

OLFACTION

Explicit and Implicit Emotional Processing

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We are surrounded by chemosignals (airborne chemicals with information value, including odors) at all times in our lives. Some like to say that we live in a "chemical soup"—not referring to factory wastes, but to the everyday chemical information that our own bodies, plants, storms, books, foods, and so forth produce. Some of this "soup" cues us about the moods and other motivational information in the air, but not in such a way that we are usually aware of it. In spite of the ubiquity of chemicals in the air, and in spite of a common acceptance that smell has an emotional component, in the past, smells have been considered unimportant by the scientific community, even for emotion (see Classen, Howes, & Synott, 1994, for a review of the dismissal history). However, emotion research in olfaction is now an area of rapid change, ripe for innovation.

As this review demonstrates, much of the new information on emotion and olfaction is related to the investigation of implicit processes in olfaction. We begin the chapter with some background on the methods in olfactory research to show how they have had an impact on changes in this area. Next we review background on the olfactory system with particular emphasis on how research questions arise related to different parts of the olfactory system. We then move to areas of research, much of it emerging only in this century. Human chemosensory mood communication is reviewed, and then the effects of nonhuman chemosignals on emotion and social behavior. The last research section examines how natural odors in the environment affect emotion. This includes a brief introduction to malodors. Finally, we provide some perspective on conceptual and theoretical advances.

Ends Not Independent of Means: The Influence of Methods

We begin with an introduction to methods commonly used in emotion and olfaction research because many of the controversies about the significance of olfaction for emotion rest upon differences between the results of research that emerged from more explicit methods and those beginning to emerge from more implicit methods (see Sela & Sobel, 2010, for a discussion of subconscious odor effects, or Haviland-Jones & Wilson, 2008, for related issues). To demonstrate, we review the traditional use of self-report, then the more recent use of narrative process as a semantic, but more implicit, approach to emotion reporting. Behavioral and attitudinal measures are becoming more used as well. Finally, we provide a brief introduction to the physiological and neurological approaches current in olfaction research pertinent to emotion.

Not long ago at a meeting of chemosensory scientists, the phrase "gold standard" for testing emotion meant that any effect of an olfactory stimulus on emotion had to live up to the standard that a person asked to smell a scent would report a change in emotion. This measure often produced rather small effects, difficult to replicate. Of course, the conclusion then was that any emotional responses to odors, scents, or chemosensory stimuli were likely to be highly individual and, with few exceptions, produced by past associations that could be difficult to verify or replicate.

The Self-Report Problem

Most often the self-report in olfaction research is completely explicit. In the research laboratory, a research participant knows the questions pertain to odor. He or she is asked to smell something. Usually the first self-report questions are the identity, hedonic, and intensity questions—the participant is first asked what the odor is, then how pleasant it is and how intense. Obviously, this explicitly brings the attention to the odor and provides a framework for associations to the odor and to two continua: hedonics and intensity. This method in itself may skew the results with expectations that there are continua, not categories, and that hedonics and intensity have primacy. Often, there is then a list of descriptives to rate including "woody," "musty," and so forth. Finally, the person is asked to rate his or her mood. Not surprisingly, under these conditions, ratings of hedonics and emotion are highly correlated, somewhat tempered by the associations revealed in the descriptives. The problem apparent to the consumer marketers, most directly, but also to experimental sensory scientists, broadly, is that ratings of pleasantness, liking, and mood state obtained using this explicit self-report method do not reliably predict behavior or physiological responses. In social psychology, we have known for some time that explicit and implicit processes (e.g., Nisbett & Wilson, 1977) do not always reveal the same types of results.

It is true that self-reports have a number of advantages, including an intuitive persuasiveness, but most important is their ease of use. However, they also come with a number of familiar drawbacks even if an explicit description is needed. Most notably, participants are not always reliable documenters of their emotions (note again Nisbett & Wilson, 1977). Questionnaires often lack precision in their assessment of complex and transitional emotions. Different people often interpret questions differently (Sheatsley, 1983), a reality more likely the more complex the assessment.

Given the caveats pertaining to explicit methods, it should be no surprise that alternative approaches are gaining in use. Alternative methods in the tradition of emotion research that do a better job of capturing nonconscious emotional experience in response to olfaction exposure include narrative, behavioral, psychophysiological, and neuroimaging methods.

Narrative Methods

One of the more interesting methods to capture nonconscious emotions is that of the narrative method. Typically, the participant is asked to write about a recent event. It is akin to self-report in that the participant is personally offering information about the self but it is implicit in two ways. First, the participants are not asked for an emotion report on their current state though they may be asked to include feelings in their event report. Second, this procedure is not necessarily linked to any odor. In many cases a perithreshold odor is used, meaning that people cannot discriminate rooms with the chemosensory input from rooms without this input. People can be asked to participate in sensory studies and told they may be in an olfactory, visual, temperature, auditory, or similar type of condition and then they can give consent to details in all conditions and in fact may be enrolled in a study with many dimensions. This further takes away any focus on olfaction. Yet our research demonstrates that such perithreshold odors influence not the content of a narrative necessarily, but categories that we call *search* categories. For example, a perithreshold floral odor is not likely to lead to writing a narrative about flowers or gardens, but instead to almost any content that includes more positive emotion words and more intimate words such as "loving" and "liking." This reflects an underlying socioemotional state in which the floral odors may prompt a search for happy and affiliative information (Haviland-Jones, Hudson, Wilson, Freyberg, & McGuire, 2013).

This use of narrative method is derived from Pennebaker's research (e.g., Pennebaker & Seagel, 1999). Generally, ordinary dialogue or text reveals underlying emotional states. This is confirmed by the Magai and Haviland-Jones (2002) finding that frequently used emotion words in writing are part of an emotional dynamic system including frequently used facial emotional signals—that is, emotion is revealed both in words and in expression. This method is a powerful tool for research on implicit process related both to fluctuating states and relatively stable ones. The use of narrative methods within olfactory research is growing as its many uses are becoming increasingly apparent (Castellanos, Hudson, Haviland-Jones, & Wilson, 2010; Freyberg & Ahren, 2011; Haviland-Jones et al., 2013; Kiecolt-Glaseret al., 2008).

Behavioral Methods

Behavioral methods have long been useful when fragrances are presented at explicit levels of detection, as well as at implicit levels. For example, Baron (1997) observed that participants exposed to pleasant odors in a shopping mall were more likely to help a confederate when their help was solicited. While the pleasant odors could easily have been detected, it is unlikely that people were aware of using them as cues. More recent extensions of this work have shown that pleasant ambient odors also encouraged spontaneous helping behaviors (Guéguen, 2012b) as well as social approach behaviors (defined as providing a phone number to a potential suitor; Guéguen, 2012a). Similarly, Haviland-Jones et al. (2013) showed that after being in a room with a perithreshold floral odor, people approached a stranger, sometimes touching him or her, to engage in a task. In this study, the behavioral method showed that scents differed in their impact on social and emotional behavior but the explicit self-report on moods used in the study showed no significant differences.

Facial movements indicative of emotion have also been used successfully in recent studies. As will be seen below in studies of human mood odors, such implicit odors can affect emotion expressions (de Groot, Smeets, Kaldewaij, Duijndam, & Semin, 2012; de Groot, Smeets, Rowson, Bulsing, Blonk, Wilkinson, & Semin, 2015).

Physiological and Neuroimaging Methods

Given that emotion involves a physiological component, it is expected that investigation of the effects of odors on emotion would seek support via physiological measures including cardiac or galvanic skin responses, or from indices of neural activity. Physiological measures may demonstrate significant effects even when a chemosignal is not detected and presumably separated from explicit associations.

Physiological indices and self-report indices sometimes support each other, but not in all instances. For example, the undetected chemosignal androstadienone (AND) has a modulating effect such that reported negative mood and heart rate response and/or galvanic skin response all decrease (Jacob & McClintock, 2000); these methods support one another. On the other hand, a study of jasmine tea and lavender odors at the lowest detectable concentration, found both significantly decreased heart rate and increased parasympathetic nerve activity, attesting to their calming and relaxing qualities (Kuroda et al., 2005) but only jasmine tea showed decreases on self-reported anxiety and tension. In a third study (Kiecolt-Glaser et al., 2008), participants reported increased positive mood for lemon oil compared with lavender on a variety of mood measures both direct (self-report) and indirect (see Kiecolt-Glaser et al., 2008); however, there were no observed changes in heart rate, blood pressure, or salivary cortisol. Findings of studies such as these, with their variability in terms of methods supporting or not supporting one another, complicate interpretation. However, the greater danger lies in equating inconsistent results with dismissal of any effects at all.

Advances in neuroimaging techniques have enabled access to brain structures that are involved in the nonconscious emotional processing of olfactory stimuli (e.g., Lundström, Boyle, Zatorre, & Jones-Gotman, 2008; see Lubke & Pause, 2015; Pause, 2012; Soudry, Lemogne, Malinvaud, Consoli, & Bonfils, 2011, for reviews). Positron emission topography (PET) or functional magnetic resonance imagery (fMRI) demonstrates that an olfactory stimulus impacts not only areas specifically dedicated to olfactory processing but other brain areas as well showing the embeddedness of the ancient olfactory system (Lubke & Pause, 2012). Jacob, Kinnunen, Metz, Cooper, and McClintock (2001) used PET following nonconscious exposure to AND and found activation in brain areas associated with mood and attention. Additionally, using commercially available fragrance, Herz, Eliassen, Beland, and Souza (2004) found that a pleasant memory odor cue was significantly more likely to activate the amygdala and hippocampus, suggesting that personally meaningful cues had demonstrable effects on the brain areas associated with emotion and memory (Panksepp, 2011).

The Biology of Olfaction

The methods of assessing the effects of airborne chemical signals rarely address the three different parts of the olfactory system separately but it is important to be aware of the different potential functions of the system as future researchers are likely to be more inclusive of this (e.g., Delplanque et al., 2008). The olfactory system involves odor detection and discrimination. The trigeminal system, in terms of olfaction, is principally concerned with somatic arousal, and detection of irritants. The vomeronasal organ (VNO) is considered vestigial in humans by most researchers but is responsible for detection of pheromones and clearly is present in a wide variety of nonhuman species. We review each system briefly, illustrating aspects of each system pertinent to emotion research.

The Olfactory System

The primary olfactory system involves detection of odor molecules by the olfactory epithelium, transmission of the information to the main olfactory bulb and then to the primary olfactory cortex (Brand, 2006). A link between olfaction and emotion is widely acknowledged, both in terms of popular wisdom and neuroscience. For example, the history of fragrances detected by the olfactory system shows usage of pleasant fragrances for love and attraction from ancient times to the present day (Classen et al., 1994; Jelinek, 1996; Stoddart, 1990). We adorn ourselves with fragrance to attract others as well as to affect our own emotions (e.g., Schiffman, Suggs, & Sattely-Miller, 1995). Detecting and reacting to these scents is the domain of the olfactory system.

The processing of both olfactory and emotional signals involves common pathways in the limbic system and related brain areas. For example, both the amygdala and the orbitofrontal cortex receive input via the olfactory tract. Emotion processing implicates both of these areas (Baas, Aleman, & Kahn, 2004; Britton et al., 2006; Rolls, 1996; Zald, 2003). Savic (2005) has noted that olfactory information, like other sensory systems, is processed both in parallel and hierarchically. However, she notes that the most primary level of odor perception involves the amygdala and an immediate emotional response.

Unlike every other sensory system, olfactory information projects directly to the central nervous system, rather than first traveling to the thalamus (Stockhorst & Pietrowsky, 2004). The olfactory epithelium is composed of exposed neurons that are replaced on a regular basis (Carleton, Petreanu, Lansford, Alvarez-Buylla, & Lledo, 2003). Further, humans have a generative capacity to "learn" to smell odors to which they had been anosmic, often after few exposures (Sela & Sobel, 2010).

A particularly interesting feature of the olfactory system is that organisms may respond physiologically and emotionally in the presence of chemical signals even when they are not aware of and cannot consciously detect any odor (see Sela & Sobel, 2010). In effect, odors may potentiate emotional and behavioral responses even when there is no attentional focus on the odor or if it is below the threshold for detection (e.g., Bensafi et al., 2003; Haviland-Jones, Wilson, & Freyberg, 2015; Lubke & Pause, 2015).

People often seem unaware of the motivational and emotional effects governed by the olfactory system and even less aware that they, themselves, produce chemical communications. Of course, we are aware of many kinds of odors from the foul odors of decay on the one hand, to the pleasant smell of infants on the other. But there is still a very large number of chemosignals, especially motivational signals that are revealed to have significant input in careful research, ones that we commonly ignore (see the section "Mood Odors").

The Trigeminal System

The trigeminal system serves a somatosensory (e.g., temperature or pain) and motor (e.g., biting and chewing) function for the face and head (see Brand, 2006, for a review). In contrast to the olfactory system, the trigeminal system first projects to the thalamus and then to the cortex. The three branches of the trigeminal nerve enervate different parts of the face with the mandibular branch only carrying motor information. The ophthalmic and the maxillary branches extend into the nasal lining resulting in complex interactions between the two systems, with most odor perception involving both systems (Hummel & Livermore, 2002).

A particular function of the trigeminal system is detection of chemical irritants, for example, recoiling from the smell of ammonia. This may lead to negative judgments, but some stimulants to the trigeminal system provide information that is judged to be exciting, generating interest. For example, the crisp and energizing smell of peppermint stimulates the trigeminal system and has several psychological effects (see Raudenbush, 2004, for a review).

The Vomeronasal System

The vomeronasal system (VNS) is a third system present in many species specifically responding to airborne chemical cues that have been termed "pheromones." The VNO, situated in the nose, responds to chemical signals, sending information via the vomeronasal nerve to the accessory olfactory bulb (Halpern, 1987). While the VNO can be detected in the human fetus and also in many adults, it may be vestigial; it may not be universal; and even when present, it may not be functional (see Meredith, 2001, for a review).

The controversy concerning the VNO in humans supports controversy concerning pheromone communication in humans. Pheromones are defined as chemical messages emitted by a member of a species and detected by another member of that species resulting in physical and/or behavioral changes (Karlson & Luscher, 1959). In addition to their connection with sexual attraction among many nonhuman species, pheromones provide other information, including information about food and predators. Emerging research has found that humans can be affected by chemical messages from other humans, a topic we return to later. Whether these messages can be considered pheromones is controversial (see Wysocki & Preti, 2004); however, these controversies need not impact a discussion of the human chemical signals (see Sela & Sobel, 2010).

Whether or not detected by the VNO, human chemical signals have been shown to elicit a range of responses from other humans. For example, both male (Preti, Wysocki, Barnhart, Sondheimer, & Leyden, 2003) and female (Stern & McClintock, 1998) axillary compounds can cause changes in a woman's menstrual cycle. There is also support for a mood effect associated with AND (Jacob & McClintock, 2000), one of this category of steroids.

A more nuanced appreciation for the olfactory system and its role in human experience has replaced a very limited early understanding (Haviland-Jones, Wilson, & Freyberg, 2015). This expanded insight interconnects with a long history of popular wisdom and naïve psychology, a history that often dismisses odor's importance while basking in its delights and distancing from its "other side." Odors do impact mood and emotional behavior. However, the exact mechanism has yet to be fully elucidated.

Recent Discoveries

There is new information from genetics, sensory perception, and psychobiology that affects our changing appreciation for the scope of olfaction in human experience and emotion. Not only are new methods opening new research territory for emotion and olfaction, there are exciting discoveries about the basic system. Buck and Axel's (1991) work revealed that fully 1% of the human genome is assigned to the genes that govern olfaction, a dedication exceeded only by those assigned to the immune system. This work earned them the 2004 Nobel Prize and played a large role in energizing research on olfaction.

New analyses unexpectedly show the exceptional acuity for odors among humans, rivaling and surpassing most mammals (Laska & Seibt, 2002). The olfactory system uses some 1,000 odor receptors in different patterns of activation to detect many hundreds of odors at concentrations as low as one part per trillion (Yeshurun & Sobel, 2010). The problematic issue is that this acuity does not link to semantic differentiation. In other words, we do not easily recognize and label the vast numbers of odors that we can discriminate. This supports our premise that approaches to research that capitalize on nonconscious processes are important.

Another significant discovery about the olfactory system may lead to our understanding of whether or not olfaction operates differently from other senses—particularly in how it regulates emotion. Kass, Rosenthal, Pottackal, and McGann (2013) found that the synaptic output of the olfactory sensory neurons, the first cells that physically contact odor molecules in the nose and project the information to the olfactory bulb, changes when an odor is paired with shock. This challenges the view that the emotional associations occur only in the cortical limbic brain regions. The synaptic changes may be related to the observation that people exposed to chemical compounds traumatically, later may have serious reactions to chemosignal levels thought to be below threshold. This finding has interesting implications for specialized olfactory system functions.

Mood Odors

Probably of most significance to the study of olfaction and emotion is the accumulating evidence demonstrating that humans communicate emotions with body chemosignals and odors. In this domain it is almost startling how much "mood odors" affect human behavior and how little credence is given to this phenomenon. This research area particularly illustrates our premise that many social–emotional cues are processed subconsciously. Our knowledge of the socioemotional effects of mood odors comes from the variety of more recently applied methods outlined above. This includes narrative "word slips" (Pennebaker & Seagel, 1999), dream memories (Castellanos et al., 2010), attributions toward others (Freyberg & Ahren, 2011), movements (Haviland-Jones et al., 2013), and changes in social patterns showing trust (Liljenquist, Zhong, & Galinsky, 2010).

Chen and Haviland-Jones (1999) were one of the first to reveal the connection between body odor and mood. Specifically, young children and both young and senior adults, male and female, wore underarm pads that allowed for the collection of axillary odors while they were wearing nightshirts for several days. In a second session, evaluators were exposed to these odors from an open glass jar while doing other tasks, though they were not asked to sniff the jars, nor was their attention drawn to them during the first part of the study. Later they would be asked to rate and identify the chemosignal. Participants reported more negative mood when exposed to the odors from the young men, whereas they reported more positive mood when exposed to the odors from the older women. Further, participants incorporated more aggressive dream content in narratives when exposed to the young men's odors, whereas they incorporated more affiliative content in dream narratives when exposed to those from the older women. Because the odors of young men and older women were not discriminated in the later task and both were considered relatively intense and unpleasant, it is unlikely that associations to gender or age led to the associations detected both in self-report and in narrative report.

The results of the Chen and Haviland-Jones (1999) study prompted additional research to explore how mood might be communicated by human body odors. We hypothesized that what was communicated was the mood of the young men or older women rather than just associations with age and gender—that the older women were actually at a happier time in their lives than the younger men who were likely in a competitive and uncertain time of their lives. In the next studies, directed at discovering mood odor, we therefore used axillary odors collected from people while they watched mood-induction videos to induce fear or happiness—the same people donated both mood odors (Chen & Haviland-Jones, 2000; Haviland-Jones & McGuire, 1999). Using forced choice procedures (detectors sometimes complained there was nothing to detect or that the task was impossible), we learned that detectors were able to identify which mood induction a group of people was exposed to at significantly above chance levels just from the odor pads.

More recently, some researchers have produced human mood odors in a variety of different settings including anxiety-producing exams (Pause, Lübke, Laudien, & Ferstl, 2010), sky-diving (Mujica-Parodi, & Strey, 2006), or a high rope course (Zernecke et al., 2011). Although similar effects are found with these different collection strategies, it is still not known what the chemical composition of these mood odors may be and how differences in components may result in either individual or in behavioral differences.

Aside from showing that the mood odors can be discriminated, recent research by de Groot and colleagues (2015) has demonstrated that happy, fear, and disgust odors produced facial expressions in perceivers that matched the odors. In other words, sensing a fearful mood odor from an unseen fearful person is likely to lead to a fear expression—that is, a motor response—in the perceiver. Such findings extend research on mirror neurons (Aglioti & Pazzaglia, 2011; Tubaldi et al., 2011). In the original mirror neuron research, the sensory system is visual: seeing a disgust face led to making a disgust face. Here, smelling disgust led to making a disgust face (and, as yet untested, possibly producing another disgust odor). This suggests that olfactory stimuli affect the motor system via different neural pathways than visual stimuli. This is an exciting new research area.

Additional studies have expanded our understanding of the effects that body odors have on those exposed to them. For example, exposure to human odors can affect decisions about the emotional qualities of pictures and faces (Pause, Ohrt, Prehn, & Ferstl, 2004; Zhou & Chen, 2009) and even affect something as automatic as a startle response (Prehn, Ohrt, Sojka, Ferstl, & Pause, 2006). Pause and colleagues (2004) showed how exposure to an anxiety chemosignal impacted how participants perceived a neutral face. In their study, participants were primed with happy, fearful, and sad faces before rating the emotion on a neutral face. Results showed that although priming with the happy face usually prompts seeing happy in a neutral face, an anxiety chemosignal disrupted this pattern. Mujica-Parodi et al. (2009), Zhou and Chen (2009), and Zernecke et al. (2011) have extended these results to other paradigms such as the morphing of faces. Taken together, this body of research suggests that the anxiety chemosignals significantly affect attributions of emotion and that they exert most of their influence on ambiguous stimuli.

There is a suggestion that communication for emotion may operate differently in the olfactory system than in other sensory systems. For example, Chen, Katdare, and Lucas(2006) expected that exposure to fear mood odors would decrease reaction times in identifying threatening words, as would exposure to a frightening visual cue. While there were no differences for threatening stimuli, the reaction times were slower for the ambiguous stimuli—the opposite of what was expected. Such findings relate to work by Sela and Sobel (2010), who presented evidence that perception in olfaction generally operates differently from visual or auditory perception. They argue that the olfactory system is not organized optimally to locate objects, even frightening ones, but instead works subconsciously and rapidly to scan environments for motivationally congruent information. In this sense, it is possible that the olfactory cue did not give definitive spatial/object information. Instead, it set a broad scope scanning for relevant types of information to be gleaned from other sensory systems. In setting up such a search for other systems, it slowed the reaction to ambiguous cues. This suggests that different sensory systems may serve different functions so that what leads to faster reactions for the visual system may lead to slower reactions for the olfactory system.

The moods that can be identified are not only negative. Positive mood odors such as happiness, calmness/relaxation, and safety can also be identified (e.g., Chen & Haviland-Jones, 2000; Haviland-Jones & McGuire, 1999; Haviland-Jones & Wilson, 2008). However, further research is needed to fully explore this phenomenon. We suggest that positive mood odors could be just as important and as discriminable as positive emotion cues in the visual domain. A smile is a cue that is discrete, easily recognized, emerges early in life, and has considerable social significance; perhaps positive mood odors have a similar impact. The fact that people seem to have no confidence that this is the case is not sufficient evidence that they have negligible impact. There is little confidence for signs of alarm yet alarm signals are now known to have important effects.

Clinical Implications

There are several approaches to the emotional saliency of odors in clinical fields that serve to indicate that this area has potential for future work. We mention two: the effect of human odor in communicating personality and the effect of anosmia on emotional health.

Personality and Body Chemosignals

Two studies show that human body odor gives cues for personality types such as neuroticism and, possibly, dominance. Body odor was collected via cotton pads from a group of donors who also rated themselves on personality traits. In two studies, one with child participants and one with young adult participants, neuroticism was identified from body odor. The young adults, but not the children, could also identify dominance. Neither group could identify extraversion. Sorokowska (2013; Sorokowska, Sorokowski, & Szmajke, 2012) explains why personality might be discernible via body odor by focusing on the production of hormones in relation to stress and anxiety. Particularly noteworthy, given the work on fear body odor, is that neuroticism can be defined as a pervasive feeling of anxiety, stress, and fear.

Using measures of brain processing and focusing on reactions to human mood odors, Pause and colleagues (Pause et al., 2010) found that socially anxious people, in comparison with those low in social anxiety, had an amplified startle response when also exposed to fear mood chemosignals. In other words, socially anxious people were especially sensitive to the chemosignals.

Anosmia and Related Problems with Olfactory Acuity

It is quite common for people who lose olfactory sensitivity to become depressed. Beyond that, a wide range of studies have demonstrated the extent of olfactory deficits in clinical populations (see Atanasova et al., 2008, for an extensive review). The most heavily researched areas include patients suffering from schizophrenia, depression, and Alzheimer's disease (e.g., Cumming, Matthews, & Park, 2011; Kästner et al., 2013; Rahayel, Frasnelli, & Joubert, 2012). However, this research needs to be considered critically as methods of assessment are not standardized and medications may affect responses as well.

Socioemotional Effects of Nonhuman Chemosignals

Nonhuman chemosignals both above and below conscious detection, tapping into explicit and implicit processes, have been demonstrated to impact both emotional and social functioning. In this section we present examples of the effects of processed or manufactured scents on human emotions and social interaction. Later in this section we turn to the effects of odors on emotional memories, and finally their use in commerce. There are a range of other studies not clearly related to emotion but still demonstrating the influence of odor on a variety of attributions (e.g., Holland, Hendriks, & Aarts, 2005) but we do not have space to review them.

Fragrance Effects on Emotion

Nearly two decades ago, Schiffman and colleagues (Schiffman, Sattely-Miller, Suggs, & Graham, 1995; Schiffman, Suggs, et al., 1995) found that using cologne improved moods for both men and women in midlife. Participants used the colognes for several weeks, reporting moods on a standard self-report. Compared with baselines or with nontreated groups, both men and women were less depressed, anxious, and irritated when using colognes.

There is some evidence that specific fragrances may have different effects for different people. Hämmerli, Schweisgut, and Kaegi (2012) found fragrance choices are likely to be influenced by genetic information. There is also evidence that different fragrances may have different social and emotional effects. Freyberg and Ahren (2011) demonstrated that when adolescent girls were asked to use a new fragrance and it was perceived as less pleasant than their own, they had lower levels of social enjoyment while using it. They also used fewer words indicative of intimacy in written narratives. Taken as a whole, such research findings confirm that man-made fragrances may affect moods and social relationships and begin to unravel the many individual differences.

Fragrance Effects on Social Interaction

Studies of the effects of nonhuman chemosignals in social interactions often show complex social context effects. For example, in a study of the impact of a college woman's fragrance on college men, it was found that the women who wore a pleasant and potent fragrance were rated as warm and romantic but only if the women were dressed informally (and appropriately for the college environment). Women who were dressed formally wearing the same fragrance were not rated favorably (Baron, 1981).

Another example of explicit effects on social behaviors involves the scent of baking pastry (cookies) or roasting coffee. Baron (1997) had experimenter confederates ask shoppers at a mall for change of a dollar while standing in front of a shop where cookies were baking, coffee was roasting, or in front of a nonscented store in another part of the mall. Shoppers who were asked for assistance in front of the baking or coffee shops were significantly more likely to help the confederate. Apparently, a pleasant, homey scent can affect social behavior. This finding has been supported recently by Guéguen (2012b) who found that spontaneous helping behavior (retrieving and returning a dropped glove in a shopping mall) was facilitated by a pleasant odor.

The studies of perfume or baking show the effects of explicit chemosignals and suggest the influence of context as well. However, even implicit nonhuman chemosignals, below conscious awareness, may have significant effects, sometimes even more potent. In a study of the impact of odor on social preferences (Li, Moallem, Patter, & Gottfried, 2007), the rating of neutral faces was primed with pleasant, neutral, or unpleasant odors presented below the threshold for conscious detection. Conscious detection thresholds are highly variable, however, so the participants also engaged in a signal detection task to determine their individual thresholds. Li and colleagues found that the subconscious detection group was influenced by the odor prime, rating a neutral face as more likable in the presence of a pleasant odor and less likable in the presence of an unpleasant odor. The conscious detection group was not affected by the primes. Similarly, Liljenquist et al. (2010) placed participants in either a room sprayed with Windex cleaner at a level near threshold or in a nonscented room. Those in the low-level clean-scented rooms were more likely to share a monetary windfall and in a second study to volunteer their services and to donate money to a cause. The researchers conclude that undetected "clean" scent can instigate social behaviors related to moral virtues. One may question, then, to what extent our everyday moods and actions are influenced by natural and/or artificial odorants.

Explicit processes can also be demonstrated by the research on the effect of odor on memory. Again summoning folk wisdom, most would acknowledge that a particular odor can conjure up a particular memory. This is the "it smells like summer at the beach when I was a kid . . . such happy times" experience. Such experiences are emotional and idiosyncratic (Wysocki & Gilbert, 1989). They have also been immortalized in literature, most prominently by Marcel Proust in *Swann's Way* (1913/1957). A passage from the novel recounts the protagonist's experience of sipping tea and eating Madeleine biscuits and then being swept away in a sea of emotion and memory back to his childhood.

Research on memory processes has shown that odor-induced memories are reported to be more emotionally laden than those induced via other sensory modalities (Herz, 2000). Other work has shown that odors associated with particular experiences evoke more memories for the experience than do random odors or no odor at all (Aggleton & Waskett, 1999). Such associations are explicit and learned, tapping into cognitive and semantic processes, and argue for the power of odor to influence autobiographical memory and its attendant emotional components.

There is substantial evidence that chemosignals provided in commercial spaces have an effect on the desirability of goods and affect consumer behavior. Marketing researchers have found that a pleasant ambient odor will heighten a consumer "shopping experience," making it more likely that the consumer will visit the store again (e.g., Douce & Janssens, 2013). Odors have been found to exert this effect even for online shopping (Vinitzky & Mazursky, 2011). In a study investigating multiple sensory experiences and shopping (Morrison, Gan, Dubelaar, & Oppewal, 2011), music and a pleasant odor (vanilla) were both found to create arousal in shoppers, directly affecting their perception of their shopping experience as pleasurable. This in turn led to behaviors desirable from the retailers' perspective, such as increasing the time spent shopping. The scent of lavender in a florist shop showed similar effects. When lavender was used (as an additive scent, not by presentation of lavender plants) more consumers were attracted and purchases increased (Jacob, Sefan, & Guéguen, 2014).

Pleasant scent seems to motivate the purchase of items through the enhancement of socioemotional behaviors. They may also affect other behaviors. Intending to counteract malodors in clubs, odors of orange, seawater, and peppermint were piped into three separate clubs (Schifferstein, Talke, & Oudshoorn, 2011). Not only was mood affected positively by all three scents compared with a no odor control, but so was dance activity, judgments of the music, and ratings of the overall experience. Adding the research on memory to the marketing domain, Morrin and Ratneshwar (2003) confirm that fragrance may provide long-term, detailed memory of products. This long-term memory effect warrants further investigation.

This selection of research on the effects of nonhuman, manufactured chemosignals clearly demonstrates that their presence can affect human mood and social behavior, quite possibly also attention and a variety of cognitive processes. Not all chemosignals will be effective and their effectiveness varies with the context in which they are used. Nevertheless, this shows the potential for future research in several areas.

Emotional Reactions to Natural Odors in the Environment

Of course, humans leaving mood messages in the air is an environmental event of a sort, as are our manufactured perfumes and scented products. There is also evidence for the effects of chemicals in the air from a "nature" less manufactured on mood, attention, and behavior related to health or well-being. Attention to this has increased with the increasing concern about industrialization, climate change, urbanization, and related problems (for more general approaches to natural environments including parks, see Jaffe, 2010) leading to the development of a new field within environmental psychology that merges psychology, architecture, urban planning, and horticulture (Sternberg, 2009). In this next section, we give a few examples of naturally occurring chemosignals in our environments that also affect our emotions and often our social behaviors. First, we review some chemosignals that have positive emotional effects and then turn to those with more negative emotional effects.

Positive Emotion Effects from Olfactory Stimuli in the Environment

In a series of studies investigating the effects of flowers, we (Haviland-Jones, Rosario, Wilson, & McGuire, 2005) studied how flowers—which are, of course, naturally occurring chemosignal producers—evoke positive emotional and social responses in humans. The first study riveted our attention because all of the participants exposed to a mixed flower bouquet responded with the Duchenne (zygomatic/orbicularis orbis) smile and significantly more reported more positive emotion over a 3-day period compared with participants who received fruit baskets or a pillar candle. In the second study, participants (older adults in retirement communities) received "doses" of floral bouquets. Those who received more than one over several weeks had lower reports of depression. Possibly related to the improved mood, they scored higher on an episodic memory task. Finally, in a third study, a single gerbera daisy—but less so, a pen—given to a person in an elevator led not only to the Duchenne smile but also movement toward a stranger and initiation of conversation. Unexpectedly, this was equally the case for men as well as women.

Our original research has been extended. For example, Weber and Heuberger (2008), using varieties of blooming plants, showed that participants reported an increase in positive mood, calmness, and alertness when in the natural odor condition as compared with the control condition. The effects of pleasant odors tended to be long-lasting. Another recent study demonstrated that simple exposure to flowers increased women's favorable perceptions of a man, and increased the likelihood of accepting a date (Guéguen, 2011). In other words, simple exposure to flowers affected mood. Showing a similar pattern to certain other chemosignals, the mood effects extend to other social interactions.

After noting the effects of multisensory florals, we started to examine just the effects of floral odors, focusing on odors from plants that have "co-evolved" with people, such as roses. We found that exposure to a floral odor that was not intense enough to be detected (i.e., at perithreshold level) led to increased uses of positive emotion words in narratives and to a greater likelihood of approaching a stranger (Haviland-Jones et al., 2013). In this case, we were comparing a cultivated "natural" fragrance to fresh air as well as to classic perfumes. Also using floral scents, Cupchik extended the research on floral odors to social memory. He and his colleagues reported that exposure to the odor of gardenias while reading a passage from literature resulted in better memories for social referents (Cupchik & Phillips, 2005; Phillips & Cupchik, 2004).

The effects of some floral odors are potent enough to rival pharmacological products. For example, exposure to floral odors reduced symptoms in depressive patients (Komori, Fujiwara, Tanida, Nomura, & Yokoyama, 1995). The fragrances affected neuroendocrine hormone levels and immune function and were "more effective than antidepressants." The physiological and behavioral effects resulting from exposure to floral odors even can be demonstrated in mice. The odor of roses reduced anxiety (de Almeida, Motta, Faturi, Catallani, & Leite, 2004; Bradley, Starkey, Brown, & Lea, 2007); similar effects were found for *Gardenia jasminoides* (Sergeeva et al., 2010) and sweet orange (Faturi, Leite, Alves, Canton, & Teixeira-Silva, 2010). These studies find the effects comparable to treatment with diazepam (Valium) but without the sedative effects—that is, without motor and attention deficits. In these additional examples, the fact that the research participants were not human makes the case for the effects even more strongly. There was no previous exposure to cultivated plant odors that would account for learning or association. The significance of the studies seems to be that some naturally occurring fragrances such as floral scents affect emotion; they at least lessen anxiety or depression, sometimes rather dramatically.

Natural odors from plants or animals affecting human motivation and behavior are not unique. Interspecies communications through chemosensory signals is not uncommon in the insect phyla (Weller, Jacobson, & Conner, 2000) and are even noted in mammals (Von Helversen, Winkler, & Bestmann, 2000). Some flowers give off an odor that brings large gatherings of bats to "party," as the researchers report (Von Helversen et al., 2000). The bats come in response to a chemosensory, airborne signal that mimics bat odors used for gathering. So it is known that plants and mammals may have coevolved systems that require chemosensory information.

We (Haviland-Jones et al., 2005) suggested that flowering plants have found a positive "mood niche" to exploit in a system coevolved with humans. Humans provide propagation and care for these special flowering plants that in turn improve human moods. There may be some places in the world or some plants or animals that evoke or provide more happiness for people than other places, plants, or animals. This may result in places with an overall better mood environment for people.

Negative Emotion Effects from Olfactory Stimuli in the Environment

As the review of positive emotions elicited by natural environmental plants above shows, chemosignals in the air from natural sources such as flowers are at least as effective in moderating mood and social behavior as fragrances produced from manufactured products. These are effects on positive emotions and moods, and social behavior. However, chemosignals, even ones that occur naturally in the environment, as well as manufactured ones, can have negative effects. It is beyond the purview of this chapter to review the large area of research that addresses odorous chemicals harmful to health that result from human activities (e.g., see Yu, Tsunoda, & Tsunoda, 2011, for a review); instead, we focus on those affecting moods or stress.

The argument that the unpleasantness of odors is in "the nose of the beholder" often leads to the conclusion that one may "adapt to" or even "learn to like" unpleasant odors. Work by Delplanque and colleagues (2008) casts doubt on this simple "familiarity" assumption. In two carefully controlled studies, participants rated odors that were similar in intensity. The expected correlation between familiarity and pleasantness occurred only for pleasant odors, not for unpleasant odors. Additionally, only the unpleasant odors were correlated with a physiological stress measure. They infer that the effects of unpleasant odors are not susceptible to familiarity and that odors do not lie on a single pleasantness continuum. This is supported by brain activity as well as autonomic changes (see Rouby & Bensafi, 2002).

Additional research implicates unpleasant odorants to stress within the laboratory context. For example, when people inhale unpleasant odors, there is an increase in blood pressure and a change in blood sugar levels (Martin, 1996; Nimmermark, 2004). Asmus and Bell (1999) demonstrated that exposure to unpleasant odors not only increases negative affect and avoidance behaviors, but that these increase as the odor becomes more unpleasant. As with the more positive effects of floral odors, there are effects on mood reports and effects on social perception as well as changes in other sensory sensations such as pain (e.g., Marchand & Arsenault, 2002; Demattè, Osterbauer, & Spence, 2007).

Another aspect of malodor in the environment is more specific to the space inside buildings and may result in "sick building syndrome" (SBS). Although the symptoms associated with SBS include physical distress such as eye irritation or nausea, recent research also documents effects with emotional components. For example, Redman, Hamilton, Malloch, and Kleymann (2011) observed that SBS had long-term associations with emotional burnout, job stress, and a variety of stress-related outcomes including diminished job satisfaction.

Regarding naturally occurring malodors, Rotton (1983) found that exposure to ethyl mercaptan adversely affected both judgments and performance. Research since that noteworthy early study has generally corroborated and extended this work, particularly to naturalistic settings. Ethyl mercaptan is a naturally occurring odor coming from many sources ranging from marshes to sewage treatment areas to industries manufacturing jet fuel. People are extremely sensitive to this odor and because of that sensitivity, it is added to natural gas used in homes so that gas leaks will be detected and promptly reported.

Another type of relatively natural malodor is associated with industrial farming (see Nimmermark, 2004, for a review). These are of particular note because they are associated with depression. They tend to impact a subset of the population generally located in poor, rural areas. For example, studies have shown that living near hog farms increases negative emotion while decreasing positive emotion (Schiffman, Bennett, & Raymer, 2001), increases depression (Bullers, 2005), and decreases quality of life (Wing & Wolf, 2000). Effects have been confirmed using a longitudinal model (Horton, Wing, Marshall, & Brownley, 2009).

Summary

In this chapter, we first provided an overview of methods needed for emerging research on emotion and olfaction and emphasized the importance of methods useful for implicit processes in recent research (see Freyberg, Wilson, & Haviland-Jones, 2015, for more detail). We then provided an overview of the three parts of the olfactory system and took particular note of recent discoveries. Future research is likely to attend to the separable functions of this complex system. The main part of the chapter reviewed examples from several areas of current research. These included human mood body odors, nonhuman chemosignals that have emotional and social significance, and, finally, naturally occurring environmental chemosignals that affect moods and health.

As we make progress in olfaction and emotion we are learning that the olfactory system does not provide much focus on the direction or identification of objects and may be constructed so that it is relatively "blind," as Sela and Sobel (2010) propose. We proposed that the olfactory system is designed more as a subconscious, parallel, rapid processor that prompts searches to be carried out often by the other senses (Haviland-Jones & Wilson, 2008). This system is probably an ongoing, not-quite-conscious, match/mismatch process that is correlating bits of information between olfaction and the other sensory systems. It is our hypothesis that the olfactory system is actively and continuously searching for existing communicative background information, especially related to emotional and motivational issues. The subtle orientation or perhaps bias provided by chemosignals can shift behavior or attention slightly to accommodate the search without interfering with ongoing behavior. That the brain responds without awareness to odors was first clearly demonstrated by Pause (2012). Her research has been the impetus for and has continued to support the position that awareness of body odor in particular is not necessary for responses; that there are different brain processes for body odor than for common odors. This has raised the question of whether there are dual roles for implicit and explicit processes in human odor communication.

We had first proposed the subconscious, parallel, rapid processor in our previous review of olfaction and emotion (Haviland-Jones & Wilson, 2008), somewhat tentatively. We called it the *search engine hypothesis*. Since then, there has been some support, both evidential and theoretical. For example, the potential emotional impact of mood chemosignals is established by several researchers. Even when not identified, one person's body chemistry affects another's facial movements and attributions, and alters the semantic web so that words related to the mood odor become more frequent in use and more quickly identified (for discussion of communicative aspects, see Haviland-Jones, Wilson, & Freyberg, 2015; Lubke & Pause, 2015). A similar process has been found for a few other nonhuman odors including "floral." Much work remains to be done before we can be confident about the extent of the possible discrete cues and the constraints on their effects.

A "Gedanken experiment" may help illustrate the functions of the putative search engine. This shows how we search for a target or event or even memory that is congruent with the olfactory cue. In the process, we are very likely to believe that the origin of the search was in the seen or heard or touched target or event that was identified later in the search, skipping the subconscious olfactory cue. If there is a lingering fear chemosignal in a room and someone enters, we would predict that it would prompt a rapid subconscious search of the environment for related contextual cues, as well as cues from an internal memory network. The mere presence of a fear chemosignal may affect arousal as the olfactory system is attentive to the cue. Whether it prompts fear behavior beyond the behavior attendant on a search such as visual scanning (head and eye movements) is not determined, but depends on other available information gathered in the memory or environmental scan. For example, if the persons greeting each other in this room continue to be relaxed, finding no other cues for fear, the incongruent fear signal will not change their behavior. If there is some other ambiguous cue, such as lights blinking, then the fear chemosignal leads to a sense of threat. If the lingering chemosensory cue had been from happiness, the same blinking lights might have been interpreted as something amusing. From a more personological position, the person in the room might be characteristically anxious (see Magai & Haviland-Jones, 2002; Pause et al., 2010) and any prompt to search for threat might initiate a well-learned set of anxious behaviors and attributions. In none of these cases would it be likely that the fear chemosignal would be identified as the source of the search.

The *search engine* also can be called into operation even by scents of which we are aware. In these instances it is the process that is not acknowledged. In the examples of perfumes and floral fragrances, it is often the case that there is an easily detectable odor; these scents influence mood, intimate behavior, attributions, and the semantic network. We expect, however, that most people attribute their better moods and friendly behavior to discernible objects and people, not to something in the air, though that is a well-worn and apt metaphor.

Future research on the search engine hypothesis will profit both from extending the research into new areas, including developmental and cross-cultural, and making it more inclusive of research in other areas. For example, in a variety of sensory fields there are parallel theories such as the automaticity theory (e.g., Bargh, Schwader, Hailey, Dyer, & Boothby, 2012; Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001). For a limited example, Bargh and colleagues (2012) found that there is an "embodiment" of sensory processes in which there are metaphoric associations for sensory inputs. Warm air is associated with warm feelings and heavy weights with seriousness. In olfaction, we find many examples to bolster the embodiment concept such as that floral scent is associated with happiness (Haviland-Jones et al., 2005), or fishy odors with untrustworthiness (Lee & Schwarz, 2012), or cleanliness with virtue

(Liljenquist et al., 2010). In the case of odors, however, more attention is needed to the adaptive origins of the connections (e.g., see Haviland-Jones et al., 2005, on the coevolution of flowers and people, or Schiffman et al. 2001, on malodors).

A critical factor to consider in olfaction and emotion is that chemosignals—whether from people, processed or synthetic scents, or the environment—can encode valuable emotional information and affect changes. In this new century alone we have discovered that people can communicate emotions with body chemicals. In addition, some scents affect wide categories of behavior, from approach to attribution to semantic networks and to effects on the immune and cardiovascular systems. In other words, chemosignals have been shown to have wide-ranging effects on mood, attention, behavior, and attribution. It remains part of the challenge to understand why much of the influence of chemosignals on emotion is out of ordinary awareness. In spite of the many recent advances and intriguing pockets of discovery, emotion research in the area of olfaction remains open—a fast, growing, exciting field for both theoretical and applied research.

References

Aggleton, J. P., & Waskett, L. (1999). The ability of odours to serve as state-dependent cues for real-world memories: Can Viking smells aid the recall of Viking experiences? *British Journal of Psychology, 90*, 1–7.

Aglioti, S. M., & Pazzaglia, M. (2011). Sounds and scent in (social) action. *Trends in Cognitive Sciences, 11*(2), 47–94.

Asmus, C. L., & Bell, P. A. (1999). Effects of environmental odor and coping style on negative affect, anger, arousal, and escape. *Journal of Applied Social Psychology, 29*(2), 245–260.

Atanasova, B., Graux, J., El Hage, W., Hommet, C., Camus, V., & Belzung, C. (2008). Olfaction: A potential cognitive marker of psychiatric disorders. *Neuroscience and Biobehavioral Reviews, 32*, 1315–1325.

Baas, D., Aleman, A., & Kahn, R. S. (2004). Lateralization of amygdala activation: A systematic review of functional neuroimaging studies. *Brain Research Reviews, 45*(2), 96–1003.

Bargh, J. A., Gollwitzer, P. M., Lee-Chai, A., Barndollar, K., & Trötschel, R. (2001). The automated will: Nonconscious activation and pursuit of behavioral goals. *Journal of Personality and Social Psychology, 81*(6), 1014.

Bargh, J. A., Schwader, K. L., Hailey, S. E., Dyer, R. L., & Boothby, E. J. (2012). Automaticity in social–cognitive processes. *Trends in Cognitive Sciences, 16*(12), 593–605.

Baron, R. A. (1997). The sweet smell of . . . helping: Effects of pleasant ambient fragrance on prosocial behavior in shopping malls. *Personality and Social Psychology Bulletin, 23*(5), 498–503.

Baron, R. A. (1981). Olfaction and human social behavior: Effects of a pleasant scent on attraction and social perception. *Personality and Social Psychology Bulletin, 7*(4), 611–616.

Bensafi, M., Brown, W. M., Tsutsui, T., Mainland, J. D., Johnson, B. N., Bremner, E. A., et al. (2003). Sex-steroid derived compounds induce sex-specific effects on autonomic nervous system function in humans. *Behavioral Neuroscience, 117*(6),1125–1134.

Bradley, B. F., Starkey, N. J., Brown, S. L., & Lea, R. W. (2007). The effects of prolonged rose odor inhalation in two animal models of anxiety. *Physiology and Behavior, 92*(5), 931–938.

Brand, G. (2006). Olfactory/trigeminal interactions in nasal chemoreception. *Neuroscience and Biobehavioral Reviews, 30*, 908–917.

Britton, J. C., Phan, K. L., Taylor, S. F., Welsh, R. C., Berridge, K. C., & Liberzon, I. (2006). Neural correlates of social and nonsocial emotions: An fMRI study. *NeuroImage, 31*(1), 397–409.

Buck, L., & Axel, R. (1991). A novel multigene family may encode odorant receptors: A molecular basis for odor recognition. *Cell, 65*, 175–187.

Bullers, S. (2005). Environmental stressors, perceived control, and health: The case of residents near large-scale hog farms in eastern North Carolina. *Human Ecology, 33*(1), 1–16.

Carleton, A., Petreanu, L. T., Lansford, R., Alvarez-Buylla, A., & Lledo, P. (2003). Becoming a new neuron in the adult olfactory bulb. *Nature Neuroscience, 6*(5), 507–518.

Castellanos, K. M., Hudson, J. A., Haviland-Jones, J., & Wilson, P. J. (2010). Does exposure to ambient odors influence the emotional content of memories? *American Journal of Psychology, 123*, 269–279.

Chen, D., & Haviland-Jones, J. (1999). Rapid mood change and human odors. *Physiology and Behavior, 68*, 241–250.

Chen, D., & Haviland-Jones, J. (2000). Human olfactory communication of emotion. *Perceptual and Motor Skills, 91*, 771–781.

Chen, D., Katdare, A., & Lucas, N. (2006). Chemosignals of fear enhance cognitive performance in humans. *Chemical Senses, 31*, 415–423.

Classen, C., Howes, D., & Synnott, A. (1994). *Aroma: The cultural history of smell.* London: Routledge.

Cumming, A. G., Matthews, N. L., & Park, S. (2011). Olfactory identification and preference in bipolar disorder. *European Archives of Psychiatry and Clinical Neuroscience, 261*, 251–259.

Cupchik, G. C., & Phillips, K. (2005). The scent of literature. *Cognition and Emotion, 19*(1),101–119.

de Almeida, R. N., Motta, S. C., de Brito Faturi, C., Catallani, B., & Leite, J. R. (2004). Anxiolytic-like effects of rose oil inhalation on the elevated plus-maze test in rats. *Pharmacology Biochemistry and Behavior, 77*(2), 361–364.

de Groot, J. H. B., Smeets, M. A. M., Kaldewaij, A., Duijndam, M. J. A., & Semin, G. R. (2012). Chemosignals communicate human emotions. *Psychological Science, 23*(11), 1417–1424.

de Groot, J. H., Smeets, M. A., Rowson, M. J., Bulsing, P. J., Blonk, C. G., Wilkinson, J., et al. (2015). A sniff of happiness. *Psychological Science, 26*(6), 684–700.

Delplanque, S., Grandjean, D., Chrea, C., Aymard, L., Cayeux, I., Le Calve, B., et al. (2008). Emotional processing of odors: Evidence for a nonlinear relation between pleasantness and familiarity evaluations. *Chemical Senses, 33*(5), 469–479.

Demattè, M. L., Osterbauer, R., & Spence, C. (2007). Olfactory cues modulate facial attractiveness. *Chemical Senses, 32*, 603–610.

Douce, L., & Janssens, W. (2013). The presence of a pleasant ambient scent in a fashion store: The moderating role of shopping motivation and affect intensity. *Environment and Behavior, 45*(2), 215–238.

Faturi, C. B., Leite, J. R., Alves, P. B., Canton, A. C., & Teixeira-Silva, F. (2010). Anxiolytic-like effect of sweet orange aroma in Wistar rats. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 34*(4), 605–609.

Freyberg, R. J., & Ahren, M. (2011). Understanding fragrance preferences in adolescent girls. *Journal of Sensory Studies, 26*, 237–243.

Freyberg, R. J., Wilson, P., & Haviland-Jones, J. M. (2015). Methods in olfactory research. In D. Matsumoto, H. D. Hwang, & M. G. Frank (Eds.), *APA handbook of nonverbal communication* (pp. 539–550). Washington, DC: American Psychological Association.

Guéguen, N. (2011)."Say it with flowers": The effect of flowers on mating attractiveness and behavior. *Social Influence, 6*(2), 105–112.

Guéguen, N. (2012a). The sweet smell of . . . courtship: Effects of pleasant ambient fragrance on women's receptivity to man's courtship request. *Journal of Environmental Psychology, 32*, 123–125.

Guéguen, N. (2012b). The sweet smell of . . . implicit helping: Effects of pleasant ambient fragrance on spontaneous help in shopping malls. *Journal of Social Psychology, 152*, 397–400.

Halpern, M. (1987). The organization and function of the vomeronasal system. *Annual Review of Neuroscience, 10*, 325–362.

Hämmerli, A., Schweisgut, C., & Kaegi, M. (2012). Population genetic segmentation of MHC-correlated perfume preferences. *International Journal of Cosmetic Science, 34*(2), 161–168.

Haviland-Jones, J., Hudson, J. A., Wilson, P., Freyberg, R., & McGuire, T. (2013). The emotional air in your space: Scrubbed, wild or cultivated? *Emotion, Space and Society, 6*, 91–99.

Haviland-Jones, J., & McGuire, D. (1999). The scents of fear and funny. *Aroma-Chology Review, 8*(2), 11.

Haviland-Jones, J., Rosario, H. H., Wilson, P. J., & McGuire, T. (2005). An environmental approach to positive emotion: Flowers. *Evolutionary Psychology, 3*, 104–132.

Haviland-Jones, J., & Wilson, P. (2008). A "nose" for emotion: Emotional information and challenges in odors and semiochemicals. In M. Lewis, J. M. Haviland-Jones, & L. Barrett-Feldman (Eds.), *Handbook of emotion* (3rd ed., pp. 235–248). New York: Guilford Press.

Haviland-Jones, J., Wilson, P., & Freyberg, R. (2015). Signs, signals, and symbols in olfactics. In D. Matsumoto, H. D. Hwang, & M. G. Frank (Eds.), *APA handbook of nonverbal communication* (pp. 363–385). Washington, DC: American Psychological Association.

Herz, R. S. (2000). Scents of time. *The Sciences, 40*(4), 34–39.

Herz, R. S., Eliassen, J. B., Beland, S. A., & Souza, T. (2004). Neuroimaging evidence for the emotional potency of odor-evoked memory. *Neuropsychologia, 42*, 371–378.

Holland, R. W., Hendriks, M., & Aarts, H. (2005). Smells like clean spirit: Nonconscious effects of scent on cognition and behavior. *Psychological Science, 16*(9), 689–693.

Horton, R. A., Wing, S., Marshall, S. W., & Brownley, K. A. (2009). Malodor as a trigger of stress and negative mood in neighbors of industrial hog operations. *American Journal of Public Health, 99*(S3), S610–S615.

Hummel, T., & Livermore, A. (2002). Intranasal chemosensory function of the trigeminal nerve and aspects of its relation to olfaction. *International Archives of Occupational and Environmental Health, 75*(5), 305–313.

Jacob, C., Stefan, J., & Guéguen, N. (2014). Ambient scent and consumer behavior: A field study in a florist's retail shop. *International Review of Retail, Distribution and Consumer Research, 24*(1), 116–120.

Jacob, S., Kinnunen, L. H., Metz, J., Cooper, M., & McClintock, M. K. (2001). Sustained human chemosignal unconsciously alters brain function. *NeuroReport, 12*(11), 2391–2394.

Jacob, S., & McClintock, M. K. (2000). Psychological state and mood effects of steroidal chemosignals in women and men. *Hormones and Behavior, 37*(1), 57–78.

Jaffe, E. (2010). This side of paradise: Discovering why the human mind needs nature. *APS Observer, 23*, 10–15.

Jellinek, P. (1996). The psychological basis of perfumery. In J. S. Jellinek (Ed.), *The psychological basis of perfumery*(4th ed., pp.1–162). London: Chapman and Hall.

Karlson, P., & Luscher, M. (1959). Pheromones: A new term for a class of biologically active substances. *Nature, 183*,55–56.

Kass, M. D., Rosenthal, M. C., Pottackal, J., & McGann, J. P. (2013). Fear learning enhances neural response to threat-predictive sensory stimuli. *Science, 342*, 1389–1392.

Kästner, A., Malzahn, D., Begermann, M., Hilmes, C., Bickeböller, H., & Ehrenreich, H. (2013). Odor naming and interpretation performance in 881 schizophrenia subjects: Association with clinical parameters. *BMC Psychiatry, 13*, 218.

Kiecolt-Glaser, J. K., Graham, J. E., Malarkey, W. B., Porter, K., Lemeshow, S., & Glaser, R. (2008). Olfactory influences on mood and autonomic, endocrine, and immune function. *Psychoneuroendocrinology, 33*, 327–339.

Komori, T., Fujiwara, R., Tanida M., Nomura, J., & Yokoyama, M. M. (1995). Effects of citrus fragrance on immune function and depressive states. *Neuroimmunomodulation, 2*, 174–180.

Kuroda, K., Inoue, N., Ito, Y., Kubota, K., Sugimoto, A., Kakuda, T., et al. (2005). Sedative effects of the jasmine tea odor and (R)-(−)-linalool, one of its major odor components, on autonomic nerve activity and mood states. *European Journal of Applied Physiology, 95*(2–3), 107–114.

Laska, M., & Seibt, A. (2002). Olfactory sensitivity for aliphatic esters in squirrel monkeys and pigtail macaques. *Behavioural Brain Research, 134*(1–2), 165–174.

Lee, S. W., & Schwarz, N. (2012). Bidirectionality, mediation, and moderation of metaphorical effects: The embodiment of social suspicion and fishy smells. *Journal of Personality and Social Psychology, 103*(5), 737.

Li, W., Moallem I., Patter, K. A., & Gottfried, J. A. (2007). Subliminal smells can guide social preferences. *Psychological Science, 18*(12), 1044–1049.

Liljenquist, K., Zhong, B., & Galinsky, A. D. (2010). The smell of virtue: Clean scents promote reciprocity and charity. *Psychological Science, 21*(3), 381–383.

Lübke, K. T., & Pause, B. M. (2015). Always follow your nose: The functional significance of social chemosignals in human reproduction and survival. *Hormones and Behavior*, 68, 134–144.

Lundström, J. N., Boyle, J. A., Zatorre, R. J., & Jones-Gotman, M. (2008). Functional neuronal processing of body odors differs from that of similar common odors. *Cerebral Cortex, 18*(6), 1466–1474.

Magai, C., & Haviland-Jones, J. (2002). *The hidden genius of emotion: Lifespan transformations of personality*. New York: Cambridge University Press.

Marchand, S., & Arsenault, P. (2002). Odors modulate pain perception: A gender-specific effect. *Physiology and Behavior, 76*, 251–256.

Martin, G. N. (1996). Olfactory remediation: Current evidence and possible applications. *Social Science Medicine, 43*, 63–70.

Meredith, M. (2001). Human vomeronasal organ function: A critical review of best and worst cases. *Chemical Senses, 26*, 433–445.

Morrin, M., & Ratneshwar, S. (2003). Does it make sense to use scents to enhance brand memory? *Journal of Marketing Research, 40*(1), 10–25.

Morrison, M., Gan, S., Dubelaar, C., & Oppewal, H. (2011). In-store music and aroma influences on shopper behavior and satisfaction. *Journal of Business Research, 64*(6), 558–564.

Mujica-Parodi, L. R., & Strey, H. (2006). *Identification and isolation of human alarm pheromones*. Stony Brook, NY: SUNY at Stony Brook Research Foundation.

Mujica-Parodi, L. R., Strey, H. H., Frederick, B., Savoy, R., Cox, D., Botanov, Y., et al. (2009). Chemosensory cues to conspecific emotional stress activate amygdala in humans. *PLoS ONE, 4*(7), e6415.

Nimmermark, S. (2004). Odour influence on well-being and health with specific focus on animal production emissions. *Annals of Agricultural Environmental Medicine, 11*, 163–173.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84*, 231–259.

Panksepp, J. (2011). The basic emotional circuits of mammalian brains: Do animals have affective lives? *Neuroscience and Biobehavioral Reviews*, *35*(9), 1791–1804.

Pause, B. M. (2012). Processing of body odor signals by the human brain. *Chemosensory Perception, 5*(1), 55–63.

Pause, B. M., Lübke, K., Laudien, J. H., & Ferstl, R. (2010). Intensified neuronal investment in the processing of chemosensory anxiety signals in non-socially anxious and socially anxious individuals. *PLoS ONE, 5*(4), e10342.

Pause, B. M., Ohrt, A., Prehn, A., & Ferstl, R. (2004). Positive emotional priming of facial affect perception in females is diminished by chemosensory anxiety signals. *Chemical Senses, 29*(9), 797–805.

Pennebaker, J. W., & Seagal, J. D. (1999). Forming a story: The health benefits of narrative. *Journal of Clinical Psychology, 55*(10), 1243–1254.

Phillips, K., & Cupchik, G. C. (2004). Scented memories of literature. *Memory, 12*(3), 366–375.

Prehn, A., Ohrt, A., Sojka, B., Ferstl, R., & Pause, B. M. (2006). Chemosensory anxiety signals augment the startle reflex in humans. *Neuroscience Letters, 394*(2), 127–130.

Preti, G., Wysocki, C. J., Barnhart, K. T., Sondheimer, S. J., & Leyden, J. J. (2003). Male axillary extracts contain pheromones that affect pulsitile secretion of luteinizing hormone and mood in women recipients. *Biological Reproduction, 68*(6), 2107–2113.

Proust, M. (1957). *Swann's way*. New York: Penguin Books. (Original work published 1913)

Rahayel, S., Frasnelli, J., & Joubert, S. (2012). The effect of Alzheimer's disease and Parkinson's disease on olfaction: A meta-analysis. *Behavioral Brain Research, 231*, 60–74.

Raudenbush, B. (2004). *The effects of peppermint on enhancing mental performance and cognitive functioning, pain threshold and tolerance, digestion and digestive processes and athletic performance*. New York: Wheeling Jesuit University Department of Psychology, prepared for the Sense of Smell Institute, the Research and Education Division of the Fragrance Foundation.

Redman, T., Hamilton, P., Malloch, H., & Kleymann, B. (2011). Working here makes me sick!: The consequences of sick building syndrome. *Human Resource Management Journal, 21*, 14–27.

Rolls, E. T. (1996). The orbitofrontal cortex. *Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences, 351*(1346), 1433–1443.

Rotton, J. (1983). Affective and cognitive consequences of malodorous pollution. *Basic and Applied Social Psychology, 4*, 171–191.

Rouby, C., & Bensafi, M. (2002). Is there a hedonic dimension to odors? In C. Rouby (Ed.), *Olfaction, taste and cognition* (pp. 140–250). New York: Cambridge University Press.

Savic, I. (2005). Brain imaging studies of the functional organization of human olfaction. *Chemical Senses, 30*(Suppl. 1), i222–i223.

Schifferstein, H. N., Talke, K. S., & Oudshoorn, D. J. (2011). Can ambient scent enhance the nightlife experience? *Chemosensory Perception, 4*(1–2), 55–64.

Schiffman, S. S., Bennett, J. L., & Raymer, J. H. (2001). Quantification of odors and odorants from swine operations in North Carolina. *Agricultural Forest Meteorology, 108*, 213–240.

Schiffman, S. S., Sattely-Miller, E. A., Suggs, M. S., & Graham, B. G. (1995). The effect of pleasant odors and hormone status on mood of women at mid-life. *Brain Research Bulletin, 36*, 19–29.

Schiffman, S. S., Suggs, M. S., & Sattely-Miller, E. A. (1995). Effects of pleasant odors on mood of males at mid-life: Comparison of African-American and European-American men. *Brain Research Bulletin, 36*(1), 31–37.

Sela, L., & Sobel, N. (2010). Human olfaction: A constant state of change-blindness. *Experimental Brain Research, 205*, 13–29.

Sergeeva, O. A., Kletke, O., Kragler, A., Poppek, A., Fleischer, W., Schubring, S. R., et al. (2010). Fragrant dioxane derivatives identify β1-subunit-containing GABAA receptors. *Journal of Biological Chemistry, 285*(31), 23985–23993.

Sheatsley, P. B. (1983). Questionnaire construction and item writing. In P. H. Rossi, J. D. Wright, & A. B. Anderson (Eds.), *Handbook of survey research* (pp. 195–230). New York: Academic Press.

Sorokowska, A. (2013). Assessing personality using body odor: Differences between children and adults. *Journal of Nonverbal Behavior, 37*, 153–163.

Sorokowska, A., Sorokowski, P., & Szmajke, A. (2012). Does personality smell?: Accuracy of personality assessments based on body odour. *European Journal of Personality, 26*, 496–503.

Soudry, Y., Lemogne, C., Malinvaud, D., Consoli, S. M., & Bonfils, P. (2011). Olfactory system and emotion: Common substrates. *European Annals of Otorhinolaryngology, Head and Neck Diseases, 128*, 18–23.

Stern, K., & McClintock, M. K. (1998). Regulation of ovulation by human pheromones. *Nature, 392*, 177–179.

Sternberg, E. M. (2009). *Healing spaces: The science of place and well-being.* Cambridge, MA: Belknap Press of Harvard University Press.

Stockhorst, U., & Pietrowsky, R. (2004). Olfactory perception, communication, and the nose-to-brain pathway. *Physiology and Behavior, 83*, 3–11.

Stoddart, D. M. (1990).*The scented ape: The biology and culture of human odour.* New York: Cambridge University Press.

Tubaldi, F., Turella, L., Pierno, A. C., Grodd, W., Tirindelli, R., & Castiello, U. (2011). Smelling odors, understanding actions. *Social Neuroscience, 6*(1), 31–47.

Vinitzky, G., & Mazursky, D. (2011). The effects of cognitive thinking style and ambient scent on online consumer approach behavior, experience approach behavior and search motivation. *Psychology and Marketing, 28*(5), 496–519.

Von Helversen, O., Winkler, L., & Bestmann, S. J. (2000). Sulfur containing "perfumes" attract flower visiting bats. *Journal of Comparative Physiology, 186*, 143–153.

Weber, S. T., & Heuberger, E. (2008). The impact of natural odors on affective states in humans. *Chemical Senses, 33*, 441–447.

Weller, S. J., Jacobson, N. L., & Conner, W. E. (2000). The evolution of chemical defenses and mating systems in tiger moths. *Biological Journal of the Linnaean Society, 68*, 557–558.

Wing, S., & Wolf, S. (2000). Intensive livestock operations, health, and quality of life among eastern North Carolina residents. *Environmental Health Perspectives, 108*, 233–238.

Wysocki, C. J., & Gilbert, A. N. (1989). National Geographic smell survey: Effects of age are heterogenous. *Annals of the New York Academy of Sciences, 561*(1), 12–28.

Wysocki, C. J., & Preti, G. (2004). Facts, fallacies, fears, and frustrations with human pheromones. *Anatomical Record Part A: Discoveries in Molecular Cellular and Evolutionary Biology, 281A*(1), 1201–1211.

Yeshurun, Y., & Sobel, N. (2010). An odor is not worth a thousand words: From multidimensional odors to unidimensional odor objects. *Annual Review of Psychology, 61*, 219–241.

Yu, M. H., Tsunoda, H., & Tsunoda, M. (2011). *Environmental toxicology: Biological and health effects of pollutants.* Boca Raton, FL: CRC Press.

Zald, D. H. (2003). The human amygdale and the emotional evaluation of sensory stimuli. *Brain Research Reviews, 41*, 88–123.

Zernecke, R., Haegler, K., Kleemann, A. M., Albrecht, J., Frank, T., Linn, J., et al. (2011). Effects of male anxiety chemosignals on the evaluation of happy facial expressions. *Journal of Psychophysiology, 25*(3), 116–123.

Zhou, W., & Chen, D. (2009). Fear-related chemosignals modulate recognition of fear in ambiguous facial expressions. *Psychological Science, 20*(2), 177–183.

CHAPTER 12

Interoception and Emotion

A Neuroanatomical Perspective

A. D. (Bud) Craig

When someone asks you "How do you feel?," your answer includes your bodily feelings as well as your emotional feelings. The embodiment of emotions is fundamental for many observers (Barrett, Quigley, Bliss-Moreau, & Aronson, 2004; James, 1890/2007; Wiens, 2005). This chapter presents evidence indicating that bodily awareness, or more accurately interoceptive awareness, has a crucial role in emotional awareness—in other words, that the neural substrates responsible for subjective awareness of your emotional state are based on the neural representation of your body's physiological state.

Interoception Redefined

The word "interoception" originally meant sensory input from the "interior" of the body (Sherrington, 1900), but modern neuroanatomical evidence shows that primates have a phylogenetically novel sensory pathway, which represents the ongoing status of all tissues and organs of the body, including viscera, muscle, bone, and skin; thus, it makes sense to redefine the term "interoception" to mean the sense of the physiological condition of the entire body (Craig, 2002). In all mammals, this sensory information provides the continuous input required for ongoing control of blood flow and respiration—that is, control of smooth muscle—whereas the exteroceptive and proprioceptive sensory inputs that underlie discriminative touch and limb position sense, respectively, are used to control skeletal (or striated) muscle. This conceptual distinction differs from the conventional view, which holds that the discriminative cutaneous feelings of temperature and pain are processed along with discriminative touch in the well-recognized body map ("homunculus") in the Rolandic cortex, while the less distinct visceral feelings are processed in more archaic regions. That categorization obscures the fact that neither stimulation nor damage of somatosensory cortices produces or alters feelings of temperature and pain, and it ignores both the inherent emotional (i.e., affective and motivational) qualities and the reflexive autonomic effects that characterize such bodily feelings. Modern evidence shows that the neural systems for interoception and exteroception are morphologically and genetically distinct, and accordingly, textbooks are beginning to incorporate this conceptual distinction. The interoceptive pathway to the cortex has deep significance, because it is most highly developed in hominids, and in humans it underlies not only all bodily feelings but also subjective awareness of "the material me."

We are all familiar with the feelings that come from our bodies, such as warm, cool, hungry, thirsty, or the feeling that something hurts, and whether that something is skin, muscle, or a tooth. Yet, we all experience these interoceptive feelings differently. Individual interoceptive awareness scores vary widely, as measured with a heartbeat perception task (e.g., the accuracy of heartbeat counts over intervals of 30–60 seconds). Interoceptive awareness correlates with sensitivity to and tolerance for a painful stimulus, with gastric sensitivity, and with self-reports of bodily awareness (Herbert & Pollatos, 2012; Pollatos, Fustos, & Critchley, 2012). An individual's heartbeat awareness score also correlates with autonomic reactivity, and with self-rated intensity of emotional feelings, whether positive or negative. Further, better heartbeat perceivers are better at reading their own emotional feelings, as well as others' emotional feelings; they also function better cognitively in tasks of selective and divided attention, and in decision-making tasks based on environmental cues or intuitive choices (Dunn, Evans, Makarova, White, & Clark, 2012). They even have a more accurate subjective sense of the passage of time in the range of 8–20 seconds (Meissner & Wittmann, 2011). Importantly, better heartbeat perceivers display better self-regulation of energy expenditure. In fact, optimal behavioral performance in elite athletes and military special operations warriors is crucially dependent on activity in the interoceptive pathway that is described in this chapter (Paulus, Flagan, Simmons, Gillis, Kotturi, et al., 2012).

Interoceptive Feelings and Homeostatic Emotions

The interoceptive pathway originates in sensory fibers that represent the condition of the body for the purpose of homeostasis, that is, the ongoing, hierarchically organized neurobiological process that maintains an optimal, energy-efficient balance across all aspects of the physiological condition of the body. Homeostasis in mammals comprises autonomic, neuroendocrine, and behavioral mechanisms that support many integrated functions. In humans, homeostatic behavioral motivations are accompanied by distinct interoceptive feelings; the interoceptive modalities include all feelings from the body, such as temperature, pain, itch, hunger, thirst, muscle ache, visceral urgency, "air hunger," and so on. Consistent with the view that an emotion in humans consists of a sensation and a motivation with direct autonomic sequelae (Rolls, 1999), I regard these feelings and the associated behavioral motivations as homeostatic emotions. This concept is directly implied by the neuroanatomical organization described below, and it emphasizes the essential autonomic role of the affectively charged feelings from the body and explains why they have strong autonomic sequelae.

Thermoregulation provides a good example of a homeostatic emotion. The salient purpose of thermoregulation, as of homeostasis, is optimal energy management in support of life. All animals thermoregulate, even amoeba, and the primordial means of thermoregulation is motivated behavior. We normally think of temperature sensation as a discriminative cutaneous (exteroceptive) sensory capacity. However, the obligatory hedonic affect (pleasantness or unpleasantness) we feel with each temperature stimulus is the perceptual concomitant of behavioral thermoregulatory motivation. This affect highlights the overarching importance of temperature sensation for homeostasis, because its valence depends directly on your body's thermoregulatory needs (Mower, 1976). Thus, the cool glass of water that feels wonderful if you are overheated feels gnawingly unpleasant if you are chilled. Conversely, if you are chilled, then a hot shower feels wonderful, even if it is stinging and prickly, but it would be called painful if you were too warm. Similarly, if you remain in a room that is too chilly (or too warm) for energy-efficient thermoneutrality (or if you place your hand on an object that is too cold or too hot), then you feel a growing discomfort (which as it increases is called painful) until you respond in a behaviorally appropriate manner. In the same way, eating salt or sugar is pleasant (and thus motivated) if the body needs it, but it becomes unpleasant and distasteful after you have eaten enough (i.e., "stimulus-specific satiety"). These affective feelings reflect behavioral motivations that are driven by the homeostatic needs of the body, and in humans this combination of a feeling and a motivation is a homeostatic emotion. Note that homeostatically motivated behaviors occur in all animals and require no awareness of accompanying feelings. In fact, the structural absence in subprimates of the pathways described below implies that they cannot experience feelings from the body of the same kind or in the same way that humans do.

Thus I concur with the idea that emotional behaviors evolved as energy-efficient means of producing goal-directed actions that fulfill homeostatic and social needs (Darwin, 1872/1965). I believe that our capacity for awareness—of our emotional behaviors and of our concomitant subjectively experienced feelings—evolved because it afforded enormous enhancement of the efficiency, complexity, and purview of emotional communication. Modern research shows that our emotions guide our decisions and our behaviors, and that interoceptive signals and interoceptive awareness are crucial (Montague, 2006). Some authors regard emotions as episodes, because they focus on measurements of strong emotions like rage or fear, but from an evolutionary neurobiological perspective, emotions are not simply occasional events, rather they are continuously ongoing. Emotional behaviors can occur without subjective awareness and feelings, as they do sometimes in humans and constantly in animals other than hominins, elephants, cetaceans, and corvids, all of which can recognize themselves in a mirror (and make music; see below). From this perspective, all of our behaviors are emotional behaviors.

Interoceptive Awareness from the Bottom Up

As a functional neuroanatomist, I have studied the organization of the brain with anatomical and physiological methods (e.g., tract-tracing, microelectrode recordings) in comparative animals, and with psychophysical and functional imaging methods (e.g., functional magnetic resonance imaging [fMRI]) in humans. My research is based on the knowledge that the brain is not a mystical structure, but rather is reproducibly and evolutionarily well organized for the purpose of maintaining and advancing both the individual and the species. The brain is not color-coded, its internal connections are not readily visible, its physiological operations are ephemeral, and it is organized in serial processing streams and hierarchical networks that are difficult to analyze. Early studies identified the sensory regions (e.g., for vision, touch) and motor regions (skeletal or visceral activation) of the human cerebral cortex with lesions and electrical stimulation. Modern functional imaging studies, which produce color-coded maps of brain activation based on changes in local blood flow, have validated the early insights and are now used in experimental psychology to reveal brain regions that are active during different cognitive and emotional tasks. Such studies are constrained by inherent limitations in temporal, spatial, and statistical resolution, and most importantly by the fact that a top-down phenomenological approach (sometimes referred to as "blob-ology"; see Sternberg, 2000) generally does not reveal the underlying neural organization. By contrast, the findings described in this chapter are built on a bottom-up view of the ascending sensory pathway that represents the physiological condition of the body.

I describe first the functional neuroanatomical characteristics of the interoceptive (homeostatic sensory) pathway in primates, beginning at the spinal level and proceeding up the neuraxis to the brainstem and thalamo-cortical levels in monkeys and in humans. Then, I highlight functional imaging experiments that demonstrate activation by cool stimuli, studies that validate the identification of the ascending interoceptive pathway and support the concept of homeostatic emotions. One of these experiments revealed the progression of interoceptive integration that underlies our subjective awareness of bodily feelings. Next, I summarize a wealth of convergent evidence indicating that the same regions are involved in all subjective emotional feelings, which substantiates the interoceptive basis of emotional awareness. Finally, I describe evidence for a left–right emotional asymmetry in forebrain processing. These insights identify interoceptive processing regions that can serve as treatment targets for emotional disorders.

The Ascending Interoceptive Pathway in the Macaque Monkey

Modality-selective peripheral sensory nerve fibers that represent all homeostatic sensory activity generate the distinct affective bodily feelings by way of discrete ascending sensory channels that originate in lamina I of the superficial dorsal horn. Activity is conveyed specifically first to the autonomic cell columns in the spinal cord, then to the cardiorespiratory and homeostatic sensorimotor regions in the brainstem. Forebrain connections that evolved in primates surmount the ancient homeostatic system and provide a dual projection to the limbic sensory cortex (in the insula) and limbic motor cortex (in the cingulate region; Figure 12.1; see Craig, 2002, 2004, 2014, for detailed descriptions).

The Interoceptive Dorsal Horn

Small-diameter (A-delta and C) primary sensory fibers (which include nociceptors, thermoreceptors, osmoreceptors, and metaboreceptors) innervate every tissue of the body (including bone) and report all aspects of the physiological status by signaling temperature, hypoxia, hypoglycemia, hypo-osmolarity, acidity, interleukin-1-beta, muscle metabolic products that uniquely signify muscular work, and so on. They conduct slowly and have low rates of ongoing activity, which is energy efficient. They terminate monosynaptically on projection neurons in lamina I (or the marginal zone) at the top of the superficial spinal (and trigeminal) dorsal horn. In contrast, the exteroceptive large-diameter A fibers that innervate mechanoreceptors and proprioceptors terminate on large neurons in the deep dorsal horn.

These two regions (i.e., the superficial [or interoceptive] dorsal horn and the deep [or exteroceptive] dorsal horn) are morphologically and genetically distinct. During development, these two regions arise differentially from apical and axial neuroepithelium, respectively, in a remarkably coordinated ontogenetic sequence. The lamina I neurons originate embryologically from cells in the lateral horn of the intermediate zone—that is, from progenitors of the autonomic cell columns—and they migrate to the top of the dorsal horn at precisely the right time to meet the ingrowing small-diameter fibers. Their migration is facilitated by a substantive rotation of the entire dorsal horn that simultaneously leads the large-diameter sensory fibers in the classic recurrent trajectory to the large neurons in the deep dorsal horn, which originate from the alar plate and serve as interneurons for skeletal motoneurons. This pattern is guided by two ancient and distinct gene regulatory networks in all vertebrates. Interestingly, in half of the families of birds, the interoceptive and exteroceptive regions end up in a side-by-side arrangement, instead of the top-and-bottom arrangement that is present in all mammals.

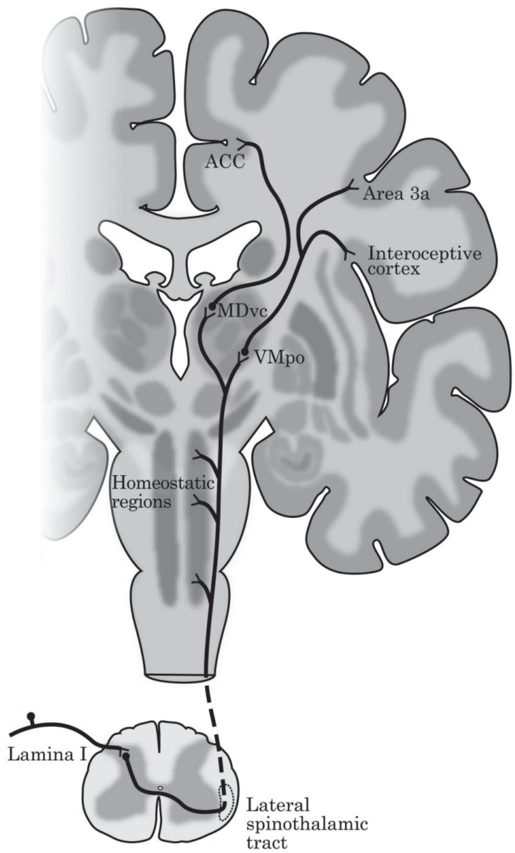

FIGURE 12.1. A schematic representation of the homeostatic (interoceptive) afferent pathway in primates that represents the physiological condition of the body. The main forebrain projections are to the dorsal posterior insula (interoceptive cortex) and to the medial prefrontal region (the anterior cingulate cortex, or ACC). The pathway that ascends from lamina I of the spinal cord via the lateral spinothalamic tract represents the sympathetic half of the homeostatic afferent system, and a parallel pathway via the nucleus of the solitary tract and the basal portion of the ventromedial nucleus in the thalamus represents its parasympathetic half (not depicted). From Craig (2003). Reprinted, with permission, from the *Annual Review of Neuroscience*, Volume 26. Copyright 2003 by Annual Reviews (*www.annualreviews.org*).

Thus, together the small-diameter sensory fibers and the lamina I neurons constitute a coherent homeostatic sensory system that is the sensory complement of the visceral motoric outputs of the sympathetic division of the autonomic nervous system. Small-diameter sensory fibers in the cranial parasympathetic nerves (e.g., vagus and glossopharyngeal) that innervate all cranial and internal organs similarly terminate in a specialized region of the medulla (the nucleus of the solitary tract [NTS]) that drives motoric outputs in the same nerves. Projection neurons in the NTS and in lamina I lead in parallel to all brainstem homeostatic regions and, in primates, also to relay nuclei in the thalamus. Together the NTS and lamina I pathways convey homeostatic sensory input from the entire body.

Lamina I Neurons

Lamina I neurons in cats and monkeys comprise several modality-selective classes that can be regarded as virtual "labeled lines," or discrete sensory channels, that engender distinct feelings from the body, such as first (sharp) pain, second (burning) pain, cool, warm, itch, affective (sensual) touch, muscle ache and cramp, and so on, upon integration in the forebrain. Each class consists of a morphologically distinct type of neuron that receives input selectively from a particular subset of small-diameter sensory fibers. These classes can be differentiated on the basis of stimulus responses, axonal projections, descending modulation, and electrophysiological, pharmacological, and immunohistochemcal properties.

For example, the cool-sensitive thermoreceptive-specific (COOL) lamina I neurons respond linearly to graded innocuous cool stimuli (Figure 12.2A) and plateau at noxious cold temperatures, just as human cool sensitivity does. In contrast, the polymodal nociceptive (heat, pinch, and cold [HPC]) lamina I neurons respond selectively to noxious *heat*, *pinch*, and noxious *cold*, and their responses correspond with the psychophysical characteristics of the human sensation of burning pain. Whereas the COOL neurons are pyramidal-shaped cells, the HPC neurons have multipolar shapes (Figure 12.2B); similarly, the HPC neurons are inhibited by morphine (both systemic and local), while the COOL neurons are facilitated.

These characteristics fit with the conventional view of lamina I neurons as "pain and temperature" cells, but certain anomalies fit better with a broader role and signify a role in homeostasis. For example, the HPC cells evince an accelerating discharge to noxious cold stimuli of increasing intensity, consistent with the feeling of burning cold that we report for thermal stimuli below approximately 59°F (15°C). However, the HPC cells are also sensitive to innocuous cool stimuli below a mean threshold of approximately 75°F (24°C)—that is, at cool temperatures that normally do not evoke a feeling of burning cold pain. Such activity is "anomalous" for a "pain cell," but it is entirely consistent with the fact that ambient temperatures below approximately 75°F become progressively uncomfortable and can ultimately be fatal. The evidence indicates that generation in the forebrain of the feeling of burning pain by HPC cells is normally inhibited by the activity of COOL cells. The COOL cells respond to temperatures cooler than neutral skin temperature (approximately 90°F [32°C]), and they are strongly activated by temperatures below 75°F. But, if COOL activity is suppressed by a blockade of A-delta fiber activity (using pressure applied to a peripheral nerve) or by simultaneous warming in the "thermal grill illusion of pain" (which does not inhibit HPC activity), then a feeling of burning pain is unmasked with cool stimuli at such temperatures. Thus, the cool activation of HPC cells below 75°F is consistent with a role in thermoregulatory behavioral motivation, because such temperatures, if maintained for only a few hours, can produce tissue necrosis (called "trench foot" during World War I) and morbid hypothermia.

The role of lamina I neurons in homeostasis is most clearly revealed by the neurons that respond selectively to small-diameter sensory fibers from muscle. While some of these sensory fibers cause feelings of muscle burn, pain, and cramping when strongly activated, many signal muscular work, or energy usage, and some are sensitive to mild vascular distension and signal blood flow; these neurons provide crucial sensory feedback to cardiovascular and respiratory control networks in the brainstem.

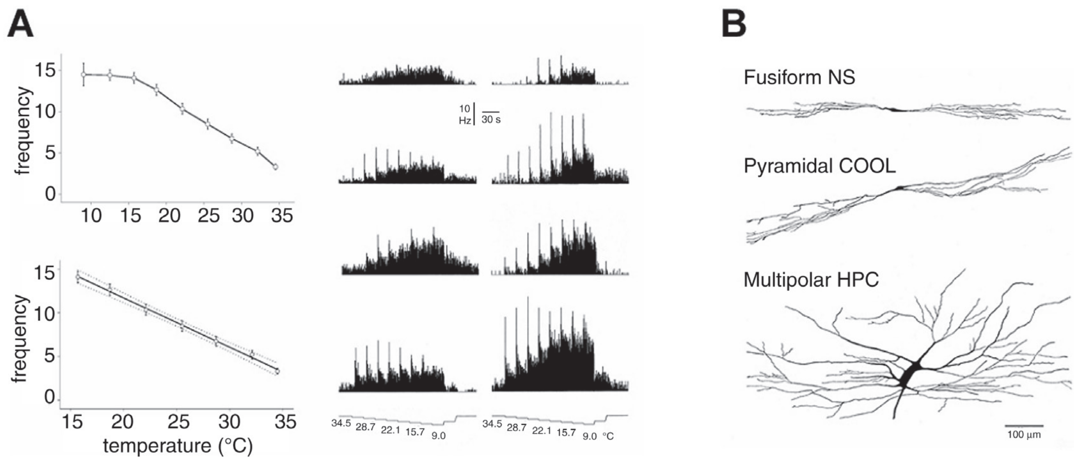

FIGURE 12.2. (A) Original data showing that thermoreceptive-specific lamina I spinothalamic neurons linearly encode skin temperature. The graphs on the left show the ensemble mean, and the graphs on the right show the responses of individual neurons to the characterizing staircase stimulus. From Craig, Krout, and Andrew (2001). Copyright 2001 by the American Physiological Society. Reprinted by permission. (B) Examples of lamina I neurons that were individually characterized and stained intracellularly, showing the correspondence of the three main physiological classes of cells with the three main morphological shapes. From Han, Zhang, and Craig (1998). Copyright 1998 by Nature Publishing Group. Reprinted by permission.

Similarly, respiration rate and depth is modulated linearly by the temperature of inhaled air, a signal that only lamina I neurons can provide. Thus, lamina I neurons do not simply act as emergency signals, rather, they are engaged in homeostasis continuously. Furthermore, they represent all physiological conditions—for example, small-diameter sensory fibers can also respond to cytokines, steroids, hormones, and other immune modulators, consistent with the roles of sympathetic and parasympathetic autonomic motor neurons in regulating immune and neuroendocrine functions.

The anatomical projections of the axons of lamina I neurons convey small-diameter homeostatic sensory activity directly to the homeostatic integration and control regions in the spinal cord and brainstem, thereby providing the substrate for the modality-selective somatoautonomic reflexes that are of fundamental significance for homeostatic function (Sato & Schmidt, 1973). In the spinal cord, their *only* major projection is to the autonomic cell columns in thoracolumbar segments, where sympathetic preganglionic output neurons are located. In the brainstem, they project *exclusively* to homeostatic integration sites, such as the ventrolateral medulla, the catecholamine cell groups A1–A2 and A5–A7, the parabrachial nucleus (PB), and the periaqueductal gray (PAG). These sites also receive sensory activity associated with the parasympathetic system by way of the NTS. These sites are all heavily interconnected with the hypothalamus and amygdala in the forebrain. The key role of lamina I in homeostasis is highlighted by the fact that the autonomic cell columns and lamina I are the only spinal sites that receive descending modulation directly from hypothalamic control sources.

Lamina I Projections to the Primate Forebrain

High-resolution anatomical tracing experiments revealed that the axons of lamina I spinothalamic neurons ascend in the lateral spinothalamic tract at the location where spinal lesions in humans interrupt contralateral feelings of pain, temperature, itch, and sensual touch (Figure 12.1). In subprimates, ascending lamina I activity is processed mainly in brainstem sites (e.g., A1, PB, and PAG), which then provide a more integrated signal to emotional behavioral control regions in the forebrain. In primates, modality-selective lamina I spinothalamic neurons terminate densely and somatotopically in a specific thalamo-cortical relay nucleus (VMpo). A parallel pathway, also unique to primates, conveys homeostatic sensory input from the vagal and glossopharyngeal nerves by way of the NTS (and PB) to a rostrally contiguous thalamo-cortical relay nucleus (VMb). These thalamic nuclei in turn project topographically to a discrete area of dorsal posterior insular cortex that is centered in the superior limiting (peri-insular) sulcus (Craig, 2014).[1]

Together, these projections provide a direct cortical image of all homeostatic sensory activity from the body. Notably, this *interoceptive cortex* is delimited by labeling for the receptors of corticotropin-releasing factor, which many investigators regard as a definitive marker for homeostatic processing (Sanchez, Young, Plotsky, & Insel, 1999). The interoceptive cortex may be the tensile anchor that is responsible for the sharp cortical fold of the lateral sulcus; this fold improves energy efficiency by minimizing the separation of interoceptive cortex from other homeostatic processing regions (e.g., in the cingulate sulcus). Our recent analyses in the macaque monkey suggest that interoceptive cortical activity is integrated topographically in the middle insula first with exteroceptive (i.e., cutaneous mechanoreceptive and proprioceptive) and other activity important for emotionally salient object-related movements, and also with multimodal amygdalar and ventral striatal inputs important for other-directed emotional behaviors (e.g., face and hand movements or vocalizations used for social communication and identification; Evrard, Logothetis, & Craig, 2014).

Lamina I neurons in primates also provide a direct thalamo-cortical pathway that activates the cingulate motor area in the anterior cingulate cortex (ACC; or the anterior middle cingulate) by way of a medial thalamic relay (MDvc) and VMpo, as well as integrated homeostatic sensory inputs from the brainstem (both PB and PAG). By contrast, in subprimates the medial thalamic sources of input to the ACC receive only the integrated inputs from the brainstem. This cingulate cortical area can be regarded as limbic motor cortex in all mammals, because of its association with homeostatic (autonomic and behavioral) output activity and its descending projections to the PAG in the brainstem; it is also a major source of descending cortico-spinal motoric activity. The insular cortex can be regarded as the complementary limbic sensory cortex, because of its association with homeostatic sensory activity via inputs from lamina I, NTS, and PB, and its descending projections to PB. This homeostatic sensory-motor concept fits well with the hierarchical organization of homeostatic sensory-motor integration and with the modern view that the frontal cortex is organized globally in a sensory and a motor network.

The Ascending Interoceptive Pathway in Humans

Thermosensory Activation of the Posterior Insula

Temperature, like pain and itch, is a feeling from our bodies that we normally externalize. We readily ascribe temperature to an object or the environment. Temperature sensation has always been regarded as a discriminative exteroceptive cutaneous sensory capacity allied with the sense of discriminative touch (i.e., mechanoreception). However, the thermoreceptors in our skin, muscles, and viscera actually report local tissue temperatures, which are needed for the energy-efficient control of body temperature (i.e., thermoregulation). The functional neuroanatomy of temperature sensation in humans reflects the primordial importance of temperature sensibility for autonomic control and homeostasis.

Our quantitative positron emission tomography (PET) study of cool stimulation of the palmar hand demonstrated that the location of discriminative thermosensory cortex in humans fits precisely with the location of interoceptive cortex identified by functional and tracing studies in the monkey described above (Craig, Chen, Bandy, & Reiman, 2000; Hua, Strigo, Baxter, Johnson, & Craig, 2005). Plate 12.1 (see color insert for plates) shows three different analyses of brain activation during the application of six different steady cool temperatures at both a low (yellow) and a high (red) statistical criterion. The first row is a simple contrast between the highest and lowest temperatures, which served as a mask for subsequent analyses. The second row shows a regression analysis against thermode temperature; it reveals that only one activation site in the contralateral cortex was linearly correlated with objective stimulus temperature (i.e., the red blob on the left side at level 24). That matches the linear response of COOL lamina I spinothalamic neurons shown in Figure 12.2, and therefore that evidence identifies primary thermosensory cortex.

That location also fits with clinical reports of patients with stroke damage that produced thermanesthesia (Schmahmann & Leifer, 1992; Greenspan, Lee, & Lenz, 1999). Strikingly, this region is not part of the somatosensory cortices that represent touch sensation, which are in the postcentral gyrus (S1) and in the parietal operculum (S2). Rather, the association of insular cortex with visceral sensation and autonomic function as limbic sensory cortex fits neatly with the view that temperature sensation is important first of all for homeostasis. These findings provided the first evidence for interoceptive cortex in humans.

Characteristics of Human Interoceptive Cortex

Consistent with our PET thermosensory study, modern functional imaging, lesion, and stimulation studies in humans confirm the crucial role of the dorsal posterior insula for sensations of graded pain, graded temperature, graded itch, dynamic or painful muscle sensation, affective (sensual) touch, hunger, thirst, taste, stomach distension, cardiorespiratory activity, "air hunger," and so on (e.g., Olausson et al., 2002; Cechetto & Shoemaker, 2009; see Craig, 2014, for additional references). The activation associated with sensory input from the cranial (parasympathetic) nerves (e.g., during stomach distension) are represented just anterior to activation by cutaneous temperature or pain (i.e., input from sympathetic innervation), though in some studies, the interoceptive activation seems to have merged with activation in the mid-insula (see Craig, 2014). Overall, the evidence supports the presence in humans of a coherent interoceptive cortex that engenders the cortical image of the physiological condition of the body and constitutes the primary sensory cortex for all affective bodily feelings. It is important to recognize that this pathway emerged evolutionarily as an extension of the hierarchical homeostatic system; thus, affective feelings from the body in humans reflect its homeostatic condition.

The findings in the macaque monkey indicate that VMpo + VMb and interoceptive cortex are topographically organized in the anterior-to-posterior (face-to-foot) direction. The available imaging evidence in humans demonstrates the same somatotopic gradient in the dorsal posterior insula for sensations of heat pain, innocuous cool, muscle pain, and affective touch (e.g., Brooks, Zambreanu, Godinez, Craig, & Tracey, 2005; Hua et al., 2005; Henderson, Gandevia, & Macefield, 2007; see Craig, 2014, for additional references). Significantly, this gradient is orthogonal to (i.e., independent of) the medial-to-lateral (face-to-foot) organizational gradient of the main somatosensory regions in the thalamus and cortex. This contrast substantiates the morphological distinctness of the interoceptive cortex. Unfortunately, its location had previously been assigned to the second somatosensory cortical area (S2), and most atlases today still contain that error.

Notably, VMpo is greatly enlarged and more complex in humans than in the macaque monkey, and so is the insula. Interoceptive cortex in the monkey extends the entire antero-posterior length of the insula (approximately 6–8 millimeters), but in humans the insula is much larger (approximately 50–60 millimeters), and interoceptive cortex occupies only the posterior third. Whereas almost all of VMpo and interoceptive cortex in the monkey is devoted to discriminative temperature, pain, and taste activity, in humans this pathway seems to represent all aspects of homeostatic sensory activity. For instance, in humans the many small-diameter sensory fibers from muscle that are activated by ongoing vascular distension are apparently included, because even mild cardiovascular maneuvers (e.g., passive cycling) activate the dorsal posterior insula; most trenchantly, the human participants in one study reportedly described a mild intramuscular vascular distension as a feeling of deep, innocuous, localized "pressure" (Haouzi, Chenuel, & Huszczuk, 2004; Cechetto & Shoemaker, 2009; Cui, McQuillan, Blaha, Kunselman, & Sinoway, 2012).

Interoceptive Activation of Human Cingulate Cortex

Activation is reported in the cingulate region in nearly all functional imaging studies of pain (referred to here simply as ACC, but including the anterior mid-cingulate cortex), as well as in studies of muscle and visceral sensation. Functional imaging studies that examined the thermal grill illusion of pain and hypnotically modulated pain unpleasantness associate ACC activation with the affective motivation of pain (i.e., negatively valenced urgency; see Craig, 2014); that interpretation is consistent with the view that pain is a homeostatic emotion, which simultaneously generates both a feeling and a motivation. That interpretation is also consistent with the association of the ACC and medial prefrontal cortex with behavioral agency, including measures of motivation (e.g., outcome value; Kennerley & Wallis, 2009) and performance (e.g., error or outcome likelihood; Brown & Braver, 2005; Alexander & Brown, 2011).

Activation in the ACC was not observed in our PET thermosensory study. However, in a subsequent fMRI study, we observed that dynamic cooling stimuli applied to the hand produced graded activation both in the dorsal posterior insular cortex and at a site in the cingulate region comparable to the site where we had previously observed activation during a painful cold (or hot) stimulus (Hua et al., 2005). Since a rapidly dropping temperature presents a homeostatic challenge, it makes sense that it would produce a stronger behavioral motivation signal than a steady innocuous cool stimulus. Together, these findings support the view that temperature produces both a feeling and a behavioral motivation in humans—that is, a homeostatic emotion.

In functional imaging studies, interoceptive stimuli usually activate both insular and cingulate regions. Just as for temperature, stimuli that cause feelings of itch, muscle ache, hunger, and thirst are also homeostatic emotions that drive behavior, and they also activate both regions. The condition of our bodies directly affects our feelings and our motivations continuously.

The Anterior Insula and Subjective Feelings from the Body

Activation during Subjective Awareness of Thermosensory Feelings

In our PET thermosensory study, we had the opportunity to ask each participant to rate the intensity of his or her subjective feeling for each cool stimulus, and thus to ask, "How do we feel temperature?" Our subjective sense of innocuous temperature is fairly linear, but it is not as linear as the ascending COOL lamina I sensory channel. The deviation is sufficient to provide a robust statistical difference between cortical activation associated with subjective rather than objective temperature. The third row in Plate 12.1 (see color insert for plates) shows a regression analysis of the same PET dataset against the participants' subjective ratings of the cool intensity. A large area of activation in the anterior insula and orbitofrontal cortex on the right side is conspicuous in these data. Close comparison of the activation blobs at level 24 in rows 2 and 3 reveals that in the subjective regression analysis, a new activation site appears just anterior to the main site activated in the objective temperature regression analysis.

These data indicate that there is an immediate rerepresentation of thermosensory activation in the middle insula on the homolateral side, just anterior to the interoceptive cortex. This rerepresentation must be an abstracted or integrated re-representation, because its activity is significantly more closely related to subjective ratings than to objective temperatures. The data show activation in the mid-insula on the other side, too, indicating a commissural transfer; that leads to a lateralized region of activation in the anterior insula and orbitofrontal cortex on the right side that appears large enough to contain a series of rerepresentations, which are strongly correlated with subjective feeling.

This is a neurobiologically parsimonious pattern of activation, because progressive rerepresentations that combine feature extraction and cross-modality integration are present in the serial processing streams observed in the visual, auditory, and (parietal) somatosensory cortical regions; serial rerepresentations are also consistent with the pattern of evolutionary emergence of new processing regions in the primate cortex (Krubitzer & Kaas, 2005). The posterior-to-anterior gradient of increasingly complex integration fits also with the gradient present in dorsal prefrontal cortex (Koechlin & Jubault, 2006).

These PET thermosensory findings demonstrated for the first time that subjective bodily feelings are based directly on interoceptive integration in insular cortex. These results suggest that the activation in the anterior insula substantializes (provides the basis for) our human experience of bodily feelings. The strong lateralization is clear evidence of hemispheric specialization (see the section "Bivalent Asymmetry in the Bicameral Forebrain").

Activation during Subjective Awareness of Other Bodily Feelings

Thus our PET imaging data on temperature sensation illuminate an anatomical model in which human subjective awareness of feelings from the body is generated directly from rerepresentations in the insular cortex of the interoceptive image of the body's homeostatic condition. Imaging and lesion data for other bodily feelings (e.g., heat pain, affective touch and taste) show a similar progression of activity from the dorsal posterior insula first to the middle insula bilaterally and then to the anterior insula (predominantly on the left or right side; e.g., Brooks, Nurmikko, Bimson, Singh, & Roberts, 2002; Olausson et al., 2002). (Note that activation peaks in the primary taste cortex and mid-insula have not yet been dissociated; see Craig, 2014.) This progression is supported by modern meta-analyses of the functional associations, functional connectivity, and structural covariance of the insular cortex, which indicate distinct differences between the posterior, middle, and anterior portions of the insular cortex (e.g., Deen, Pitskel, & Pelphrey, 2010), with greatest complexity in the anterior insula (Cauda, Costa, Torta, Sacco, D'Agata, et al., 2012).

Whereas subjective bodily feelings and emotional feelings alike associate most strongly with activation in the anterior insula (see the section "The Anterior Insula and Subjective Emotional Feelings"), the evidence suggests that bodily feelings emerge first in the middle insula, as revealed in our PET thermosensory study. Activation in the middle insula also occurs during cutaneous mechanical stimulation or hand movement (which first activates the somatosensory and motor cortices); complementary clinical reports suggest that this represents a "feeling," because a lesion of the mid-insula (especially on the right side) can produce loss of the subjective feeling of (deficits in) touch or limb movement on the entire opposite side of the body (called "anosognosia for hemianesthesia or hemiplegia"; Karnath & Baier, 2010). The subjective feeling of limb ownership also correlates with activation in the mid-insula, based on studies of the "rubber hand illusion" (see Craig, 2009, 2015).

Similarly, the affective bodily feeling of craving cigarettes (or cocaine or food; i.e., hunger) correlates with mid-insula activation, and this is complemented by the observation that a lesion of the middle and anterior insula enabled heavy smokers to quit immediately, saying that the feeling of craving cigarettes was gone (Naqvi & Bechara, 2010). Last, a PET study of a maintained feeling of unpleasantness due to a painful cutaneous or intramuscular stimulus showed maintained activation exclusively in the bilateral mid-insula (Schreckenberger, Siessmeier, Viertmann, Landvogt, Buchholz, et al., 2005). Nevertheless, subjective awareness of bodily feelings correlates most strongly with activation in the anterior insula, as clearly demonstrated (for the first time) in our PET thermosensory study. Similarly, the anterior insula is the region most strongly activated during subjective bodily feelings of lust and intumescence in men or orgasmic quality in women (Bianchi-Demicheli & Ortigue, 2009). Affective touch activates contralateral dorsal posterior insula, then bilateral mid-insula, then left anterior insula in association with a subjective feeling of pleasure (Olausson et al., 2002). The same pattern has also been shown in studies of heat pain (see Craig, 2015, for additional references).

The location of taste cortex in humans was initially assigned to the anterior insula, analogous to the monkey. Subjective ratings of flavors and tastes correlate most strongly with activation in the anterior insula (predominantly left); in contrast, gustatory activation in the posterior/mid-insula is modulated by attention (i.e., primary representation) and homeostatic bodily needs (i.e., overlapping mid-insula integration). Notably, responses to brief tastes of high-quality wines in professional sommeliers were observed in posterior/mid-insula and bilateral mid-insula, and the strongest activation associated with the subjective ratings was to aftertaste in the left anterior insula (which they called "OFC"; Castriota-Scanderbeg, Hagberg, Cerasa, Committeri, Galati, et al., 2005). Thus, this pattern is the same as for other bodily feelings. Last, an individual's subjective interoceptive awareness (measured with a heartbeat perception task and a bodily awareness questionnaire) is most strongly correlated with activation in the right anterior insula, and remarkably, with the physical volume of that area only (Critchley, Weins, Rotshtein, Öhman, & Dolan, 2004).

The Anterior Insula and Subjective Emotional Feelings

Activation in the anterior insula is associated with subjective feelings of each of the six emotional feelings regarded by many as primary: anger, sadness, happiness, surprise, disgust, and fear. Evidence has been obtained by using movie clips or sound tracks lasting 2–3 minutes or by showing a standardized set of photographs depicting emotional scenes. Feelings associated with secondary emotions (e.g., empathic happiness or empathic pain) are also characterized by activation of the anterior insula. Individuals listening to music they enjoy display activation in the anterior insula (L > R; Koelsch et al., 2006). Feelings of romantic love or maternal love in individuals viewing a photograph of their romantic partner or their baby display strong activation in the anterior insula (also L > R). Feelings of unfairness, uncertainty, joy, trust or distrust, and social exclusion are all associated most strongly with activation in the anterior insula (see Craig, 2002, 2009, 2015, for references).

Convergent functional imaging findings reveal that the anterior insula and the anterior cingulate cortices are conjointly activated during all human emotions (Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012). To my mind, that fits with the idea that the limbic sensory representation of subjective "feelings" (in the anterior insula) and the limbic motor representation of motivations (agency, in the anterior cingulate) together form the fundamental neuroanatomical basis for all human emotions (Craig, 2009, 2015). These two regions are the sites most commonly activated across all functional imaging studies.

These findings are complemented by clinical observations; most of the available evidence suggests that the anterior insula is crucial for experiencing feelings, because insular damage disrupts subjective feelings. For instance, a study of patients who had a stroke with restricted insular damage reported "loss of awareness to external stimuli" (Ibanez, Gleichgerrcht, & Manes, 2010). Damage specifically to the anterior insula interrupts emotional awareness and self-conscious behaviors in patients with a neurodegenerative syndrome known as fronto-temporal dementia (Seeley et al., 2007), or patients with depersonalization disorder (Medford, 2012). In one study, three patients were examined who had focal damage in the anterior insula on one side (two left, one right) that specifically included the site that is activated normally during behavioral tests for pain empathy; the authors reported that all three patients had markedly reduced emotional awareness. In rigorous tests, the patients identified pain in others significantly less often and more slowly than normal subjects, and they all failed an interference test of empathic pain feelings (in contrast to patients with damage in the cingulate region; Gu, Gao, Wang, Liu, Knight, et al., 2012).

Contradictory evidence was described in two patients with encephalitis who reportedly retained self-awareness even though the insular cortex of their brains was "completely" destroyed bilaterally (Feinstein, Rudrauf, Khalsa, Cassell, Bruss, et al., 2009; Damasio, Damasio, & Tranel, 2013). However, close examination of the published magnetic resonance imagings (MRIs) reveals that a significant amount of the dorsal anterior insula remains intact in one case on the right side (patient B; see figure 4, row II, left side of image in Damasio et al., 2013), and in the other case on the left (patient R or Roger; see figure 1, 4c, 5c, right side of image in Feinstein et al., 2009), as addressed earlier (see Craig, 2011, 2015). Furthermore, a study by a team that included investigators at the same institution as the prior authors described seven patients who had a stroke with damage to more than half of one insula (four right, three left); they found significantly reduced affect to both pleasant and unpleasant stimuli, along with a "marked attenuation of valence ratings" in response to emotional images, consistent with a crucial role of insular cortex in subjective emotional awareness (Berntson, Norman, Bechara, Bruss, Tranel, et al., 2011). Similarly, more recent clinical lesion studies concluded that the insula is a key structure for emotional embodiment or "the feeling of self" (Grossi, Di Vita, Palermo, Sabatini, Trojano, et al., 2014; Besharati, Forkel, Kopelman, Solms, Jenkinson, et al., 2014).

Intersection of Interoceptive Awareness and Emotional Awareness in the Anterior Insular Cortex

Evidence of several different kinds has accumulated supporting the interoceptive basis (or the embodiment) of emotional feelings. Studies showed that thermal stimulation of the hand can alter interpersonal feelings of closeness or of trust (see Craig, 2009, 2015, for references). A close correspondence was demonstrated between vasoconstriction on the hand and the intensity of feelings of limb ownership during the "rubber hand illusion," and the investigators concluded that "awareness of our physical self and the physiological regulation of self are closely linked in a top-down manner" (Moseley, Olthof, Venema, Don, Wijers, et al., 2008, p. 13169). Others found that emotional intensity and insular activation varied cyclically following each heartbeat (Gray, Beacher, Minati, Nagai, Kemp, et al., 2012), and that pain-related autonomic responses were correlated with the personality traits of neuroticism and introversion (Paine, Kishor, Worthen, Gregory, & Aziz, 2009).

More directly, several fMRI studies reported that the neural activation associated with subjective interoceptive feelings and the activation associated with emotional feelings overlap uniquely in the anterior insula, consistent with psychological evidence that interoceptive (heartbeat) awareness and self-reports of emotional experience are directly correlated (Barrett et al., 2004). One early study (with low spatial resolution) demonstrated synergistic activation of the anterior insula when interoceptive feelings (non-noxious esophageal distension) and graded emotions (viewing graded facial expressions of disgust) occurred simultaneously (Phillips et al., 2003). A more recent study directly compared activation during a heartbeat interoceptive awareness task with activation during emotional feelings evoked by watching a movie; the investigators found a unique region of overlap in the right anterior insula, and critically, the activation at that site was correlated with the intensity of the emotional feelings reported by the participants. The authors interpreted their findings as evidence for the "functional convergence" of emotional and bodily feeling experiences (Zaki, Davis, & Ochsner, 2012).

Studies by another group compared activation while participants attended either to their own internal bodily state or to their own emotional state (Terasawa et al., 2013a, 2013b). In the first study, they found activation during both tasks in the right anterior insula (and the left ventromedial prefrontal cortex); in the second, they identified overlapping activation in the bilateral anterior insular cortex (AIC; and areas in the bilateral temporoparietal junction, lingual gyrus, and medial frontal cortex, and portions of the brainstem). They also reported that the emotional activation in the right anterior insula was positively correlated with neuroticism, while the interoceptive activation there was negatively correlated with "extraversion, agreeableness, and openness to experience," which resembles other results cited above (p. 264). Together, these findings provide strong support for the concept that subjective awareness of both feelings from the body and emotional feelings is engendered in the AIC. In other words, the evidence suggests that all of our feelings are based on the integration of interoceptive activity in the insular cortex that enables us to experience feelings from our bodies. This conclusion was validated by a recent study showing that happiness, or "momentary subjective well-being," is directly correlated with activation in the ventral striatum and the ventral AIC during a series of simple choices with monetary rewards (Rutledge, Skandali, Dayan, & Dolan, 2014).

On the other hand, one paper described a region activated by taste stimuli (while simply held in the mouth) in the left mid-insula and another in the left anterior insula; both regions had also responded to food images in a preceding food discrimination task, but only the food image responses in the posterior region were modulated (selectively) by blood glucose levels. The authors concluded provocatively that their observations contradicted the pattern of interoceptive integration described above (Simmons, Rapuano, Kallman, Ingeholm, Miller, et al., 2013). In fact, their results fit well with these ideas. The posterior region likely included both the primary gustatory cortex (which is modulated by attention to food) and the mid-insular region (which is modulated by homeostatic integration of energy needs); by contrast, the activation in the anterior region corresponds with the activation that occurs during a cognitive task of any kind. That activation was not modulated by blood glucose levels during either the food image discrimination task or the subsequent passive tastant stimulation because in both situations they were irrelevant to the task.

In summary, there is overwhelming evidence that the integrative homeostatic processing mechanisms in the anterior insula (both right and left) provide a crucial substrate for all subjective feelings. This is a major conclusion that has now received convincing support from many convergent lines of inquiry, and in my opinion, deserves to be described in textbooks.

A Homeostatic Model of the Subjective Awareness of Feelings

Thus a refined and integrated image of the state of the body in the AIC seems to provide the basis for the "feeling self." In the homeostatic model I have proposed (Craig, 2009, 2015), the homeostatic sensory (interoceptive) activity that represents the physiological condition of the body is integrated first in the mid-insula—with emotionally salient inputs from all sensory modalities, from subcortical homeostatic control regions (hypothalamus and amygdala) and regions with bivalent hedonic signals of incentive and motivation (ventral striatum, orbitofrontal cortex),—and next in the anterior insula—with emotionally and socially salient activity from other limbic cortical regions (ACC, ventromedial prefrontal cortex), as well as cognitive/planning regions (e.g., dorsolateral prefrontal cortex). This posterior-to-anterior progression of increasingly complex interoceptive rerepresentation and integration in the human insula provides a foundation for the sequential integration of the homeostatic condition of the body with all activity in the body and in the brain representing; the sensory environment; internal autonomic/homeostatic motor state; affective motivational conditions; and finally, emotional, social, cognitive, and intentional conditions (see Figure 12.3).

In this model, the progressive integration of all neural activity—for the purpose of attaining optimal energy efficiency in the control of emotion and behavior—culminates in a complete representation of homeostatic salience as vivid feelings that are continuously changing in the immediate moment (the ongoing *global emotional moment* of

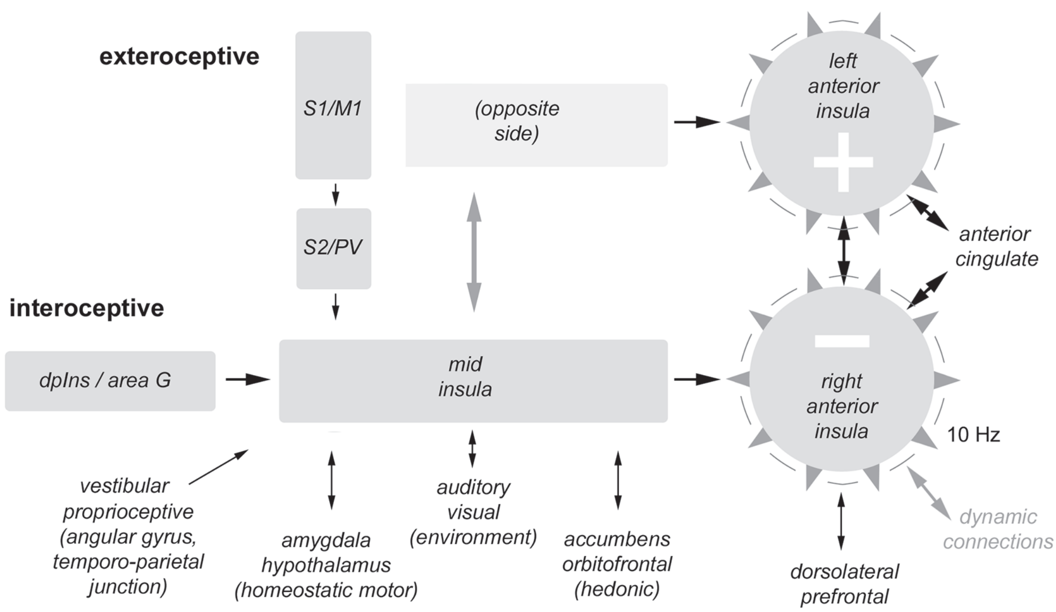

FIGURE 12.3. A conceptual diagram of the progressive integration in the posterior, middle, and anterior insula of interoceptive state with the sensory, autonomic, motivational, and contextual conditions of the body and the brain to produce a finite set of global emotional representations. In this homeostatic model, the right anterior insula represents the energy-consuming (sympathetic) conditions, and the left anterior insula represents the energy-enriching (parasympathetic) conditions.

"now"). The passage of time is incorporated with the generation of quantal storage units that can represent all feelings during a discrete period of present time; in particular, they store the feelings that accumulate in the ongoing global emotional moment during the current discrete time period (or moment). The frame rate of moments is synchronized with a global oscillation frequency (e.g., the alpha waves associated with alert attention; Sadaghiani, Scheeringa, Lehongre, Morillon, Giraud, et al., 2010), consistent with evidence showing that recurrent updating of awareness is synchronized with the alpha rhythm (Chakravarthi & VanRullen, 2012). The array of quantal storage units underpins a cinemascopic representation of the sentient self, or the "material me" across time. This construct has remarkable emergent characteristics, and it offers sensible explanations for a variety of psychological phenomena (e.g., the perceptual moment, emotional time dilation), philosophical concepts (e.g., subjectivity), and clinical syndromes (e.g., anxiety disorders and postraumatic stress disorder [PTSD]). The finite set of quantal storage units constrains the extent of the "specious present"; it provides a flexible mental resource for storing and comparing any neural activity patterns, and it manifests anticipated feelings based on internal models learned by experience. Future expectations and surprises can be described by a temporal-difference reinforcement model or a Bayesian predictive coding model (Seymour et al., 2005; Seth & Critchley, 2013) that is sensitive to negative value prediction errors with the goal of maximizing energy efficiency in the control of emotional behavior (see below; Vidal, Perrone-Bertolotti, Kahane, & Lachaux, 2014).

As I summarized earlier (Craig, 2009, 2015), activation in the AIC is also associated with subjective time perception, directed or maintained attention, perceptual decision making, self-performance monitoring, perception of visual images of one's own face or body, and cognitive functions and mental operations (e.g., during the "feeling-of-knowing"); essentially, the AIC is active during all feelings and all tasks. Accordingly, in the model, the ongoing global emotional moment includes feelings about motivations, intentions, plans, and thoughts, and it can be modified by expectations and motivations based on interconnections between the anterior insula and the ACC and other sites. This perspective mitigates a main criticism of the James–Lange theory (i.e., that it did not allow for feelings of internally generated emotion). It also affords ready explanations of the bidirectional interactions between homeostatic functions and emotional states—for example, in anxiety, somatization, and psychosomatic illness. The model's predictions of the key role of the AIC in subjective time perception are rapidly being confirmed (e.g., Wittmann, 2013; Pfeuty, Dilharreguy, Gerlier, & Allard, 2015; Tomasi, Wang, Studentsova, & Vokow, 2014)

No other region of the brain is activated during all feelings and all tasks. Hence, I proposed that the AIC engenders awareness. To my mind, awareness means knowing that I exist, being able to feel (perceive) that I am feeling (experiencing) the feeling of being alive. As detailed elsewhere, I suggest that the feelings that we experience from our bodies emerge from the integration of the high-resolution interoceptive image with homeostatic and emotional motor signals; in particular, the beat-by-beat sensory activity of small-diameter receptors sensitive to vascular flow and energy utilization throughout the body enables us to feel the ongoing process of homeostasis in the living body. In my view, that generates homeostatic sentience; I feel that I am (alive). This homeostatic motor–sensory–motor paradigm differentiates self from other, automatically valuates any sensory stimulus by its autonomic reflex activation pattern, and provides the basis for the perception of emotional feelings as if they were feelings from the body, actualized by their central and peripheral homeostatic motor pattern. This proposal is supported by evidence from studies of perceptual recognition, attentional blink, error awareness, inspection time, and so on (see Craig, 2009, 2015). Quantitative evidence that the emotional "vividness" of a visual stimulus (and importantly, of the memory of that event) is mediated by activation in the mid-insula strongly corroborates this model (Todd, Talmi, Schmitz, Susskind, & Anderson, 2012). A recent electroencephalogram (EEG) study of visual perceptual suppression concluded that the timing of alpha and gamma oscillations in the anterior insula "could reflect the first emergence of conscious visual perception from the top of the cortical hierarchy" (Vidal et al., 2015).

In this model, whatever comes into awareness is a "feeling." Being able to "feel" every thought, perception, emotion, or potential behavior provides a powerful "common currency" for the evaluation of physical energy costs and benefits in support of optimizing behavior. The optimization of energy utilization compelled the evolutionary development of a common valuation system for energy cost–benefit analysis (for a similar viewpoint, see

Cabanac, Cabanac, & Parent, 2009). In hominids, the brain consumes 25% of the entire energy budget, and the enlargement of the hominid brain during evolution required an enormous increase in dietary energy, perhaps afforded by fish and cooked meat. The complete interoceptive integration of all salient activity in the insular cortex fulfills the overarching need to optimize energy utilization in the control of the emotional behavior of each individual, which includes the cooperative behavior within each social group. This model fits with the observation that the most anterior portion of the insular cortex grew more rapidly ("hyperallometrically") than the rest of the brain during hominid evolution (Bauernfeind et al., 2013). This model is also supported by recent fMRI evidence indicating that the anterior insula is crucially involved in computing the anticipated and actual effort needed to obtain a desired goal (Fitzgerald, Friston, & Dolan, 2012; Skvortsova, Palminteri, & Pessiglione, 2014; Engström, Karlsson, Landtblom, & Craig, 2014).

The anterior insula does not function independently; it is interconnected with the central autonomic network at the brainstem and forebrain levels, all distributed cortical networks, its complement on the other side of the brain (via the anterior commissure), and with the bilateral ACC. In order to represent all feelings, it must have dynamic connectivity throughout the cortex, which recent findings support (Cauda, Costa, Torta, Sacco, D'Agata, et al., 2012; Sepulcre, Sabuncu, Yeo, Liu, Johnson, et al., 2012; see Craig, 2009, 2015). It is also organized into numerous partitions that are being analyzed (e.g., Touroutoglou, Hollenbeck, Dickerson, & Feldman, 2012; Cauda et al., 2012; Power, Schlaggar, Lessov-Schlaggar, & Petersen, 2013). The bilateral anterior insula and anterior cingulate constitute key hubs that can function as a "core control network" that issues coordination signals and conveys information that guide network interactions in the multiplex "microstate" activity of the brain, thereby guiding all behavior (e.g., Cole & Schneider, 2007; Britz, Van, & Michel, 2010; Menon & Uddin, 2010). This network may not be present in monkeys (Mantini et al., 2013). The most recent network analyses of attentional control and fluid intelligence are consistent with this model (Uddin, Supekar, Ryali, & Menon, 2011; Cole, Yarkoni, Repovs, Anticevic, & Braver, 2012; Duncan, 2013; Power et al., 2013; Müller, Langner, Cieslik, Rottschy, & Eickhoff, 2014; Crittendon & Duncan, 2014; Dixon, Fox, & Christoff, 2014). Finally, this model can explain why the bilateral AIC and ACC are uniquely disrupted in all forms of Axis I mental illness (including anxiety, bipolar, depressive, obsessive–compulsive, schizoaffective, and substance use disorders; Goodkind et al., 2015). They orchestrate energy utilization in the body and brain alike.

If the anterior insula engenders feelings and controls network activity in the human brain, then that might seem to imply that feelings drive behavior. Nevertheless, literally hundreds of studies in the psychology literature support the hypothesis that feelings do not propel behavior, but rather are the consequence or concomitant of behavior (e.g., Laird, 2014; Wegner, 2014). In this model, the limbic motor system generates behavior, while the anterior insula guides and coordinates its agency.

Bivalent Asymmetry in the Bicameral Forebrain

In the established psychophysiological model that many authors espouse, emotion is more strongly associated with the right forebrain than the left. However, psychophysiological evidence has accumulated indicating that the left and right halves of the human forebrain are differentially associated with emotion. Based on studies of EEG activity, cortisol secretion, and cardiac and immune function, the left or right forebrain respectively associated with positive or negative valence, approach or avoidance (withdrawal) behavior, and affiliative or personal relevance, albeit with possible underlying circuits that are specialized for particular emotions (Davidson, 2004; Allen & Kline, 2004). Similarly, ethological evidence indicates that the right forebrain participates in arousal and predator avoidance, and the left forebrain in feeding and routine behaviors, in all vertebrates (MacNeilage, Rogers, & Vallortigara, 2009; Rogers, 2014). Clinical evidence from studies of the Wada (amobarbital) test, depression, heart rate variability, and cortisol release generally support the same asymmetry (Heilman, 2000; Conway et al., 2013). It seems likely that this pattern of forebrain emotional asymmetry is anatomically based on an asymmetrical representation of homeostatic and emotional motor activity that originates from asymmetries in the peripheral autonomic nervous system, and which first the descending motor pathways and later the substrates for our feelings evolved to match (see Craig, 2005, 2009, 2015).

In autonomic terms, in this proposal emotions are organized according to the fundamental principle of autonomic opponency for the management of physical and mental energy. In this homeostatic model, the left forebrain is associated predominantly with parasympathetic activity, and thus with nourishment, safety, positive affect, approach (appetitive) behavior, and group-oriented (affiliative) emotions; the right forebrain is associated predominantly with sympathetic activity, and thus with arousal, danger, negative affect, withdrawal (aversive) behavior, and individual-oriented (survival) emotions. In this model, management of physical and mental (meaning neural and representational) energy is the salient organizational motif (as for homeostasis), such that energy enrichment is associated with the left forebrain and energy expenditure is associated with the right forebrain, consistent with the general respective roles of the parasympathetic and sympathetic efferent systems. The homeostatic sensory representations evolved to match the preexisting autonomic and emotional asymmetries in the vertebrate forebrain, which provided a substantial improvement in the energy efficiency of the control of emotional behavior and communication, and thus facilitated increasingly complex (and cooperative) social interaction. In this model, for example, the homeostatically parsimonious role of the left insula in positive (parasympathetic) emotional affiliation grounds its association with verbal emotional communication (the left anterior insula is included in Broca's area) and the predominant use of the contralateral (right) hand for deictic pointing among humanoid primates (De Waal, 2003).

Thus, in this model coordinated opponent interactions between the two hemispheres, mirroring the autonomic principle of coordinated opponency, can provide an energy-efficient means for precise representation, control, and regulation, as it does for antagonistic muscles across a joint and for hormones that regulate water and salt (i.e., angiotensin and atrial natriuretic peptide). To explain the efficiency of an opponent regulatory system, the analogy of driving a car is useful: Rather than using only one hand to move the steering wheel in opposite directions, it is more efficient if you place your two hands on opposite sides (e.g., at the 9:00 and 3:00 positions), because then you can control it more easily by exerting a steady downward pressure with one hand and simply varying the downward pressure applied with the other hand. This is exactly how the coordinated opponent autonomic control of the heart functions; tonic excitatory sympathetic drive is modulated by rapid variations in inhibitory parasympathetic drive. Note that in an opponent control system the sensors and the controller outputs are optimally tuned to the balance between the antagonist effectors (e.g., Dimitriou, 2014).

In this model, the forebrain coordinates emotional control in the same manner. This model instantiates neurobiologically the psychological proposal that a hypothetical "calm and connection system" opposes the arousal–stress system (Uvnas-Moberg, Arn, & Magnusson, 2005). It substantializes the bivalent concept of emotion, in which positive and negative affects are different psychological dimensions, yet it is consistent with an aspect of the core affect concept, in which energization is a key dimension (Russell & Barrett, 1999). It also fits with imaging evidence that pleasure and pain are opposed hedonically within the limbic reward–punishment circuitry (Seymour et al., 2005; Ellingsen et al., 2014; Baliki et al., 2013).

Thus, the model provides a structural basis for the idea that coordinated opponent interactions between the left and right insula and cingulate are fundamentally significant for emotional balance and regulation. Positive and negative affect interact in an opponent fashion—for example, social engagement (and oxytocin) can suppress arousal, stress, depression, and cortisol release, whereas the latter factors can reduce mood, sociability, and immune function (Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003). This model is directly supported by evidence that increased vagal sensory activity caused by breathing slowly inhibits pain affect, but only in individuals who have a supply of positive energy to utilize (Zautra, Fasman, Davis, & Craig, 2010). Similarly, listening to emotionally pleasing music activates the left anterior insula more strongly than the right (Koelsch et al., 2006), and damage in the left anterior insula can produce a selective loss of musical enjoyment (see Craig, 2009, 2015; Griffiths, Warren, Dean, & Howard, 2004). A strikingly clear asymmetry in anterior insula activation is produced using auditory clicks, which activate the left anterior insula more strongly if faster than 3 Hz but the right if slower (Ackermann & Riecker, 2004). These temporal effects are consistent with the actions of parasympathetic and sympathetic activity on heart rate, respectively. Finally, these considerations provide a solid neurobiological foundation for explaining how increased parasympathetic sensory activity can synergistically enhance positive emotion and reduce negative emotion—for example, by electrical stimulation of the vagus nerve in patients who are treatment-resistant chronically depressed (Conway et al., 2013; see Craig, 2009, 2015).

Two quantitative meta-analyses of functional imaging studies that used emotional tasks (88 in one, 143 in the other) revealed asymmetric activation in both the amygdala and the AIC: During positive feelings, there was strong activation almost exclusively in the left amygdala and left AIC; during negative feelings, there was bilateral activation in the amygdala and the anterior insula (Stevens & Hamann, 2012; Duerden, Arsalidou, Lee, & Taylor, 2013). These findings fit the pattern of forebrain asymmetry described above, given that it makes sense for both sides of the brain (and thus, both sides of the body) to be immediately responsive to dangerous conditions. The fact that opponent control usually involves coordinate activation of both sides can explain why this pattern is difficult to observe because predominant activation of one side or the other will be observed only under strongly polarized conditions and because opponent activation is also required for regulation. Both studies also reported that this pattern is partially obscured by subtle differences between males and females; that finding could explain why a different meta-analysis and an imaging study of sympathetic nerve activity found consonant asymmetric activation in the amygdala but not in the insular cortex (Kühn & Gallinat, 2012; Henderson et al., 2012). Confirmation is provided by a more recent study of feedback evaluation that found responses to losses in the right anterior insula and to both losses and wins in the left anterior insula, which the authors interpreted to mean that "the right anterior insula is mainly involved in processing the salience of the outcome, whereas the left is . . . important for subsequent behavioral adaptations" (Späti et al., 2014, pp. 4428–4429). Transcription of an immediate early gene associated with emotional memory formation in the basolateral amygdala also shows consonant asymmetry, with left positive and right negative (Young & Williams, 2013). A high-resolution magnetoencephalographic study of participants who passively viewed standard emotional images similarly reported that the right basolateral amygdala was activated by negative (unpleasant) images (along with the right insula if they were also arousing), while the left centromedial amygdala was activated by pleasant images (if they were arousing; Styliadis, Ioannides, Bamidis, & Papadelis, 2014).

The largest hurdle for the acceptance of these ideas has been the lack of clear neuroanatomical evidence. However, the critical experiments needed to demonstrate asymmetric connections in the emotional motor system and the reward–punishment system are difficult to perform; that would require, for example, complete bilateral double-labeling of descending pallidal and amygdalar projections to the upper brainstem, or of interconnections between the left and right habenular nuclei and the serotoninergic and dopaminergic neurons in the upper brainstem. A stark morphological example of such asymmetry has been available in the size of the habenular nuclei of the zebrafish, but similar anatomical differences have not been observed in mammals. Nevertheless, two landmark studies in humans were recently published (Tomer, Slagter, Christian, Fox, King, et al., 2013, 2014); the authors used PET imaging to measure binding density of a dopamine D_2 receptor ligand, and they found that asymmetric binding in the striatum and medial prefrontal cortex was highly correlated with the trait-like behavioral orientation bias and the approach–avoidance behavior of individual human participants, and thus with affective asymmetry. Their work provides convincing neuroanatomical evidence for the forebrain asymmetry of emotion in humans.

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Note

1. The insula is a cortical "island" buried within the lateral sulcus that is interconnected with amygdala, hypothalamus, ventral striatum, and cingulate and orbitofrontal cortices. It is a well-developed but hidden, operculated fifth lobe of the brain only in anthropoid primates. The primordial role of the insular cortex is integration of olfactory, gustatory, and viscerosensory activity with emotional behavior, primarily ingestion.

References

Ackermann, H., & Riecker, A. (2004). The contribution of the insula to motor aspects of speech production: A review and a hypothesis. *Brain and Language, 89*, 320–328.

Alexander, W. H., & Brown, J. W. (2011). Medial prefrontal cortex as an action–outcome predictor. *Nature Reviews Neuroscience, 14*, 1338–1344.

Allen, J. J., & Kline, J. P. (2004). Frontal EEG asymmetry, emotion, and psychopathology: The first, and the next 25 years. *Biological Psychology, 67*, 1–5.

Baliki, M. N., Mansour, A., Baria, A. T., Huang, L., Berger, S. E., Fields, H. L., et al. (2013). Parceling human accumbens into putative core and shell dissociates encoding of values for reward and pain. *Journal of Neuroscience, 33*, 16383–16393.

Barrett, L. F., Quigley, K. S., Bliss-Moreau, E., & Aronson, K. R. (2004). Interoceptive sensitivity and self-reports of emotional experience. *Journal of Personality and Social Psychology, 87*, 684–697.

Bauernfeind, A. L., de Sousa, A. A., Avasthi, T., Dobson, S. D., Raghanti, M. A., Lewandowski, A. H., et al. (2013). A volumetric comparison of the insular cortex and its subregions in primates. *Journal of Human Evolution, 64*, 263–279.

Berntson, G. G., Norman, G. J., Bechara, A., Bruss, J., Tranel, D.,& Cacioppo, J. T. (2011). The insula and evaluative processes. *Psychological Science, 22*, 80–86.

Besharati, S., Forkel, S. J., Kopelman, M., Solms, M., Jenkinson, P. M., & Fotopoulou, A. (2014). The affective modulation of motor awareness in anosognosia for hemiplegia: Behavioural and lesion evidence. *Cortex, 61*, 127–140.

Bianchi-Demicheli, F., & Ortigue, S. (2009). Mental representation of subjective pleasure of partnered experiences in women's brain conveyed through event-related fMRI. *Medical Science Monitor, 15*, CR545–CR550.

Britz, J., Van, D. V., & Michel, C. M. (2010). BOLD correlates of EEG topography reveal rapid resting-state network dynamics. *NeuroImage, 52*, 1162–1170.

Brooks, J. C., Nurmikko, T. J., Bimson, W. E., Singh, K. D., & Roberts, N. (2002). fMRI of thermal pain: Effects of stimulus laterality and attention. *NeuroImage, 15*, 293–301.

Brooks, J. C., Zambreanu, L., Godinez, A., Craig, A. D., & Tracey, I. (2005). Somatotopic organisation of the human insula to painful heat studied with high resolution functional imaging. *NeuroImage, 27*, 201–209.

Brown, J. W., & Braver, T. S. (2005). Learned predictions of error likelihood in the anterior cingulate cortex. *Science, 307*, 1118–1121.

Cabanac, M., Cabanac, A. J., & Parent, A. (2009). *Behavioural Brain Research, 198*, 267–272.

Castriota-Scanderbeg, A., Hagberg, G. E., Cerasa, A., Committeri, G., Galati, G., Patria, F., et al. (2005). The appreciation of wine by sommeliers: A functional magnetic resonance study of sensory integration. *NeuroImage, 25*, 570–578.

Cauda, F., Costa, T., Torta, D. M., Sacco, K., D'Agata, F., Duca, S., et al. (2012). Meta-analytic clustering of the insular cortex: Characterizing the meta-analytic connectivity of the insula when involved in active tasks. *NeuroImage, 62*, 343–355.

Cechetto, D. F., & Shoemaker, J. K. (2009). Functional neuroanatomy of autonomic regulation. *NeuroImage, 47*, 795–803.

Chakravarthi, R., & VanRullen, R. (2012). Conscious updating is a rhythmic process. *Proceedings of the National Academy of Science USA, 109*, 10599–10604.

Cole, M. W., & Schneider, W. (2007). The cognitive control network: Integrated cortical regions with dissociable functions. *NeuroImage, 37*, 343–360.

Cole, M. W., Yarkoni, T., Repovs, G., Anticevic, A., & Braver, T. S. (2012). Global connectivity of prefrontal cortex predicts cognitive control and intelligence. *Journal of Neuroscience, 32*, 8988–8999.

Conway, C. R., Chibnall, J. T., Gebara, M. A., Price, J. L., Snyder, A. Z., Mintun, M. A., et al. (2013). Association of cerebral metabolic activity changes with vagus nerve stimulation antidepressant response in treatment-resistant depression. *Brain Stimulation, 6*, 788–797.

Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. *Nature Reviews Neuroscience, 3*, 655–666.

Craig, A. D. (2003). Pain mechanisms: Labeled lines versus convergence in central processing. *Annual Review of Neuroscience, 26*, 1–30.

Craig, A. D. (2004). Distribution of trigeminothalamic and spinothalamic lamina I terminations in the macaque monkey. *Journal of Comparative Neurology, 477*, 119–148.

Craig, A. D. (2005). Forebrain emotional asymmetry: A neuroanatomical basis? *Trends in Cognitive Sciences, 9*, 566–571.

Craig, A. D. (2009). How do you feel—now?: The anterior insula and human awareness. *Nature Review Neuroscience, 10*, 59–70.

Craig, A. D. (2011). Significance of the insula for the evolution of human awareness of feelings from the body. *Annals of the New York Academy of Sciemce, 1225*, 72–82.

Craig, A. D. (2014). Topographically organized projection to posterior insular cortex from the posterior portion of the ventral medial nucleus in the long-tailed macaque monkey. *Journal of Comparative Neurology, 522*, 36–63.

Craig, A. D. (2015). *How do you feel?: An interoceptive moment with your neurobiological self.* Princeton, NJ: Princeton University Press.

Craig, A. D., Chen, K., Bandy, D., & Reiman, E. M. (2000). Thermosensory activation of insular cortex. *Nature Neuroscience, 3*, 184–190.

Craig, A. D., Krout, K., & Andrew, D. (2001). Quantitative response characteristics of thermoreceptive and nociceptive lamina I spinothalamic neurons in the cat. *Journal of Neurophysiology, 86*, 1459–1480.

Critchley, H. D., Weins, S., Rotshtein, P., Öhman, A., & Dolan, R. J. (2004). Neural systems supporting interoceptive awareness. *Nature Neuroscience, 7*, 189–195.

Crittenden, B. M., & Duncan, J. (2014). Task difficulty manipulation reveals multiple demand activity but no frontal lobe hierarchy. *Cerebral Cortex, 24*, 532–540.

Cui, J., McQuillan, P. M., Blaha, C., Kunselman, A. R., & Sinoway, L. I. (2012). Limb venous distension evokes sympathetic activation via stimulation of the limb afferents in humans. *American Journal of Physiology—Heart and Circulatory Physiology, 303*, H457–H463.

Damasio, A., Damasio, H., & Tranel, D. (2013). Persistence of feelings and sentience after bilateral damage of the insula. *Cerebral Cortex, 23*, 833–846.

Darwin, C. (1965). *The expression of the emotions in man and animals*. Chicago: University of Chicago Press. (Original work published 1872)

Davidson, R. J. (2004). Well-being and affective style: Neural substrates and biobehavioural correlates. *Philosophical Transactions of the Royal Society of London: Series B. Biological Sciences, 359*, 1395–1411.

Deen, B., Pitskel, N. B., & Pelphrey, K. A. (2011). Three systems of insular functional connectivity identified with cluster analysis. *Cerebral Cortex, 21*, 1498–1506.

De Waal, F. B. M. (2003). Darwin's legacy and the study of primate visual communication. *Annals of the New York Academy of Sciences, 1000*, 7–31.

Dimitriou, M. (2014). Human muscle spindle sensitivity reflects the balance of activity between antagonistic muscles. *Journal of Neuroscience, 34*, 13644–13655.

Dixon, M. L., Fox, K. C., & Christoff, K. (2014). Evidence for rostro-caudal functional organization in multiple brain areas related to goal-directed behavior. *Brain Research, 1572*, 26–39.

Duerden, E. G., Arsalidou, M., Lee, M., & Taylor, M. J. (2013). Lateralization of affective processing in the insula. *NeuroImage, 78*, 159–175.

Duncan, J. (2013). The structure of cognition: Attentional episodes in mind and brain. *Neuron, 80*, 35–50.

Dunn, B. D., Evans, D., Makarova, D., White, J., & Clark, L. (2012). Gut feelings and the reaction to perceived inequity: The interplay between bodily responses, regulation, and perception shapes the rejection of unfair offers on the ultimatum game. *Cognitive, Affective, and Behavioral Neuroscience, 12*, 419–429.

Ellingsen, D. M., Wessberg, J., Chelnokova, O., Olausson, H., Laeng, B., & Leknes, S. (2014). In touch with your emotions: Oxytocin and touch change social impressions while others' facial expressions can alter touch. *Psychoneuroendocrinology, 39*, 11–20.

Engstrom, M., Karlsson, T., Landtblom, A. M., & Craig, A. D. (2014). Evidence of conjoint activation of the anterior insular and cingulate cortices during effortful tasks. *Frontiers in Human Neuroscience, 8*, 1071.

Evrard, H. C., Logothetis, N. K., & Craig, A. D. (2014). Modular architectonic organization of the insula in the macaque monkey. *Journal of Comparative Neurology, 522*, 64–97.

Feinstein, J. S., Rudrauf, D., Khalsa, S. S., Cassell, M. D., Bruss, J., Grabowski, T. J., et al. (2010). Bilateral limbic system destruction in man. *Journal of Clinical and Experimental Neuropsychology, 32*, 88–106.

Fitzgerald, T. H., Friston, K. J., & Dolan, R. J. (2012). Action-specific value signals in reward-related regions of the human brain. *Journal of Neuroscience, 32*, 16417–16423a.

Goodkind, M., Eickhoff, S. B., Oathes, D. J., Jiang, Y., Chang, A., Jones-Hagata, L. B., et al. (2015). Identification of a common neurobiological substrate for mental illness. *JAMA Psychiatry, 72*(4), 305–315.

Gray, M. A., Beacher, F. D., Minati, L., Nagai, Y., Kemp, A. H., Harrison, N. A., et al. (2012). Emotional appraisal is influenced by cardiac afferent information. *Emotion, 12*, 180–191.

Greenspan, J. D., Lee, R. R., & Lenz, F. A. (1999). Pain sensitivity alterations as a function of lesion location in the parasylvian cortex. *Pain, 81*, 273–282.

Griffiths, T. D., Warren, J. D., Dean, J. L., & Howard, D. (2004). "When the feeling's gone": A selective loss of musical emotion. *Journal of Neurology, Neurosurgery and Psychiatry, 75*, 344–345.

Grossi, D., Di Vita, A., Palermo, L., Sabatini, U., Trojano, L., & Guariglia, C. (2014). The brain network for self-feeling: A symptom-lesion mapping study. *Neuropsychologia, 63*, 92–98.

Gu, X., Gao, Z., Wang, X., Liu, X., Knight, R. T., Hof, P. R., et al. (2012). Anterior insular cortex is necessary for empathetic pain perception. *Brain, 135*, 2726–2735.

Han, Z. S., Zhang, E. T., & Craig, A. D. (1998). Nociceptive and thermoreceptive lamina 1 neurons are anatomically distinct. *Nature Neuroscience, 1*(3), 218–225.

Haouzi, P., Chenuel, B., & Huszczuk, A. (2004). Sensing vascular distension in skeletal muscle by slow conducting afferent fibers: Neurophysiological basis and implication for respiratory control. *Journal of Applied Physiology, 96*, 407–418.

Heilman, K. M. (2000). Emotional experience: A neurological model. In R. D. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 328–344). New York: Oxford University Press.

Heinrichs, M., Baumgartner, T., Kirschbaum, C., & Ehlert, U. (2003). Social support and oxytocin interact to suppress cortisol and subjective responses to psychosocial stress. *Biological Psychiatry, 54*, 1389–1398.

Henderson, L. A., Gandevia, S. C., & Macefield, V. G. (2007). Somatotopic organization of the processing of muscle and cutaneous pain in the left and right insula cortex: A single-trial fMRI study. *Pain, 128*, 20–30.

Henderson, L. A., Stathis, A., James, C., Brown, R., McDonald, S., & Macefield, V. G. (2012). Real-time imaging of cortical areas involved in the generation of increases in skin sympathetic nerve activity when viewing emotionally charged images. *NeuroImage, 62*, 30–40.

Herbert, B. M., & Pollatos, O. (2012). The body in the mind: On the relationship between interoception and embodiment. *Topics in Cognitive Science, 4*, 692–704.

Hua, L. H., Strigo, I. A., Baxter, L. C., Johnson, S. C., & Craig, A. D. (2005). Anteroposterior somatotopy of innocuous cooling activation focus in human dorsal posterior insular cortex. *American Journal of Physiology: Regulatory, Integrative, and Comparative Physiology, 289*, R319–R325.

Ibanez, A., Gleichgerrcht, E., & Manes, F. (2010). Clinical effects of insular damage in humans. *Brain Structure and Function, 214*, 397–410.

James, W. (2007). The principles of psychology. Retrieved from *psychclassics.yorku.ca.James/Principles/index.htm.* (Original work published 1890)

Karnath, H. O., & Baier, B. (2010). Right insula for our sense of limb ownership and self-awareness of actions. *Brain Structure and Function, 214*, 411–417.

Kennerley, S. W., & Wallis, J. D. (2009). Evaluating choices by single neurons in the frontal lobe: Outcome value encoded across multiple decision variables. *European Journal of Neuroscience, 29*, 2061–2073.

Koechlin, E., & Jubault, T. (2006). Broca's area and the hierarchical organization of human behavior. *Neuron, 50*, 963–974.

Koelsch, S., Fritz, T., V Cramon, D. Y., Müller, K., & Friederici, A. D. (2006). Investigating emotion with music: An fMRI study. *Human Brain Mapping, 27*, 239–250.

Krubitzer, L., & Kaas, J. (2005). The evolution of the neocortex in mammals: How is phenotypic diversity generated? *Current Opinion in Neurobiology, 15*, 444–453.

Kühn, S., & Gallinat, J. (2012). The neural correlates of subjective pleasantness. *NeuroImage, 61*, 289–294.

Laird, J. D. (2014). *Feelings: The perception of self.* New York: Oxford University Press.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*, 121–143.

MacNeilage, P. F., Rogers, L. J., & Vallortigara, G. (2009). Origins of the left and right brain. *Scientific American, 301*, 60–67.

Mantini, D., Corbetta, M., Romani, G. L., Orban, G. A., & Vanduffel, W. (2013). Evolutionarily novel functional networks in the human brain? *Journal of Neuroscience, 33*, 3259–3275.

Medford, N. (2012). Emotion and the unreal self: Depersonalization disorder and de-affectualization. *Emotion Review, 4*, 139–144.

Meissner, K., & Wittmann, M. (2011). Body signals, cardiac awareness, and the perception of time. *Biological Psychology, 86*, 289–297.

Menon, V., & Uddin, L. Q. (2010). Saliency, switching, attention and control: A network model of insula function. *Brain Structure and Function, 214*, 655–667.

Montague, R. (2006). *Your brain is (almost) perfect: How we make decisions*. New York: Penguin.

Moseley, G. L., Olthof, N., Venema, A., Don, S., Wijers, M., Gallace, A., et al. (2008). Psychologically induced cooling of a specific body part caused by the illusory ownership of an artificial counterpart. *Proceedings of the National Academy of Science USA, 105*, 13169–13173.

Mower, G. (1976). Perceived intensity of peripheral thermal stimuli is independent of internal body temperature. *Journal of Comparative and Physiological Psychology, 90*, 1152–1155.

Müller, V. I., Langner, R., Cieslik, E. C., Rottschy, C., & Eickhoff, S. B. (2014). Interindividual differences in cognitive flexibility: Influence of gray matter volume, functional connectivity and trait impulsivity. *Brain Structure and Function, 220*, 2401–2414.

Naqvi, N. H., & Bechara, A. (2010). The insula and drug addiction: An interoceptive view of pleasure, urges, and decision-making. *Brain Structure and Function, 214*, 435–450.

Olausson, H., Lamarre, Y., Backlund, H., Morin, C., Wallin, B. G., Starck, G., et al. (2002). Unmyelinated tactile afferents signal touch and project to insular cortex. *Nature Neuroscience, 5*, 900–904.

Paine, P., Kishor, J., Worthen, S. F., Gregory, L. J., & Aziz, Q. (2009). Exploring relationships for visceral and somatic pain with autonomic control and personality. *Pain, 144*, 236–244.

Paulus, M. P., Flagan, T., Simmons, A. N., Gillis, K., Kotturi, S., Thom, N., et al. (2012) Subjecting elite athletes to inspiratory breathing load reveals behavioral and neural signatures of optimal performers in extreme environments. *PLoS ONE, 7*, e29394.

Pfeuty, M., Dilharreguy, B., Gerlier, L., & Allard, M. (2015). fMRI identifies the right inferior frontal cortex as the brain region where time interval processing is altered by negative emotional arousal. *Human Brain Mapping, 36*, 981–995.

Phillips, M. L., Gregory, L. J., Cullen, S., Cohen, S., Ng, V., Andrew, C., et al. (2003). The effect of negative emotional context on neural and behavioural responses to oesophageal stimulation. *Brain, 126*, 669–684.

Pollatos, O., Fustos, J., Critchley, H. D. (2012). On the generalised embodiment of pain: How interoceptive sensitivity modulates cutaneous pain perception. *Pain, 153*, 1680–1686.

Power, J. D., Schlaggar, B. L., Lessov-Schlaggar, C. N., & Petersen, S. E. (2013). Evidence for hubs in human functional brain networks. *Neuron, 79*, 798–813.

Rogers, L. J. (2014). Asymmetry of brain and behavior in animals: Its development, function, and human relevance. *Genesis, 52*, 555–571.

Rolls, E. T. (1999). *The brain and emotion*. Oxford, UK: Oxford University Press.

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology, 76*, 805–819.

Rutledge, R. B., Skandali, N., Dayan, P., & Dolan, R. J. (2014). A computational and neural model of momentary subjective well-being. *Proceedings of the National Academy of Science USA, 111*, 12252–12257.

Sadaghiani, S., Scheeringa, R., Lehongre, K., Morillon, B., Giraud, A. L., & Kleinschmidt, A. (2010). Intrinsic connectivity networks, alpha oscillations, and tonic alertness: A simultaneous electroencephalography/functional magnetic resonance imaging study. *Journal of Neuroscience, 30*, 10243–10250.

Sanchez, M. M., Young, L. J., Plotsky, P. M., & Insel, T. R. (1999). Autoradiographic and in situ hybridization localization of corticotropin-releasing factor 1 and 2 receptors in nonhuman primate brain. *Journal of Comparative Neurology, 408*, 365–377.

Sato, A., & Schmidt, R. F. (1973). Somatosympathetic reflexes: Afferent fibers, central pathways, discharge characteristics. *Physiological Reviews, 53*, 916–947.

Schmahmann, J. D., & Leifer, D. (1992). Parietal pseudothalamic pain syndrome: Clinical features and anatomic correlates. *Archives of Neurology, 49*, 1032–1037.

Schreckenberger, M., Siessmeier, T., Viertmann, A., Landvogt, C., Buchholz, H. G., Rolke, R., et al. (2005). The unpleasantness of tonic pain is encoded by the insular cortex. *Neurology, 64*, 1175–1183.

Seeley, W. W., Menon, V., Schatzberg, A. F., Keller, J., Glover, G. H., Kenna, H., et al. (2007). Dissociable intrinsic connectivity networks for salience processing and executive control. *Journal of Neuroscience, 27*, 2349–2356.

Sepulcre, J., Sabuncu, M. R., Yeo, T. B., Liu, H., & Johnson, K. A. (2012). Stepwise connectivity of the modal cortex reveals the multimodal organization of the human brain. *Journal of Neuroscience, 32*, 10649–10661.

Seth, A. K., & Critchley, H. D. (2013). Extending predictive processing to the body: Emotion as interoceptive inference. *Behavioral and Brain Sciences, 36*, 227–228.

Seymour, B., O'Doherty, J. P., Koltzenburg, M., Wiech, K., Frackowiak, R., Friston, K., et al. (2005). Opponent appetitive–aversive neural processes underlie predictive learning of pain relief. *Nature Neuroscience, 8*, 1234–1240.

Sherrington, C. S. (1900). *The integrative action of the nervous system*. Cambridge, UK: Cambridge University Press.

Simmons, W. K., Rapuano, K. M., Kallman, S. J., Ingeholm, J. E., Miller, B., Gotts, S. J., et al. (2013). Category-specific integration of homeostatic signals in caudal but not rostral human insula. *Nature Neuroscience, 16*, 1551–1552.

Skvortsova, V., Palminteri, S., & Pessiglione, M. (2014). Learning to minimize efforts versus maximizing rewards: Computational principles and neural correlates. *Journal of Neuroscience, 34,* 15621–15630.

Späti, J., Chumbley, J., Brakowski, J., Dorig, N., Grosse, H. M., Seifritz, E., et al. (2014). Functional lateralization of the anterior insula during feedback processing. *Human Brain Mapping, 35*, 4428–4439.

Sternberg, R. J. (2000). Cognition: The holy grail of general intelligence [Comment]. *Science, 289*, 399–401.

Stevens, J. S., & Hamann, S. (2012). Sex differences in brain activation to emotional stimuli: A meta-analysis of neuroimaging studies. *Neuropsychologia, 50*, 1578–1593.

Styliadis, C., Ioannides, A. A., Bamidis, P. D., & Papadelis, C. (2014). Amygdala responses to valence and its interaction by arousal revealed by MEG. *International Journal of Psychophysiology, 93*, 121–133.

Terasawa, Y., Fukushima, H., & Umeda, S. (2013a). How does interoceptive awareness interact with the subjective experience of emotion?: An fMRI study. *Human Brain Mapping, 34*, 598–612.

Terasawa, Y., Shibata, M., Moriguchi, Y., & Umeda, S. (2013b). Anterior insular cortex mediates bodily sensibility and social anxiety. *Social Cognitive and Affective Neuroscience, 8*, 259–266.

Todd, R. M., Talmi, D., Schmitz, T. W., Susskind, J., & Anderson, A. K. (2012). Psychophysical and neural evidence for emotion-enhanced perceptual vividness. *Journal of Neuroscience, 32*, 11201–11212.

Tomasi, D., Wang, G. J., Studentsova, Y., & Volkow, N. D. (2014). Dissecting neural responses to temporal prediction, attention, and memory: Effects of reward learning and interoception on time perception. *Cerebral Cortex, 25*, 2856–2857.

Tomer, R., Slagter, H. A., Christian, B. T., Fox, A. S., King, C. R., Murali, D., et al. (2013). Dopamine asymmetries predict orienting bias in healthy individuals. *Cerebral Cortex, 23*, 2899–2904.

Tomer, R., Slagter, H. A., Christian, B. T., Fox, A. S., King, C. R., Murali, D., et al. (2014). Love to win or hate to lose?: Asymmetry of dopamine D2 receptor binding predicts sensitivity to reward versus punishment. *Journal of Cognitive Neuroscience, 26*, 1039–1048.

Touroutoglou, A., Hollenbeck, M., Dickerson, B. C., & Feldman, B. L. (2012). Dissociable large-scale networks anchored in the right anterior insula subserve affective experience and attention. *NeuroImage, 60*, 1947–1958.

Uddin, L. Q., Supekar, K. S., Ryali, S., & Menon, V. (2011). Dynamic reconfiguration of structural and functional connectivity across core neurocognitive brain networks with development. *Journal of Neuroscience, 31*, 18578–18589.

Uvnas-Moberg, K., Arn, I., & Magnusson, D. (2005). The psychobiology of emotion: The role of the oxytocinergic system. *International Journal of Behavioural Medicine, 12*, 59–65.

Vidal, J. R., Perrone-Bertolotti, M., Kahane, P., & Lachaux, J. P. (2015). Intracranial spectral amplitude dynamics of perceptual suppression in fronto-insular, occipito-temporal, and primary visual cortex. *Frontiers in Psychology, 5*, 1545.

Wegner, D. M. (2014). *The illusion of conscious will*. Cambridge, MA: MIT Press.

Wiens, S. (2005). Interoception in emotional experience. *Current Opinion in Neurology, 18*, 442–447.

Wittmann, M. (2013). The inner sense of time: How the brain creates a representation of duration. *Nature Reviews Neuroscience, 14*, 217–223.

Young, E. J., & Williams, C. L. (2013). Differential activation of amygdala arc expression by positive and negatively valenced emotional learning conditions. *Frontiers in Behavioral Neuroscience, 7*, 191.

Zaki, J., Davis, J. I., & Ochsner, K. N. (2012). Overlapping activity in anterior insula during interoception and emotional experience. *NeuroImage, 62*, 493–499.

Zautra, A. J., Fasman, R., Davis, M. C., Craig, A. D. (2010). The effects of slow breathing on affective responses to pain stimuli: An experimental study. *Pain, 149*, 12–18.

CHAPTER 13

THE AFFECT OF TASTE AND OLFACTION

The Key to Survival

Linda Bartoshuk and Derek J. Snyder

The notion that affect (pleasure and pain) are linked to well-being and survival is an old one. Jeremy Bentham (1789) is widely quoted: "Nature has placed mankind under the governance of two sovereign masters, pain and pleasure. It is for them alone to point out what we ought to do, as well as to determine what we shall do."

Pain is, of course, innately negative, but taste is both innately negative (bitter, sour) and positive (sweet, salty). The dislike of pain lets us escape physical damage. Dislike of bitter lets us avoid poisons. Dislike of sour is less clear; some have argued that sour taste might warn of unripe fruit, but it certainly warns of acid. Love of the sweetness of mother's milk leads a newborn to nurse right after birth; love of the saltiness of dilute sodium allows rapid replacement of the sodium necessary for nerves to fire and muscles to contract after losses of sodium and water (e.g., sweating during exercise; loss of fluid with birth). Where hard-wired affect fails to protect us, learning steps in. Learning attaches pleasure to stimuli that do us good and displeasure to stimuli that do us harm.

This chapter discusses how nature uses the affect of taste and olfaction to help us survive. We begin with the innate affect of taste, then move on to the learned affect of olfaction. In essence, the olfactory system identifies objects for us; the olfactory sensations acquire affect based on the consequences of our interactions with those objects. Early studies focused on the biological motivations that fueled the acquisition of olfactory affect associated with foods (e.g., ingestion of calories endows associated olfactory sensations with positive affect; nausea endows them with negative affect). However, olfaction not only helps us identify foods but also helps us identify important objects in our environments (predators, prey). Thus, studies of the acquisition of affect associated with environmental stimuli have also been targets of innovative studies.

Measurement of affect is essential to the study of affect. We have made great progress in quantification of our experiences including quantification of affect. However, attempts to compare sensory and hedonic experiences across groups have been flawed. We discuss the flaw and a solution in the final section of this chapter.

Studies of taste and olfaction have broader significance as well. Our experience of affect guides our philosophical views of good and bad. If the insights gained from taste and olfaction generalize to broader domains, those insights may help us make the world a better place.

Taste and Innate Affect

Taste Affect Is Hard-Wired in the Brain

Taste Senses Certain Nutrients

Nature uses taste to solve nutritional problems that must be solved rapidly. However, this kind of solution only works for nutrients that produce a clear sensory cue (we thus must have receptors that signal that nutrient) and stimulate parts of our brains that are hard-wired to recognize them. This kind of hard-wired solution is viable for nutrients that are commonly present in our environments. Table 13.1 shows the nutrient sensed by each of the "four basic tastes."

Salty, sour, sweet, and bitter were identified in the 19th century as the basic taste qualities. Attempts to add other categories (e.g., metallic) were dismissed in that era, but more recent attempts to add umami and fat taste are still under discussion. We prefer not to include these sensations as basic taste sensations since the affect associated with them is not innate but rather is learned (to be discussed later); we see the innate affect associated with taste qualities as one of the most important characteristics that dissociate taste from other sensations.

Facial Expressions Reflect Hard-Wired Affect

Some of the best-known evidence for the hard-wired affect of taste comes from the work of Jacob Steiner (1977) on facial expressions in the newborn. "The sweet stimulus leads to a marked relaxation of the face, resembling an expression of 'satisfaction.' This expression is often accompanied by a slight smile and was almost always followed by an eager licking of the upper lip, and sucking movements." Sour leads to lip pursing. "Stimulation with the bitter fluid leads to a typical arch form opening of the mouth with the upper lip elevated, the mouth angles depressed, and the tongue protruded in a flat position. . . . It was often followed by spitting or even by the preparatory movements of vomiting." Facial expressions have been studied by other investigators (Rosenstein & Oster, 1988) and in other species as well (Ganchrow, Oppenheimer, & Steiner, 1979; Jacobs, Smutz, & DuBose, 1977), most recently, the horse (Jankunis & Whishaw, 2013).

Incidentally, sweet affect is apparently present prior to birth. De Snoo (1937), a pediatrician, sought to medicate the fetus by inducing it to drink amniotic fluid to which a medication could be added. He induced drinking by injecting saccharin into amniotic fluid. The willingness of the fetus to drink the sweetened amniotic fluid demonstrated sweet affect prior to birth.

Human neonatal responses to NaCl are ambiguous. However, developmental work with sheep (Mistretta, 1981) led to the insight that in some species the salt receptors develop after birth.

TABLE 13.1. Four Basic Tastes: Nutrient and Mechanism

Nutrient	Taste	Mechanism
Sodium	Salty	Na^+ channels in certain taste cell membranes allows Na^+ ions to enter salty receptor cells and initiate events that lead to a neural signal.
Acid	Sour	H^+ channels in certain taste cell membranes allow H^+ ions to enter sour receptor cells; in addition, undissociated acid molecules can enter in other ways and dissociate intracellularly; the signal for sour is the total H^+ concentration within the sour receptor cell (DeSimone & Lyall, 2006).
Glucose	Sweet	Glucose is the fuel of the brain. In addition to glucose alone, the sucrose molecule is broken down into its constituent glucose and fructose by digestion. Fructose is converted to glucose in the liver. Sweet receptors are G-protein-coupled receptors (GPCRs). The major receptor (called a heterodimer) is constructed of two proteins. The taste (TA) genes expressing these proteins are *TA1R2* and *TA1R3*; the heterodimer has binding sites for glucose, fructose, sucrose, and a variety of other molecules. The biological purpose of the sites for those other molecules is unknown, but their existence is responsible for what we call "artificial sweeteners." In addition to the heterodimer, one of the proteins (expressed by *TA1R3*) can act as a receptor for high concentrations of sugar (Zhao et al., 2003).
Poison	Bitter	Most poisons taste bitter. Bitter receptors, like sweet receptors, are GPCRs. There are 25 different genes that express bitter receptors (Meyerhof et al., 2010). Some of those receptors are highly specific for a given compound (specialists), while others can bind multiple compounds (generalists). Multiple bitter receptors allow evolution to equip an individual (or species) with receptors that warn of poisons in a given environment.

When the receptors are mature, human newborns like dilute NaCl but reject higher concentrations, presumably because they sting as well as taste salty. The lack of ability to taste sodium in the newborn is unlikely to prove dangerous under normal circumstances; however, six infants died of salt poisoning in a hospital where salt was accidentally substituted for sugar in formula (Finberg, Kiley, & Luttrell, 1963).

Gustotopic Mapping in the Brain

In order for each of the tastes to serve its biological function, investigators have long assumed that each would project to a different part of the brain. Discovery of that gustotopic map has been elusive. However, recent work using an imaging procedure is consistent with such a map (Barretto et al., 2014; Chen, Gabitto, Peng, Ryba, & Zuker, 2011).

Liking for Sweet and Salty Is Dependent on Body Need

Cabanac coined the term "alliesthesia" to describe hedonic changes produced by changing the state of the body. The "Cabanac effect" is the decline in the palatability of sweet following ingestion of sugar (Cabanac, Minaire, & Adair, 1968). In the opposite of this, the injection of insulin depletes the body of glucose and enhances the palatability of sweet. A dramatic example of this was provided by a treatment for schizophrenia pioneered by Manfred Sakel (1938) in the 1930s. Joseph Wortis, an American psychiatrist, introduced the treatment to the United States after observing its use by Sakel in Vienna (see Halmi, 1995). During the treatment some patients experienced intense cravings for carbohydrates. This stimulated Mayer-Gross and Walker (1946) to design a sucrose preference test; they demonstrated that patients were more likely to choose a 30% sucrose solution when their blood glucose was low. This was subsequently supported by more detailed studies (e.g., see Rodin, Wack, Ferrannini, & DeFronzo, 1985).

The liking of salt is similarly dependent on body need. The liking for salt requires no experience, but if an organism is made sodium deficient, that liking intensifies (Bare, 1949) allowing species to regulate sodium intake (Schulkin, 1991). Salt hunger is shown by a variety of species (see Schulkin, 1991 for a review). Rats made sodium deficient will ingest sodium immediately on given the opportunity. In one important experiment, rats were given experience with a T maze when thirsty. One arm of the T contained water, the other contained NaCl. When thirsty, the rats learned to run to the arm containing water and avoided the arm containing NaCl. Subsequently, when made sodium deficient, the rats ran to the NaCl arm of the maze even though they had not previously experienced NaCl taste in the presence of sodium need (Krieckhaus, 1970).

The classic paper of Wilkins and Richter (1940) documented the sad story of a 3.5-year-old child with an adrenal tumor (this leads to loss of sodium). This boy loved salt and added it to his food when allowed to at home. During a hospitalization he was unable to get the salt he craved and he died from loss of sodium (Wilkins & Richter, 1940). The parents' description of the boy's behavior toward salty foods suggests that he liked them on initial exposure to the salty taste.

In humans, exercising (sweating) depletes the body of both water and salt. The liking for these two substances alters such that the human rehydrates in three stages. First, thirst motivates water consumption; during this phase salty taste is not pleasant even though the body needs sodium. In the second phase, salty taste is pleasant again and the athlete ingests salt. Once enough salt is in the body, new thirst motivates enough further water consumption to rehydrate completely (Takamata, Mack, Gillen, & Nadel, 1994). Interestingly, this could be done in one stage by simply making a beverage containing enough salt to appropriately rehydrate. However, such a beverage would taste salty enough to engage the salty taste rejection shown during dehydration. Sports beverages are formulated with less than the physiologically needed salt and thus avoid this salty rejection response.

Taste provides a beautiful example of how hardwired affect can promote survival. Love of sweet and salt ensures that these nutrients will be consumed. Dependence on body need ensures that the correct amounts will be consumed. Aversion to bitter keeps us away from most poisons. The only problem is that this mechanism must have a sensory signal for each nutrient. Evolution could find such signals for sweet, salty, and sour; bitter turned out to be a bit of a problem. There are too many different poisons to have a receptor for each. Evolution did her best and provided 25 receptors along with genetic variation on what these receptors can sense; however, there are still poisons that escape this innate aversion (e.g., lithium chloride).

Curt Richter and "Wisdom of the Body"

The elegance of the body's ability to alter the palatability of sweet and salty to meet body needs led Curt Richter (1942–1943) to propose a general regulatory theory. The origin of the phrase, "wisdom of the body," was a Harvey lecture by Starling (1923) on automatic mechanisms that allow the body to adapt to a variety of circumstances (e.g., the heart beats faster during exercise). Cannon (1939) used this title for his book on homeostasis out of respect for Starling. Richter extended the idea to voluntary behavior. He proposed that body needs requiring resources from the environment might produce craving that would motivate an organism to seek out the needed nutrient (Richter, 1942–1943).

Early studies done by Clara Davis (1939) seemed to support this theory. Davis, a pediatrician, allowed children (beginning at weaning) to eat as they chose from a variety of foods. The children thrived. This led to the widespread belief (which still survives in some quarters today) that humans are born with the capacity to select a healthy diet. Richter (1942–1943) did a series of rat studies confirming sweet and salty cravings resulting from need; however, when wisdom of the body was extended to vitamins, the theory failed. Deficiencies in the water-soluble B vitamins can make an organism ill relatively quickly. Deficiency of vitamin B_1 (thiamin) produces beriberi in humans; rats show weight loss and anorexia. Initially, rat studies were conducted just as they had been for sweet and salty: rats were deprived of the nutrient and, when ill, were given a choice of the same diet or a new diet containing the nutrient. The rats switched immediately to the new diet. However, Paul Rozin, a psychologist who has made revolutionary contributions to our understanding of food behavior, did a critical control: he also offered the rats a third diet deficient in B_1 but with a novel flavor. The rats immediately chose the novel-flavored diet even though it was deficient in B_1. In other words, the rats were not choosing a diet that their bodies knew contained the needed nutrient; rather, they were avoiding the diet that they associated with illness. Thus Rozin demonstrated conditioned aversions to a diet on which the rats had become ill (Rozin & Kalat, 1971).

This appeared to leave the Davis (1939) experiments unexplained, but the psychologist Barbara Rolls (1986) had discovered "sensory specific satiety": pleasure diminishes with an unchanging diet. The babies in the Davis studies were not seeking the nutrients their bodies knew they needed. Rather, they were eating a variety to avoid boredom maximize pleasure. Since all of the foods offered were healthy, they thrived. Had the babies been offered the junk foods of today, it us unlikely the result would have been the same.

Olfaction and Acquired Affect: The Omnivore's Dilemma

Important Distinctions in the Study of Olfaction and Affect

The affect-driven, hard-wired nutrient systems discussed above deal with only a small portion of nutritional challenges. Some species need make few choices since they subsist on limited food sources (e.g., Koala bears and eucalyptus leaves), but consider humans. We are omnivores. We must consume foods that will sustain life and avoid those that will kill us. Rozin coined the term "omnivore's dilemma" to describe this biological imperative (Rozin & Rozin, 1981). Michael Pollan (2006), the food writer, subsequently borrowed Rozin's term to underline the even more complex dilemma that we face in the modern era given the dizzying choices available to us. How do we select a successful diet? We learn. Sensory cues from our environments can acquire the ability to make us experience pleasure or disgust—that is, we can learn to like the foods that do us good and to dislike those that do us harm.

There are two bodies of literature on the learned affect of olfaction. One of these is associated with the biology of eating and the other, evaluative conditioning, originated in cognitive psychology. We discuss studies from these two fields using distinctions not always noted in attempts to integrate this material. First, we distinguish between orthonasal and retronasal olfaction (the two routes by which olfactory volatiles reach olfactory receptors) and second, we distinguish between what we call primary (i.e., hard-wired) and acquired affect.

Historically, studies on the olfactory affect of foods came first, while the more cognitive studies of olfactory affect associated with environmental stimuli tended to come later. We follow that order in summarizing these studies.

Distinction between Orthonasal and Retronasal Olfaction

We smell odors in our environments by sniffing. Air enters the nostrils and passes over bones called "turbinates." These bones provide turbulence to the stream of odorized air so a sample of it moves to the top of the nasal cavity, passes through a small opening called the "olfactory cleft," and reaches the olfactory mucosa where it encounters the ciliated endings of olfactory neurons; the olfactory receptors are on those cilia. This is called "orthonasal olfaction." On the other hand, when food or beverages that emit odors enter the mouth, chewing and swallowing forces the odors up behind the palate and into the nasal cavity from the rear. This is called "retronasal olfaction." This distinction is easily demonstrated with jellybeans. Pinch your nose closed (this prevents the air currents that provide retronasal olfaction) and chew a jellybean. You may taste some sweet or sour, but you will not be able to detect the flavor of the jellybean. Once chewed, swallow and open your nose. The odorized air will rush up behind your palate and stimulate your odor receptors; you will suddenly be able to perceive the flavor of the jellybean. If you are a very good observer, you will notice something else; the sweetness of the jellybean will intensify. The enhancement of sweet taste by certain volatiles may lead to a new way to reduce sugars in foods without sacrificing sweetness (L. M. Bartoshuk & Klee, 2013).

The importance of the distinction between orthonasal and retronasal olfaction has been appreciated only in recent years. Rozin (1982) emphasized the functional differences: orthonasal olfaction tells us about the world outside ourselves, while retronasal olfaction tells us about the food we are eating. Small (Small & Jones-Gotman, 2001) used functional imaging to reveal that the two forms of olfaction do not project to identical brain areas. Retronasal olfaction and taste project to some of the same areas; presumably this is where flavor is created in the brain.

Given the functional differences between retronasal and orthonasal olfaction, are there differences in their affective properties? A colleague once noted that he loved the smell of newly cut grass, but he certainly would not want to eat it (D. G. Laing, personal communication). This illustrates our common-sense knowledge that olfaction plays very different roles in the outside world and in our mouths.

Distinction between Primary (Hard-Wired) and Acquired Affect

Carl Pfaffmann (1960), one of the earliest sensory experts to focus on the affective properties of sensations, emphasized an important distinction in "The Pleasures of Sensation." He called the biological or hard-wired affect (e.g., love of sweet and aversion to bitter; hunger, nausea) "primary affect" and distinguished this from the "acquired affect" associated with sensations that are initially neutral and acquire affect by "one method or another." In evaluative conditioning, the nature of the affect (primary or acquired) that serves as the source for the transfer is not a major concern. One of the tasks of the present chapter is to inquire a bit further into Pfaffmann's distinction. Is there something special about primary affect?

Eating: Primary Affect

Positive Olfactory Affect Is Easy to Create or Alter Using Primary Sources of Affect

With regard to food (and so retronasal olfaction) we note that simple exposure can alter olfactory affect (Cain, 1979). In addition, social factors can change the affect of food odors. Galef (1989) demonstrated that rats show preferences for diet items preferred by another rat. Social exposure can even lead a rat to ingest cayenne pepper (a relatively mild but usually rejected concentration). Birch (1980) found that children could acquire preferences for vegetables by exposure to children who liked those vegetables. Pliner and Pelchat (1986) looked at the similarities of likes and dislikes for children with their parents and with their siblings. Although there were similarities between children and parents, the most impressive similarities were between siblings.

We know that odors can become liked by pairing with sweet. The Zellner–Rozin "flavor–flavor" paradigm was first described in 1983 (Zellner, Rozin, Aron, & Kulish, 1983). Pairing sucrose with teas transferred positive affect from sweetness to the teas. Baeyens and his colleagues later found that pairing Tween 20 (a bitter detergent) can transfer that dislike to flavors. Comparison of these effects (Baeyens, Eelen, Van den Bergh, & Crombez, 1990) demonstrates an interesting feature: enhancement of liking appears to be harder to produce than reduction of liking (Rozin & Zellner, 1985). This may reflect a bias toward learning about harmful stimuli (De Houwer & Thomas, 2001).

We note that the terminology "flavor–flavor" conditioning appropriately suggests that both the unconditioned stimulus (US) and the conditioned stimulus (CS) are chemosensory stimuli, but fails to appropriately distinguish between taste and olfaction. This is important because the nature of affect in these two senses is very different. As noted above, evidence suggests that taste affect is primary, but olfactory affect is acquired.

The Zellner–Rozin paradigm has produced practical benefits. Using sweet as a US has been utilized successfully to improve children's liking for vegetables; sweetening vegetable drinks with glucose increased their palatability (Havermans & Jansen, 2007). A similar study used a liked dip (ketchup, ranch dressing, cinnamon yogurt) to increase the palatability of vegetables. In this case, the affect of the US (dip) may have reflected nutritive properties of the dip (primary) as well as retronasally perceived odors (acquired; Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012). What is important here is that the transferred affect remained when the sugar was removed.

Pairing flavors with salt to show an increase in the palatability of the flavors is easiest under sodium need. This could be done in humans (and may have been, although we are unaware of any such work), but creating a sodium need is easy in rats and does not evoke concern from institutional review boards. Fudim (1978) made rats sodium deficient with injections of formalin and showed that flavors paired with sodium became more preferred.

Odors can become liked by pairing with macronutrients (sources of calories). Sclafani and his colleagues have used animal models to show conditioned preferences using carbohydrates, fats, and proteins (e.g., see Ackroff & Sclafani, 1991; Figueroa, Sola-Oriol, Borda, Sclafani, & Perez, 2012). Booth, Lee, and McAleavey (1976) and Birch, McPhee, Steinberg, and Sullivan (1990) demonstrated similar effects in humans. Pleasure from drugs of abuse can also make associated odorants liked (e.g., see Ehrman, Robbins, Childress, & O'Brien, 1992).

Recently, umami has been touted as a fifth basic taste. The origin of this was advertising claims by Ajinomoto (a manufacturer of monosodium glutamate). Glutamate receptors have been said to be the receptors for the umami taste; the biological purpose of these receptors is supposed to be the detection of protein. However, protein molecules are too large to be sensed by taste or olfactory receptors; thus the supposed stimulus for umami is not present in intact protein. We now know that taste receptors are found throughout the gastrointestinal (GI) tract (gut). Digestion of protein breaks it into its constituent amino acids, releasing free glutamate that can stimulate the gut glutamate receptors. Apparently, that sensory input signals the brain that an organism has consumed protein and the brain creates a conditioned preference for the sensory properties (usually the retronasal olfaction) of the food eaten (Ackroff & Sclafani, 2011; Prescott, 2004; Yeomans, Gould, Mobini, & Prescott, 2008). This mechanism has the advantage of leading to preferences for many proteins that do not produce an umami taste.

Similarly, fatty acid receptors in the mouth have been linked to fat taste (Gilbertson, 1998). Just as with proteins, fat molecules are too large to stimulate either taste or olfactory receptors; fatty acids are smaller constituents of fats. Digestion breaks down fats releasing fatty acids, which stimulate fatty acid receptors in the gut. Just as with protein, the signal from the gut leads to conditioned preferences for the sensory properties associated with the food containing the fat (usually the retronasal olfaction). Thus both proteins and fats acquire affect by learning.

Negative Olfactory Affect Is Also Easy to Create or Alter Using Primary Sources of Affect

Just as with olfactory pleasure, simple exposure can alter olfactory displeasure (Cain, 1979). The similarities of food likes and dislikes in siblings suggest that social interactions affect dislikes as well as likes.

An experiment with a single child done by Moss (1924) shows an example of the transfer of negative affect from vinegar to orange flavor. Moss squirted solutions into the child's mouth using a medicine dropper. Orange juice was usually the stimulus with episodes of vinegar interspersed. The child lost his fondness for oranges and "very much preferred apples."

In rats, Fanselow and Birk (1982) showed that neutral flavors (almond and vanilla) paired with quinine came to be avoided. In humans, pairing flavors with quinine is not an attractive study and we know of no demonstrations like that in rats; however, as noted above, Baeyens and his colleagues (1990) showed that Tween 20 (a bitter detergent) paired with flavors rendered them less palatable.

Conditioned aversions have been widely studied in both rats and humans. In the 1950s, Garcia, Kimeldorf, and Koelling (1955) observed an aversion to saccharin paired with radiation and suspected GI illness caused by the radiation as the source of the aversion. Some years later lithium chloride was used to produce GI illness in coyotes that were preying on lambs to render the odor and flavor of the lambs unpleasant to the coyotes (Gustavson, Hankins, & Rusiniak, 1974). However, conditioned aversions actually have a much longer history. As early as the 1930s, clinicians attempting to help alcoholics used conditioned aversions to render the odors and flavors of alcoholic beverages unpleasant (Lemere & Voegtlin, 1940; Voegtlin, 1940).

The role of taste and olfaction in conditioned aversions has been explored by a variety of investigators. Garcia, Lasiter, Bermudez-Rattoni, and Deems (1985) suggested that taste is the sensory cue producing these aversions. They were correct for the rat; however, in humans it is difficult or impossible to create genuine taste aversions. The sensory stimuli evoking the aversion is retronasal olfaction (Bartoshuk & Wolfe, 1990). Thus, "food aversion" is more appropriate than "taste aversion" for human research. The biological purpose of a conditioned aversion is to prevent ingestion of a food previously associated with illness. Therefore, conditioning an aversion to an odor that labels the food makes good sense. Given that the stimuli that play the most salient role in labeling food are the retronasal olfaction sensations, calling these aversions "retronasal olfactory aversions" makes even better sense but is not likely to catch on.

Making odors unpleasant by associating them with nausea is an all-too-common experience among college students experimenting with alcohol for the first time. The primacy of nausea in creating food aversions was established by Pelchat (Pelchat, Grill, Rozin, & Jacobs, 1983). Individuals form conditioned aversions to many foods and beverages under the normal conditions of life (Garb & Stunkard, 1974; Logue, Ophir, & Strauss, 1981; Pelchat & Rozin, 1982; Rozin & Vollmecke, 1986; Rozin, Wrzesniewski, & Byrnes, 1998). In addition, such aversions are formed during nausea-inducing radiation (Smith et al., 1984) and chemotherapy (Bernstein & Webster, 1980) treatments for cancer. Of special interest, Bernstein (1978) gave a novel flavor of ice cream to children just before they were about to receive chemotherapy. The children developed a conditioned aversion to that flavor of ice cream. The control children who were not exposed to the novel ice cream developed aversions to items in their normal diets. The children who received the ice cream were less likely to experience these aversions. The novel ice cream served as a scapegoat; the aversions formed to that novel stimulus and thus protected the diet (Bernstein & Webster, 1980).

Evaluative Conditioning: Transfer of Affect

The omnivore's dilemma focuses on the power of olfaction to help us survive by avoiding poison and taking in food that will contribute to good health. However, olfaction has non-nutritive functions as well, especially for nonhuman species. Olfaction can help an organism avoid predators as well as identify potential mates and resources that mean safety (smell of home, smell of kin). As Rozin (1982) noted, retronasal olfaction deals with olfactory sensations arising from food objects in the mouth. Orthonasal olfaction deals with olfactory sensations arising from objects in the world around us. Thanks to evolution we can expect olfactory affect to show different properties depending on its contributions to our survival and to show different properties across different species.

Evaluative conditioning deals with transfer of affect. That affect can be associated with taste and/or olfaction but evaluative conditioning includes transfer of affect among other stimuli as well. As De Houwer and Thomas (2001) noted, "Evaluative conditioning refers to changes in the liking of a stimulus that are due to the fact that the stimulus has been paired with other, positive or negative stimuli." Early work now seen as the intellectual beginnings of evaluative conditioning dealt with a variety of domains. Razran (1940) asked Queens College students to evaluate sociopolitical slogans either while consuming a free lunch or while smelling unpleasant odors. The slogans evaluated during lunch became more positive, while those evaluated while smelling the unpleasant odors became less positive. Staats and Staats (1958) paired national names (e.g., Swedish, Italian) with valenced words (e.g., positive: "happy," "gift"; negative: "ugly," "failure"). The national names changed valence in the direction of the valenced word with which they were paired. Levey and Martin (1975) showed transfer of affect from liked postcards to neutral postcards.

Evaluative conditioning has been described in several excellent reviews (Capaldi & Powley, 1990; De Houwer & Thomas, 2001; Hermans & Baeyens, 2002; Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; Rozin et al., 1998; Rozin & Zellner, 1985; Zellner, 1991; Zucco, 2012). Zucco's account of olfaction in evaluative conditioning offers an important beginning point for this discussion.

Classification of Evaluative Conditioning Paradigms Involving Olfaction

Primary Affect (Sweet, Salty, Calories, Drug Intoxication, Nausea, Etc.). Experiences like hunger and nausea are innately affective; reducing hunger is a positive experience, nausea is a negative experience. Taste sensations (sweet, salty, sour, bitter) are also innately affective. In the language of evaluative conditioning, pairing one of these innately affective experiences with olfactory sensations can be seen as transferring affect. What we wish to emphasize here is that the source of the affect is primary. The acquired olfactory affect that results is powerful. We suggest that olfactory affect acquired from a primary source may be more powerful than olfactory affect acquired from sources that are themselves acquired.

Transfer of Affect from a Valenced Everyday Experience to an Odor. Rozin and colleagues (1998) attempted to transfer affect from a variety of everyday experiences (valenced pictures, hair washing, seeing a dead cockroach) and had some, but limited success. The most powerful result was reduced liking for odors paired with a dead cockroach. Rozin noted that neutral odors for the studies were hard to find. There are some other successful attempts to pair odors with real-world experiences. For example, children made frustrated by an unsolvable maze found odors scenting the room less pleasant (Epple & Herz, 1999). Baeyens, Wrzesniewski, de Houwer, and Eelen (1996) scented the air in bathrooms. For those individuals who reported using the bathroom for a relaxing break, liking for the odor increased. For those who reported bathroom activities associated with displeasure, the liking for the odor decreased.

In sum, the affect of everyday activities could be transferred to orthonasal olfactory sensations, but the transfer was not very impressive.

Transfer of Affect from an Odor to Neutral Stimuli. On the other hand, Todrank showed that people-related odors (liked and disliked) could transfer affect to pictures of faces. Faces paired with liked odors became more liked; pictures paired with disliked odors became less liked (Todrank, Byrnes, Wrzesniewski, & Rozin, 1995; Wrzesniewski, McCauley, & Rozin, 1999). Two additional studies produced similar results (Hermans, Baeyens, & Eelen, 1998; van Reekum, van den Berg, & Frijda, 1999). These studies show that the acquired affect of olfaction can be transferred to neutral objects. Note that these examples involved orthonasal olfaction.

Transfer of Affect from One Odor to Another. Given the frequency with which we encounter olfactory combinations in foods, there must be many opportunities for olfactory affect to be transferred from a liked or disliked odorant to a neutral odorant. Yet this phenomenon receives little attention in the laboratory. Note that this involves retronasal olfaction.

Consider the transfer of affect from one odor to another with orthonasal olfaction. Again it seems that everyday experiences should include many examples of this, but we know of no laboratory studies with positive affect. However, one study might be an example of the transfer of negative olfactory affect. In the Baeyens et al. (1996) bathroom study noted above, individuals who reported fewer positive experiences were presumably using the bathroom for its primary intended purpose: urination or evacuation. These activities transferred negative affect to the scent in the room. Unfortunately, we do not know what part of the bathroom experience produced the negative affect. GI discomfort or pain would have been a primary affect and reducing the odor affect would thus be expected. However, if the smells of urination or evacuation provided the negative affect, this would have been an example of an acquired olfactory negative affect transferring to the room scent.

Transfer of Affect from Retronasal to Orthonasal Olfaction or Vice Versa. Anecdotes show that transfer of retronasally conditioned affect transfers to orthonasal olfaction. For example, one of us (Bartoshuk) developed an aversion to maraschino cherries from eating a box of chocolate-covered cherries while reading comic books (and getting carsick) in the back seat of the family car during a vacation trip. The characteristic volatile flavoring the cherries was benzaldehyde. The same volatile is used to scent hand soap. Bartoshuk now assiduously avoid such hand soaps, as well as benzaldehyde in anything (e.g., marzipan pastries). On the positive side, one can imagine experiencing a new flavor in a food containing calories and later experiencing pleasure when smelling that food.

It is harder to think of anecdotes showing transfer from orthonasal olfaction to retronasal olfaction. One can imagine orthonasal odors that become liked but that liking would not be likely to transfer to ingesting that volatile and thus perceiving it retronasally.

Can We Come to Any Conclusions about the Power of the Transfer of Affect Involving Olfaction? We suspect that it is too early to draw many definitive conclusions, but offer some thoughts. As suggested above, the acquisition of olfactory affect in the context of food is very powerful. A novel olfactory sensation (perceived retronasally) paired once with nausea can condition a lifelong aversion. Conditioning preference tends to take more pairings, but the positive affect resulting is very powerful as well. Simply thinking about one's favorite foods provides ample evidence of this. These examples involve retronasal olfaction. On the other hand, the difficulties encountered in many experiments attempting to transfer olfactory affect to a variety of neutral items or to transfer affect from some nonolfactory stimulus to a neutral olfactory stimulus suggest weaker effects. Needless to say, the use of the terms "powerful" and "weak" are poorly defined. We are left with the thought that one approach might be to measure the intensity of the olfactory affect involved in these various studies. We consider this quantification of affect in the section "How Do We Measure Affect?"

Is There Any Evidence for Innate Olfactory Affect?

We are concentrating on learned or acquired olfactory affect in this chapter, but the question about innate olfactory affect is still open. Early work argued against innate olfactory affect in humans. Engen and Lipsitt (cited in Engen, 1982; Engen & Engen, 1997) performed an experiment with 1- and 2-year-old children that suggested that children can perceive but are indifferent to odors. The children (with their mothers nearby) were seated in front of a table with a screen showing a colorful tree; several toys were placed in front of the screen. Once the child appeared to be engaged with the toys, odorants were presented with atomizers through small holes in the screen. Graduate students in psychology served as observers; they were in another room behind a one-way mirror and so could not smell the odorants. The child's reaction to the odorant was rated as "pleasant, neutral, or unpleasant." Two of the stimuli used are considered to be pleasant to adults: amyl acetate (banana) and lavender. The other two stimuli are considered to be unpleasant to adults: dimethyl disulfide (rotten cabbage) and butyric acid (vomit). The odorants had been matched for perceived intensity by adults. The odorants were detected (often the child stopped playing with the toys briefly and looked vigilant), but the most common rating of the child's affect was "neutral." A variety of studies show that as children age, their hedonic responses to olfactory stimuli come to resemble those of adults (see Engen & Engen, 1997, for a review).

Do such studies prove there is no innate orthonasal olfactory affect? The answer must be no. The difficulty of doing research with young children limits the number of odorants that can be tested. The possibility remains that some odorants do evoke innate affect.

Although species other than humans can learn the significance of olfactory cues, nature also uses hard-wired solutions for these species. For example, innate olfactory preferences have been claimed for drosophila (Semmelhack & Wang, 2009). Herz notes that for species "restricted to specific habitats" (specialists), hard-wired responses to certain odorants are biologically wise (Herz, Beland, & Hellerstein, 2004). Mice appear to show innate aversions to certain odors associated with predators. Mutant mice in which specific olfactory glomeruli were absent failed to show those aversions, even though they could detect the odors and learn to avoid them (Kobayakawa et al., 2007). Innate olfactory aversions have also been claimed for the rat (Johnson et al., 2012), zebrafish (Hussain et al., 2013) and drosophila (Semmelhack & Wang, 2009). In particular, physiological evidence has identified specific receptors (trace amine-associated receptors [TAARS]) that appear to "constitute a distinct olfactory subsystem" that detects "mostly aversive odors" (Johnson et al., 2012). In zebrafish, one of those receptors (TAAR13c) has been associated with the "death-associated" odor cadaverine (Hussain et al., 2013).

Humans have TAARs, but the evidence in humans for any innate olfactory aversion is not impressive. For one thing, any argument for innate olfactory aversion in humans must include a control for pain/irritation. Many odor volatiles we consider aversive are also irritants; that is, they stimulate the trigeminal system (Herz, 2006). The aversion to irritation is hard-wired. Thus, to claim that an odorant produces hard-wired aversion, one must show it does not evoke irritation. This is relatively easy to do since the presence of an irritant in a volatile can be detected. Irritation can be localized to the nostril stimulated; pure olfactory input cannot be so localized (Schneider & Schmidt, 1967).

Some authors have noted that innate olfactory affect may be harnessed in different ways by different species. For example, Hussain and colleagues (2013) noted that while cadaverine, putrescine, and other biogenic diamines produce avoidance in zebrafish, these same odorants can act as attractants for species that feed on carcasses.

Does the importance of innate aversions in some nonhuman species suggest that there are innate olfactory aversions in humans as well? The senior author, Sakano, of the mouse article described above (Kobayakawa et al., 2007) was interviewed about the research (Callaway, 2007). The interview notes, "Humans probably have a similar system for discerning smells, but learned behaviours can sometimes over-rule innate ones." However, generalists (like humans) can live in a variety of habitats; the ability to adapt as needed is biologically wise in this group, which supports the value of learning (Herz et al., 2004). Evidence to date does not support innate olfactory aversions in humans.

If There Were Innate Olfactory Affect in Humans, How Would We Find It?

In 350 B.C.E., Aristotle wrote about olfaction in his treatise *On Sense and the Sensible* (Beare, 1906). He described two classes of odors, the first group associated with foods. Aristotle notes that these are

> agreeable as long as animals have an appetite for the food, but they are not agreeable to them when sated and no longer in want of it. The other class of odours consists of those agreeable in their essential nature, e.g., those of flowers. . . . Of this species of odour man alone is sensible.

Are there likely to be innately positive odors in humans? Goff and Klee (2006) made an interesting argument for the biological utility of hard-wiring affect for some odorants. There are important nutrients that serve chemically as the source of volatiles emitted by fruits and vegetables. If such volatiles were innately pleasant, this would increase consumption of those fruits and vegetables. Interestingly, the sensations evoked by those volatiles tend to be floral. Was Aristotle right? Could our love of the smells of flowers reflect hard-wired love of volatiles signaling the presence of nutrients? If so, is there any way to prove this?

Transfer of Olfactory Affect Along Chains?

We can think of evaluative olfactory affect chains. For example, consider a newborn's first nursing experience. The odors of mother's milk (as well as the odors associated with mother herself) are paired with sweet (in Pfaffmann's [1960] terminology, a primary affect). Suppose that our newborn's mother wears a distinctive lily-of-the-valley perfume. That scent becomes liked. Now imagine our newborn, growing up and going to school where her kindergarten teacher wears the same perfume and introduces her to play dough. Play dough's distinctive odor becomes liked and later transmits its affect to the lilac smell of the bouquet placed in her playroom at home.

Once we begin to think of olfactory affect chains, additional questions arise. Is there a difference between the first link in a chain (created by primary affect) and additional links (created by acquired affect)? To the best of our knowledge, this is not a question that arises in the literature on evaluative conditioning. If such a difference were to be identified, could this provide a way to identify any volatiles that produce hard-wired olfactory affect and thus behave as primary sources of affect?

Another question raised by the chain metaphor relates to the Cabanac effect. Consuming sugar can reduce liking for sweet; injecting insulin can enhance liking for sweet. In one study, Cabanac (1971) showed that liking for orange odor declined after consumption of sugar. It is likely that the liking for orange odor results in most people because orange odor and sweet have been paired in their lives. Could it be that the affect for orange odor has retained some of the properties of the affect for sweet? Would liking for roast beef (presumably acquired from fat ingestion) show a decline after consumption of sugar? This has never been tested to the best of our knowledge.

Why Does Pleasure Sometimes Lead Us Astray?

In spite of the elegance of nature's solutions to the omnivore's dilemma, a number of nutritional disorders (e.g., obesity) testify to her failure to endow us with perfect food wisdom. Part of the problem is that nature uses pleasure to help us survive when we are very young, but that same pleasure begins to be maladaptive when we age. Consider the pleasure associated with macronutrients. Fats are critical sources of calories when we are growing. However, the learning mechanism that ensures we will love the odors and flavors of foods containing energy-rich fats when we are young continues through our lifespan. Once we are past producing young, evolution cares little about our fates. The positive affect we have accumulated toward the odors and flavors of high-fat foods ultimately contributes to obesity, metabolic syndrome, and so forth. The many books written on the subject of weight loss illustrate the difficulty of countering this love of high-fat foods. If any of these books worked, there would be little need for the rest.

How Do We Measure Affect?

Galileo (1564–1642) is supposed to have said, "Measure what is measurable and make measureable what is not so." Debates on what can be measured with regard to human sensory experience have raged for years. In 1932, the British Association for the Advancement of Science appointed a committee chaired by Allan Ferguson, a physicist, to debate "Quantitative Estimates of Sensory Events." The committee published its final report in 1940 (Ferguson et al., 1940). Perhaps, given the number of physicists on the committee, it is not surprising that the measurement of subjective sensory experiences aroused considerable skepticism (Michell, 1999). S. S. Stevens (1946) became involved with the debate because the committee chose his sone scale (loudness) for discussion. This motivated Stevens to publish his famous paper "On the Theory of Scales of Measurement," in *Science* in which he classified scales as nominal, ordinal, interval, and ratio. Fortunately for psychology, Stevens's views prevailed and measures of perceived intensity of sensations are now respectable.

The measurement issue to be discussed here concerns comparisons of sensations. It is not enough to know we are experiencing pleasure or pain; we want to know how our experiences compare to those of others. How can we do this? There are those among us who claim that they can: mind readers, psychics, and some psychophysicists who misuse scales. The sections that follow discuss that misuse.

Early Attempts to Compare Affective Experiences: Visual Analogue and Category Scales

Attempts to quantify experience go back many years. The oldest scales appear to be category scales. For example, the Greek astronomer Hipparchus (190–120 B.C.E.) devised a 6-point scale to quantify the brightness of stars. More recent examples: food scientists created a 9-point scale that can be used for sensory (e.g., sweetness) or hedonic (e.g., dislike–like sweetness) intensity, and clinicians created a 10-point scale for pain intensity. In 1932, Likert constructed a 6-point category scale for the measurement of attitudes. Interestingly, the Likert-scale type was so widely used that some erroneously now use "Likert" as a synonym for "category" scale.

In the 1960s, the category scale morphed into the visual analogue scale (VAS). Early examples were devised to measure hunger. For example, Spence and Ehrenberg (1964) asked subjects to rate their hunger on a line labeled "not hungry at all" at one end and "very hungry" at the other end, while Silverstone and Stunkard (1968) used the labels "not at all hungry" and "as hungry as you have ever felt." However, the formal introduction of the VAS appeared in the "Section of Measurement in Medicine," a special portion of the prestigious British journal *Proceedings of the Royal Society of Medicine*. This section was introduced to the journal in 1965 with an inaugural essay (Cohen, 1965) noting, "It is not surprising that this Section should enter so late into the Society's activities, for mensuration appears late in the advance of medical knowledge." Of special interest to those in the behavioral sciences, this essay discussed measurement only as seen by the physical sciences. However, 4 years later, Aitken (1969) published his "Measurement of Feelings Using Visual Analogue Scales" in this section (Zealley & Aitken, 1969). He noted,

> An understanding of many problems in clinical research presupposes that it is possible to communicate the desired information from patient to clinician in a way amenable to measurement. . . . For the measurement of feelings, communication based on a simple visual analogue seems appropriate.

Of special interest here, Aitken went on to note a profoundly important limitation: "The same word used by different people need not convey that they experience the same feeling, neither does comparable positioning of marks on lines." In spite of that clear warning, others went on to use the VAS as if values on such a scale could be directly compared across individuals or groups. Later in this chapter, we present two examples of this misuse: one from taste and one from pain.

Measurement Theory

Sensory Scales

VAS and category scales are essentially atheoretical. There are many of these and they have been devised to measure single attributes (e.g., sweetness, pain intensity). The VAS was considered by many to be an advance over a category scale because the VAS has ratio properties (Price, McGrath, Rafii, & Buckingham, 1983)—that is, distance on the VAS is like distance on a ruler. A designation at 4 inches denotes a perceived intensity double that of a designation at 2 inches. This is not true of designations on a category scale; these are ordinal only (Stevens, 1946).

On the other hand, measurement theory evolved over much the same time frame as these practical scales. The earliest of the measurement theorists who is still well known to us is Gustav Fechner. He formalized three methods of threshold measurement that still remain today. He focused on two kinds of thresholds: absolute and relative. The absolute threshold was the lowest magnitude of stimulus that a person could experience; the relative threshold was the amount that a stimulus had to be increased to produce a just-noticeable difference (JND). He created a scale of perceived intensity from these two measures in the following way. Beginning at the absolute threshold, intensity is reflected by the number of JNDs up to the stimulus of interest.

The reign of this theorist ended with the work of S. S. Stevens in the 1960s. Stevens pointed out a fatal flaw in the JND scale: it lacked ratio properties. For example, if we were to measure loudness with a JND scale, a loudness of eight JNDs would be louder than twice the loudness of four JNDs. It is as if the subjective size of the JND is growing with stimulus intensity. Stevens tackled this problem head on. He devised methods with the intention of providing ratings with ratio properties. For example, the most popular of the new direct methods introduced by Stevens was magnitude estimation. In brief, if we want to measure sweetness with magnitude estimation, we might ask a subject to assign a number to the sweetness of a given sucrose solution. Then, when we provided a different concentration of sucrose, the instructions to the subject would be to assign a number to the second solution that reflects its relation to the first. If it were twice as sweet, it should be assigned a number twice as large, and so forth. Assuming that subjects can do this, the resulting ratings will have ratio properties. Duncan Luce provided the theoretical underpinning for this critical assumption (Luce, Steingrimsson, & Narens, 2010).

Hedonic Scales

Although opinions vary on this point, many psychophysicists (the authors included) believe that the perceived intensities of hedonic experiences can be rated on scales similar to those used for conventional sensory experiences (brightness, loudness, etc.), but with valence added. Thus we can use a sensory scale to measure sweetness and a hedonic scale to measure liking–disliking of sweetness.

Development of Methods for Valid Comparisons

Earliest Usage of Scales Focused on Comparing Stimuli

The commercial impact of food preferences has motivated a great deal of hedonic scaling: Is coffee A liked better than coffee B? This is a legitimate comparison since each subject can taste each of the samples to be compared; this is a within-subject comparison that can be made with virtually any scale.

However, we now know that there are important differences across individuals in the intensities of our experiences. In order to measure these, some investigators began to use the methods devised to compare samples. But this usage makes an implicit assumption: the labels on the scales denote the same perceived intensities to all subjects. This was recognized as an error by a variety of experts.

As noted above, one of those experts was R. C. B. Aitken (1969), who sought to measure depression in patients in the Royal Edinburgh Hospital. He and a colleague asked patients to mark a horizontal 100 millimeter line labeled "normal" at one end and "most depressed" at the other end (Zealley & Aitken, 1969). Aitken's realization that the VAS could not be used to compare individuals (or groups) was very important but was essentially ignored by his colleagues. Additional experts who provided such warnings (e.g., see Biernat & Manis, 1994; Birnbaum, 1999; Narens & Luce, 1983) are reviewed in Bartoshuk et al. (2002).

Comparisons of pain across individuals and groups provide an example of one of the most widespread errors. The most common pain scales are the 10-point scale and its VAS analogue. The bottom of the scale is 0 or no pain. The top of the scale is some indication of an individual's maximum pain,(i.e., the most intense pain ever experienced [or imagined]). Consider attempts to compare pain in women and men. If there were a systematic difference in the most intense pain for women and men, the scale could not provide valid comparisons between women and men. That such a difference does exist can be demonstrated (Bartoshuk, Duffy, Chapo, et al., 2004). We asked subjects to rate the perceived intensity of a variety of everyday experiences including these two: the most intense pain ever experienced (naming the pain) and the brightest light ever seen. Among the women who chose childbirth as their worst pain, their worst pain was about 20% more intense than their brightest light. On the other hand, among the men, their worst pain was about equal to their brightest light. If we can assume that these women and men show no systematic difference in their perception of brightness, we have demonstrated that for these women, childbirth pain was about 20% more intense than the most intense pain those men experienced. The problem becomes even more complex. Pain is so variable that no investigator can know if the particular women and men in a given study show the same difference we saw; the difference could be worse, less, or not present at all. Only valid comparisons can provide this information. We noted above that some investigators ask subjects to consider the top of the pain scale to denote the most intense imaginable pain (e.g., see Price et al., 1983). This seems to suggest that some investigators believe that even though actual pains experienced can vary enormously across subjects, we all can imagine the same "worst pain." Unfortunately, without mind readers and psychics we cannot prove this. However, simply asking subjects about their worst imaginable pain is illuminating. One creative subject told us that being sucked into a black hole would qualify, but others simply tell us that the most intense pain they can imagine is the most intense pain they have ever experienced (Bartoshuk, 2014). This does not suggest that "imaginable pain" is the same for all.

A Solution to This Dilemma Evolved from Taste Studies

In 1932, Arthur L. Fox, a chemist working at Dupont, synthesized some PTC (phenylthiocarbamide). Some was spilled accidentally and a colleague visiting at the time commented on how bitter the crystals were. Fox did not perceive them as bitter. This led to a demonstration at the annual meeting of the American Association for the Advancement of Science (AAAS); about three-quarters of the 2,000 attendees who took part could taste the crystals (tasters) while the remaining quarter could not (nontasters; Blakeslee & Fox, 1932). A family study seemed to suggest that nontasting was a Mendelian recessive: two nontaster parents always produced nontaster children, whereas if one or both parents were tasters, a child could be a taster (Snyder, 1931). This was the first demonstrated genetic taste difference. The early studies used thresholds to sort subjects into nontasters (high thresholds) and tasters (low thresholds). Even this relatively primitive psychophysics led the way to an amazing number of studies from demonstrating that the Dionne quintuplets were all tasters (Ford & Mason, 1941) to studies relating taster/nontaster status to food preferences and health risks (Fischer, Griffin, & Rockey, 1966).

The next important development was the discovery by J. C. Stevens (1959) that humans are very good at matching stimuli of different qualities for intensity using magnitude estimation. Note that although many have used magnitude estimation to scale the perceived intensities of single attributes (e.g., for sweetness) magnitude estimation can be used to rate sensations of many different qualities on a common scale.

Once we move beyond single-attribute scales, a solution emerges. Consider a demonstration of the error and a possible solution in taste. Suppose we recruit two groups: one with a high density of fungiform papillae (the structures that house taste buds on the anterior tongue) and one with a low density. We ask all subjects to rate the sweetness of a cola from "no sweetness" to "the sweetest sensation I have ever experienced." The two groups will behave in a similar manner—that is, both groups will rate the sweetness to be about two-thirds of the distance from no sweetness to sweetest ever experienced. Now put earphones on each subject and ask them to adjust the loudness of a tone to match the sweetness of the cola. Those with the most fungiform papillae will set the loudness to about 90 decibels; those with the fewest will set the loudness to about 80 decibels. We know a great deal about loudness. For example, each increase of 10 decibels is equivalent to doubling the loudness. Thus, the subjects with the most fungiform papillae matched the sweetness they perceived to twice the loudness. We can infer that these subjects experienced twice the sweetness from the cola.

The first experiment is an example of using a single attribute scale (sweetness) to compare two different groups of people. The second experiment uses a technique formalized as "magnitude matching" that asks subjects to rate a sensation of interest, sweetness, relative to an unrelated sensation, loudness (see Bartoshuk, 1979; Bartoshuk, Duffy, Green, et al., 2004; Hall, Bartoshuk, Cain, & Stevens, 1975; Marks, Borg, & Westerlund, 1992). Once we do this, we see that those with the most fungiform papillae are actually experiencing twice the sweetness of the cola. The first experiment implicitly assumed that "the sweetest sensation ever experienced" is the same for all. That is not true. It turns out that the more fungiform papillae you have, the more intense taste is. Thus, those with the most fungiform papillae have a greater capacity to experience sweetness. For them, the cola is twice as sweet. Incidentally, those subjects who experience the most intense tastes are called "supertasters."

Note that the discussions both for pain and taste show that the solution to the problem posed by comparisons across groups is to use a "standard" unrelated to the sensation to be compared. That the standard (e.g., the 90-decibel sound in the taste example, brightness of the sun in the pain example) is not related to the sensation to be compared (taste and pain, respectively) is an assumption. Thus, even though magnitude matching avoids the errors of making comparisons with single-attribute category or VASs, magnitude matching only provides valid comparisons when the standard chosen is genuinely independent of the stimuli to be compared. However, we can reduce the possibility of bad standard choices by using multiple standards.

What Kinds of Errors Result from Invalid Comparisons?

For taste and pain, we have discussed the kinds of errors that result from erroneously assuming that scale intensity descriptors denote the same absolute perceived intensities to all (Bartoshuk et al., 2002; Dionne, Bartoshuk, Mogel, & Witter, 2005). The most common error is to fail to reveal differences that are real. However, in a few cases, a reversal artifact occurs—that is, an apparent difference between two groups can actually be in the wrong direction (Bartoshuk, Duffy, Chapo, et al., 2004; Dionne et al., 2005; Snyder, Prescott, & Bartoshuk, 2006).

Conclusions

Innate taste affect and acquired olfactory affect contribute to survival in humans and other species. There is still much to be learned about the acquisition of olfactory affect.

Evaluative conditioning has taught us about the transfer of affect among olfactory stimuli as well as between olfaction and other everyday experiences. We suggest that adding the distinction between retronasal and orthonasal olfaction may provide some clarification. These two olfactory functions serve very different purposes and have quite different contributions to make to our survival. All species require food and so there may be considerable overlap across species in how we use retronasal olfaction to avoid poisons and find healthy food. However, lower species seem to depend on orthonasal olfaction for safety in their environments much more than humans do. This need for safety may have provided the evolutionary pressure to create hard-wired olfactory affect to guide these species to safety. Does hard-wired olfactory affect exist to some extent in humans even though we have so many other ways to find safe environments? Some investigators seem to favor this possibility, but no evidence supports this at present.

Evaluative conditioning focuses on the transfer of affect. Some olfactory generalizations are possible. In the food world, transfer of affect from primary sources to olfactory stimuli is common and powerful. Transfer of affect involving nonfood experiences is less impressive. Will evaluative conditioning involving olfaction give us new insights about evaluative conditioning in general?

Our growing sophistication in psychophysical measurement is giving us new tools to quantify affective differences among us. With valid comparisons, we can now look at variables of great interest to us (affective differences across sex, age, health status, etc.) as well as differences across cultures, ethnicities, and so forth. The insights to be gained from valid affective comparisons are likely to have benefits we can hardly imagine now.

References

Ackroff, K., & Sclafani, A. (1991). Flavor preferences conditioned by sugars: Rats learn to prefer glucose over fructose. *Physiology and Behavior, 50*, 815–824.

Ackroff, K., & Sclafani, A. (2011). Flavor preferences conditioned by post-oral infusion of monosodium glutamate in rats. *Physiology and Behavior, 104*, 488–494.

Aitken, R. C. B. (1969). Measurement of feelings using visual analogue scales. *Proceedings of the Royal Society of Medicine, 62*, 989–993.

Anzman-Frasca, S., Savage, J. S., Marini, M. E., Fisher, J. O., & Birch, L. L. (2012). Repeated exposure and associative conditioning promote preschool children's liking of vegetables. *Appetite, 58*, 543–553.

Baeyens, F., Eelen, P., Van den Bergh, O., & Crombez, G. (1990). Flavor–flavor and color–flavor conditioning in humans. *Learning and Motivation, 21*, 434–455.

Baeyens, F., Wrzesniewski, A., de Houwer, J., & Eelen, P. (1996). Toilet rooms, body massages, and smells: Two field studies on human evaluative odor conditioning. *Current Psychology, 15*(11), 77–96.

Bare, J. (1949). The specific hunger for sodium chloride in normal and adrenalectomized white rats. *Journal of Comparative and Physiological Psychology, 42*, 242–253.

Barretto, R. P. J., Gillis-Smith, S., Chandrashekar, J., Yarmolinsky, D. A., Schnitzer, M. J., Ryba, N. J. P., et al. (2014). The neural representation of taste quality at the periphery. *Nature, 517*(7534), 373–376.

Bartoshuk, L. (2014). The measurement of pleasure and pain. *Perspectives on Psychological Science, 9*(1), 91–93.

Bartoshuk, L. M. (1979). Bitter taste of saccharin: Related to the genetic ability to taste the bitter substance 6-n-propylthiouracil (PROP). *Science, 205*, 934–935.

Bartoshuk, L. M., Duffy, V. B., Chapo, A. K., Fast, K., Yiee, J. H., Hoffman, H. J., et al. (2004). From psychophysics to the clinic: Missteps and advances. *Food Quality and Preference, 15*, 617–632.

Bartoshuk, L. M., Duffy, V. B., Fast, K., Green, B. G., Prutkin, J. M., & Snyder, D. J. (2002). Labeled scales (e.g., category, Likert, VAS) and invalid across-group comparisons: What we have learned from genetic variation in taste. *Food Quality and Preference, 14*, 125–138.

Bartoshuk, L. M., Duffy, V. B., Green, B. G., Hoffman, H. J., Ko, C.-W., Lucchina, L. A., et al. (2004). Valid across-group comparisons with labeled scales: The gLMS vs. magnitude matching. *Physiology and Behavior, 82*, 109–114.

Bartoshuk, L. M., & Klee, H. J. (2013). Better fruits and vegetables through sensory analysis. *Current Biology, 23*, R374–R378.

Bartoshuk, L. M., & Wolfe, J. M. (1990). Conditioned taste aversions in humans: Are they olfactory aversions? [Abstract]. *Chemical Senses, 15*, 551.

Beare, J. I. (1906). *Greek theories of elementary cognition from Alemaeon to Aristotle*. Oxford, UK: Clarendon Press.

Bentham, J. (1789). *An introduction to the principles of morals and legislation*. Oxford, UK: Clarendon Press.

Bernstein, I. L. (1978). Learned taste aversions in children receiving chemotherapy. *Science, 200*, 1302–1303.

Bernstein, I. L., & Webster, M. M. (1980). Learned taste aversions in humans. *Physiology and Behavior, 25*(3), 363–366.

Biernat, M., & Manis, M. (1994). Shifting standards and stereotype-based judgements. *Journal of Personality and Social Psychology*, 66, 5–20.

Birch, L. (1980). Effects of peer models' food choices and eating behaviors on preschoolers' food preferences. *Child Development, 51*, 489–496.

Birch, L. L., McPhee, L., Steinberg, L., & Sullivan, S. (1990). Conditioned flavor preferences in young children. *Physiology and Behavior, 47*, 501–505.

Birnbaum, M. H. (1999). How to show that 9 > 221: Collect judgements in a between-subjects design. *Psychological Methods, 4*, 243–249.

Blakeslee, A. F., & Fox, A. L. (1932). Our different taste worlds. *Journal of Heredity, 23*, 97–107.

Booth, D. A., Lee, M., & McAleavey, C. (1976). Acquired sensory control of satiation in man. *British Journal of Psychology, 67*(2), 137–147.

Cabanac, M. (1971). Physiological role of pleasure. *Science, 173*, 1103–1107.

Cabanac, M., Minaire, Y., & Adair, E. R. (1968). Influence of internal factors on the pleasantness of a gustative sweet sensation. *Communications in Behavioral Biology, Part A, 1*(1), 77–82.

Cain, W. S. (1979). Lability of odor pleasantness. In J. H. A. Kroeze (Ed.), *Preference behaviour and chemoreception* (pp. 303–315). London: IRL Press.

Callaway, E. (2007). Fear no smell. *Nature* News. Retrieved from *www.nature.com/news/2007/071107/full/news.2007.224.html*.

Cannon, W. B. (1939). *The wisdom of the body*. New York: Norton.

Capaldi, E. D., & Powley, T. L. (1990). *Taste, experience, and feeding.* Washington, DC: American Psychological Association.

Chen, X., Gabitto, M., Peng, Y., Ryba, N. J. P., & Zuker, C. S. (2011). A gustotopic map of taste qualities in the mammalian brain. *Science, 333*, 1262–1266.

Cohen, H. (1965). Opening address of the innaugural meeting. *Proceedings of the Royal Society of Medicine, 58*, 659–663.

Davis, C. M. (1939). Results of the self-selection of diets by young children. *Canadian Medical Association Journal, 41*, 257–261.

De Houwer, J., & Thomas, S. (2001). Associative learning of likes and dislikes: A review of 25 years of research on human evaluative conditioning. *Psychological Bulletin, 127*(6), 853–869.

De Snoo, K. (1937). Das trinkende Kind im Uterus. *Monatschrift für Geburtshilfe und Gynäkologie, 105*, 88–97.

DeSimone, J. A., & Lyall, V. (2006). Taste receptors in the gastrointestinal tract III. Salty and sour taste: Sensing of sodium and protons by the tongue. *American Journal of Physiology Gastrointestinal and Liver Physiology, 291*, G1005–G1010.

Dionne, R. A., Bartoshuk, L. M., Mogel, J., & Witter, J. (2005). Individual responder analyses for pain: Does one pain scale fit all? *Trends in Pharmacological Sciences, 26*, 125–130.

Ehrman, R. N., Robbins, S. J., Childress, A. R., & O'Brien, C. P. (1992). Conditioned responses to cocaine-related stimuli in cocaine abuse patients. *Psychopharmacology, 107*, 523–529.

Engen, T. (1982). *The perception of odors*. New York: Academic Press.

Engen, T., & Engen, E. A. (1997). Relationship between development of odor perception and language. *Enfance, 1*, 125–140.

Epple, G., & Herz, R. S. (1999). Ambient odors associated to failure influence cognitive perfomance in children. *Developmental Psychobiology, 35*, 103–107.

Fanselow, M. S., & Birk, J. (1982). Flavor–flavor associations induce hedonic shifts in taste preference. *Animal Learning and Behavior, 10*(2), 223–228.

Ferguson, A., Myers, C. S., Bartlett, R. J., Banister, H., Bartlett, F. C., Brown, W., et al. (1940). Quantitative estimates of sensory events: Final report of the committee appointed to consider and report upon the possibility of quantitative estimates of sensory events. *Advancement of Science, 1*, 331–349.

Figueroa, J., Sola-Oriol, D., Borda, E., Sclafani, A., & Perez, J. F. (2012). Flavour preferences conditioned by protein solutions in post-weaning pigs. *Physiology and Behavior, 107*, 309–316.

Finberg, L., Kiley, J., & Luttrell, C. N. (1963). Mass accidental salt poisoning in infancy. *Journal of the American Medical Association, 184*(3), 187–190.

Fischer, R., Griffin, F., & Rockey, M. A. (1966). Gustatory chemoreception in man: Multidisciplinary aspects and perspectives. *Perspectives in Biology and Medicine, 9*(4), 549–577.

Ford, N., & Mason, A. D. (1941). Taste reactions of the Dionne quintuplets. *Journal of Heredity, 10*, 365–368.

Fudim, O. K. (1978). Sensory preconditioning of flavors with a formalin-produced sodium need. *Journal of Experimental Psychology, 4*(3), 276–285.

Galef, B. G. (1989). Enduring social enhancement of rats' preferences for the palatable and the piquant. *Appetite, 13*, 81–92.

Ganchrow, J. R., Oppenheimer, M., & Steiner, J. E. (1979). Behavioral displays to gustatory stimuli in newborn rabbit pups. *Chemical Senses and Flavor, 4*, 49–61.

Garb, J. L., & Stunkard, A. J. (1974). Taste aversions in man. *American Journal of Psychiatry, 131*, 1204–1207.

Garcia, J., Kimeldorf, D. J., & Koelling, R. A. (1955). Conditioned aversion to saccharin resulting from exposure to gamma radiation. *Science, 122*, 157–158.

Garcia, J., Lasiter, P. S., Bermudez-Rattoni, F., & Deems, D. A. (1985). A general theory of aversion learning. *Annals of the New York Academy of Sciences, 443*, 8–21.

Gilbertson, T. A. (1998). Gustatory mechanisms for the detection of fat. *Current Opinion in Neurobiology, 8*, 447–452.

Goff, S. A., & Klee, H. J. (2006). Plant volatile compounds: Sensory cues for health and nutritional value? *Science, 311*, 815–819.

Gustavson, C. R., Hankins, W. G., & Rusiniak, K. W. (1974). Coyote predation control by aversive conditioning. *Science, 184*, 581–583.

Hall, M. J., Bartoshuk, L. M., Cain, W. S., & Stevens, J. C. (1975). PTC taste blindness and the taste of caffeine. *Nature, 253*, 442–443.

Halmi, K. A. (1995). Joseph Wortis, MD October 2, 1906 to February 22, 1995. *Archives of General Psychiatry, 52*(12), 1077–1078.

Havermans, R. C., & Jansen, A. (2007). Increasing children's liking of vegetables through flavour–flavour learning. *Appetite, 48*, 259–262.

Hermans, D., & Baeyens, F. (2002). Acquisition and activation of odor hedonics in everday situations: Conditioning and priming studies. In C. Rouby, B. Schaal, D. DuBois, R. Gervais, & A. Holley (Eds.), *Olfaction, taste and cognition* (pp. 119–139). Cambridge, UK: Cambridge University Press.

Hermans, D., Baeyens, F., & Eelen, P. (1998). Odours as affective-processing context for word evaluation: A case of cross-modal affective priming. *Cognition and Emotion, 12*(4), 601–613.

Herz, R. S. (2006). I know what I like: Understanding odor preferences. In J. Drobnick (Ed.), *The smell culture reader* (pp. 190–203). New York: Oxford University Press.

Herz, R. S., Beland, S. L., & Hellerstein, M. (2004). Changing odor hedonic perception through emotional associations in humans. *International Journal of Comparative Psychology, 17*, 315–338.

Hofmann, W., De Houwer, J., Perugini, M., Baeyens, F., & Crombez, G. (2010). Evaluative conditioning in humans: A meta-analysis. *Psychological Bulletin, 136*, 390–421.

Hussain, A., Saraiva, L. R., Ferrero, D. M., Ahuja, G., Krishna, V. S., Liberles, S. D., et al. (2013). High-affinity olfactory receptor for the death-associated odor cadaverine. *Proceedings of the National Academy of Sciences, 110*(48), 19579–19584.

Jacobs, H. L., Smutz, E. R., & DuBose, C. N. (1977). Comparative observations on the ontogeny of taste preference. In J. M. Weiffenbach (Ed.), *Taste and development: The genesis of sweet preference* (pp. 99–107). Bethesda: U.S. Department of Health, Education and Welfare.

Jankunis, E. S., & Whishaw, I. Q. (2013). Sucrose bobs and quinine gapes: Horse (Equus caballus) responses to taste support phylogenetic similarlity in taste reactivity. *Behavioral Brain Research, 256*, 284–290.

Johnson, M. A., Tsai, L., Roy, D. S., Valenzuela, D. H., Mosley, C., Magklara, A., et al. (2012). Neurons expressing trace amine-associated receptors project to discrete glomeruli and constitute an olfactory subsystem. *Proceedings of the National Academy of Sciences, 109*(33), 13410–13415.

Kobayakawa, K., Kobayakawa, R., Matsumoto, H., Oka, Y., Imai, T., Ikawa, M., et al. (2007). Innate versus learned odour processing in the mouse olfactory bulb. *Nature, 450*(22), 503–510.

Krieckhaus, E. E. (1970). "Innate recognition" aids rats in sodium regulation. *Journal of Comparative and Physiological Psychology, 73*, 117–122.

Lemere, F., & Voegtlin, W. L. (1940). Conditioned reflex therapy of alcoholic addiction: Specificity of conditioning against chronic alcoholism. *California and Western Medicine, 53*, 268–269.

Levey, A. B., & Martin, I. (1975). Classical conditioning of human "evaluative" responses. *Behaviour Research and Therapy, 4*, 221–226.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology, 140*, 5–55.

Logue, A. W., Ophir, I., & Strauss, K. E. (1981). The acquisition of taste aversions in humans. *Behavior Research and Therapy, 19*, 319–333.

Luce, R. D., Steingrimsson, R., & Narens, L. (2010). Are psychophysical scales of intensities the same or different when stimuli vary on other dimensions?: Theory with experiments varying loudness and pitch. *Psychological Review, 117*(4), 1247–1258.

Marks, L. E., Borg, G., & Westerlund, J. (1992). Differences in taste perception assessed by magnitude matching and by category-ratio scaling. *Chemical Senses, 17*, 493–506.

Mayer-Gross, W., & Walker, J. W. (1946). Taste and selection of food in hypoglycaemia. *British Journal of Experimental Pathology, 27*, 297–305.

Meyerhof, W., Batram, C., Kuhn, C., Brockhoff, A., Chudoba, E., Bufe, B., et al. (2010). The molecular receptive ranges of human TAS2R bitter taste receptors. *Chemical Senses, 35*, 157–170.

Michell, J. (1999). *Meaurement in psychology*. Cambridge, UK: Cambridge University Press.

Mistretta, C. M. (1981). Neurophysiological and anatomical aspects of taste development. In R. N. Aslin, J. R. Alberts, & M. R. Petersen (Eds.), *Development of perception: Psychobiological perspectives* (Vol. 1, pp. 433–455). New York: Academic Press.

Moss, F. A. (1924). Note on building likes and dislikes in children. *Journal of Experimental Psychology, 7*(6), 475–478.

Narens, L., & Luce, R. D. (1983). How we may have been misled into believing in the interpersonal comparability of utility. *Theory and Decision, 15*, 247–260.

Pelchat, M. L., Grill, H. J., Rozin, P., & Jacobs, J. (1983). Quality of acquired responses to tastes by *Rattus norvegicus* depends on type of associated discomfort. *Journal of Comparative Psychology, 97*, 140–153.

Pelchat, M. L., & Rozin, P. (1982). The special role of nausea in the acquisition of food dislikes by humans. *Appetite, 3*, 341–351.

Pfaffmann, C. (1960). The pleasures of sensation. *Psychological Review, 67*, 253–268.

Pliner, P., & Pelchat, M. L. (1986). Similarities in food perferences between children and their siblings and parents. *Appetite, 7*, 333–342.

Pollan, M. (2006). *The omnivore's dilemma*. New York: Penguin Books.

Prescott, J. (2004). Effects of added glutamate on liking for novel food flavors. *Appetite, 42*, 143–150.

Price, D. D., McGrath, P. A., Rafii, A., & Buckingham, B. (1983). The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. *Pain, 17*, 45–56.

Razran, G. (1940). Conditioned respons changes in rating and appraising socio-political slogans. *Psychological Bulletin, 37*, 481.

Richter, C. P. (1942–1943). Total self regulatory functions in animals and human beings. *Harvey Lecture* Series, *38*, 63–103.

Rodin, J., Wack, J., Ferrannini, E., & DeFronzo, R. A. (1985). Effect of insulin and glucose on feeding behavior. *Metabolism, 34*(9), 826–831.

Rolls, B. J. (1986). Sensory-specific satiety. *Nutrition Reviews, 44*, 93–101.

Rosenstein, D., & Oster, H. (1988). Differential facial responses to four basic tastes in newborns. *Child Development, 59*, 1555–1568.

Rozin, E., & Rozin, P. (1981). Culinary themes and variations. *Natural History, 90*, 6–14.

Rozin, P. (1982). "Taste–smell confusions" and the duality of the olfactory sense. *Perception and Psychophysics, 31*, 397–401.

Rozin, P., & Kalat, J. W. (1971). Specific hungers and poison avoidance as adaptive specializations of learning. *Psychological Review, 78*(6), 459–486.

Rozin, P., & Vollmecke, T. A. (1986). Food likes and dislikes. *Annual Review of Nutrition, 6*, 433–456.

Rozin, P., Wrzesniewski, A., & Byrnes, D. (1998). The elusiveness of evaluative conditioning. *Learning and Motivation, 29*, 397–415.

Rozin, P., & Zellner, D. (1985). The role of Pavlovian conditioning in the acquisition of food likes and dislikes. *Annals of the New York Academy of Sciences, 443*, 189–202.

Sakel, M. (1938). *The pharmacological shock treatment of schizophrenia*. New York: Nervous and Mental Disease Publishing.

Schneider, R. A., & Schmidt, C. E. (1967). Dependency of olfactory localization on non-olfactory cues. *Physiology and Behavior, 2*, 305–309.

Schulkin, J. (1991). Hedonic consequences of salt hunger. In R. C. Bolles (Ed.), *The hedonics of taste*. Hillsdale, NJ: Erlbaum.

Semmelhack, J. L., & Wang, J. W. (2009). Select drosophila glomeruli mediate innate olfactory attraction and aversion. *Nature, 459*, 218–224.

Silverstone, T., & Stunkard, A. J. (1968). The anorectic effect of dexamphetamine sulphate. *British Journal of Pharmacology and Chemotherapy, 33*, 513–522.

Small, D. M., & Jones-Gotman, M. (2001). Neural substrates of taste/smell interactions and flavour in the human brain. *Chemical Senses, 26*, 1034.

Smith, J. C., Blumsack, J. T., Bilek, F. S., Spector, A. C., Hollander, G. R., & Baker, D. L. (1984). Radiation-induced taste aversion as a factor in cancer therapy. *Cancer Treatment Reports, 68*, 1219–1227.

Snyder, D. J., Prescott, J., & Bartoshuk, L. M. (2006). Modern psychophysics and the assessment of human oral sensation. *Advances in Oto-Rhino-Laryngology, 63*, 221–241.

Snyder, L. H. (1931). Inherited taste deficiency. *Science, 74*, 151–152.

Spence, D. P., & Ehrenberg, B. (1964). Effects of oral deprivation on responses to subliminal and supraliminal verbal food stimuli. *Journal of Abnormal and Social Psychology, 69*, 10–18.

Staats, A. W., & Staats, C. K. (1958). Attitude established by classical conditioning. *Journal of Abnormal and Social Psychology, 57*, 37–40.

Starling, E. H. (1923). *The wisdom of the body (Harveian oration)*. London: Lewis.

Steiner, J. E. (1977). Facial expressions of the neonate infant indicating the hedonics of food-related chemical stimuli. In J. M. Weiffenbach (Ed.), *Taste and development: The genesis of sweet preference* (pp. 173–188). Bethesda, MD: U.S. Department of Health, Education and Welfare.

Stevens, J. C. (1959). Cross-modality validation of subjective scales for loudness, vibration, and electric shock. *Journal of Experimental Psychology, 57*, 201–209.

Stevens, S. S. (1946). On the theory of scales of measurement. *Science, 103*(2684), 677–680.

Takamata, A., Mack, G. W., Gillen, C. M., & Nadel, E. R. (1994). Sodium appetite, thirst, and body fluid regulation in humans. *American Journal of Physiology, 266*(5, Part 2), R1493–R1502.

Todrank, J., Byrnes, D., Wrzesniewski, A., & Rozin, P. (1995). Odors can change preferences for people in photographs: A cross-modal evaluative conditioning study with olfactory USs and visual CSs. *Learning and Motivation, 26*, 116–140.

van Reekum, C. M., van den Berg, H., & Frijda, N. H. (1999). Cross-modal preference acquisition: Evaluative conditioning of pictures by affective olfactory and auditory cues. *Cognition and Emotion, 13*(6), 831–836.

Voegtlin, W. L. (1940). The treatment of alcoholism by establishing a conditioned reflex. *American Journal of Medical Sciences, 199*, 802–810.

Wilkins, L., & Richter, C. P. (1940). A great craving for salt by a child with cortico-adrenal insufficiency. *JAMA, 114*, 866–868.

Wrzesniewski, A., McCauley, C., & Rozin, P. (1999). Odor and effect: Individual differences in the impact of odor on liking for places, things and people. *Chemical Senses, 24*, 713–721.

Yeomans, M. R., Gould, N. J., Mobini, S., & Prescott, J. (2008). Acquired flavor acceptance and intake facilitated by monosodium glutamate in humans. *Physiology and Behavior, 92*, 958–966.

Zealley, A. K., & Aitken, R. C. B. (1969). Measurement of mood. *Proceedings of the Royal Society of Medicine, 62*, 993–996.

Zellner, D. A. (1991). How foods get to be liked: Some general mechanisms and some special cases. In R. C. Bolles (Ed.), *The hedonics of tasten* (pp. 199–217). Hillsdale, NJ: Erlbaum.

Zellner, D. A., Rozin, P., Aron, M., & Kulish, C. (1983). Conditioned enhancement of human's liking for flavor by pairing with sweetness. *Learning and Motivation, 14*, 338–350.

Zhao, G. Q., Zhang, Y., Hoon, M. A., Chandrashekar, J., Erlenbach, I., Ryba, N. J., et al. (2003). The receptors for mammalian sweet and umami taste. *Cell, 115*, 255–266.

Zucco, G. M. (2012). The acquisition of odour preferences via evaluative olfactory conditioning: Historical background and state of the art. In G. M. Zucco, R. S. Herz, & B. Schaal (Eds.), *Olfactory cognition: From perception and memory to environmental odours and neurosciene* (pp. 95–114). Amsterdam: Benjamins.

PART III

DEVELOPMENTAL PERSPECTIVES

CHAPTER 14

The Development of Facial Expressions

Current Perspectives on Infant Emotions

Linda A. Camras, Serah S. Fatani, Brittney R. Fraumeni, and Michael M. Shuster

Although the relevance of facial expression to emotion is widely acknowledged, the nature of the relationship between them has been subject to considerable debate. As emphasized in the previous edition of this volume, facial expressions are a particularly important focus of attention for researchers studying infant emotional development. There are two primary reasons why this is true. First, infants are unable to verbally report their emotions and therefore researchers must rely on nonverbal indicators of their affective states. Second, starting with Darwin (1872/1998), many influential theories covering emotion (e.g., Ekman, 1972; Izard, 1991; Tomkins, 1962) have allotted a special place to the role of emotional facial expressions. In the previous edition of this handbook, our chapter presented a number of infant emotion theories that occupy the current landscape of research on infant emotion. In the present chapter, we both revisit these theories and selectively review what we consider the most relevant empirical research on infant emotional expression. While we include seminal early research in this area, the bulk of our focus is on more recent studies. As we will see, many of these studies have been conducted by investigators aligned with one or the other theories that we describe. Yet, as we shall also see, much of the research is not designed to discriminate among these theories but instead can be considered consistent with a number of different perspectives. Still, contemporary research on infant expression indisputably contributes to our overall knowledge of this important aspect of emotion and emotional development. Furthermore, it contributes to the building of a research "database" that may eventually help us arrive at a consensus regarding the most appropriate theoretical framework within which to situate our empirical observations and research findings.

Background

Charles Darwin's (1872/1998) *The Expression of the Emotions in Man and Animals* is most often cited as the seminal work on emotional expression, providing a detailed account of expressive behavior across both animal species and human cultures. Darwin argued that expressive behavior in both animals and humans could be explained in terms of three principles: serviceable associated habits, antithetical actions, and nervous system excitation. According to the principle of serviceable associated habits, some expressive behaviors are derived from instrumental actions that can serve adaptive functions when carried out in their entirety. For example, one component of the anger expression (baring the teeth) originated in the action of biting. However, Darwin was notably ambiguous regarding the current adaptive value of emotional expressions and their relationship to human motivation (see Fridlund, 1994, for discussion). Nonetheless, starting with Silvan Tomkins (1962), most recent and contemporary emotion theorists (e.g., Ekman, 1994, 2003; Izard & Ackerman, 2000; Izard, 1991) implicitly share the view that emotions are primary motivational forces in humans and that much of human behavior is organized in the service of emotion-related functions and goals.

In addition to advocating the central role of emotion in human motivation, Tomkins also revived scientific interest in emotional facial expression—a topic that had languished in the 20th century. As cogently reviewed and critiqued by Ekman (1982), several studies conducted from the 1920s through the 1950s had purported to find no systematic relationship between facial expression and emotion in either adults or infants. Nevertheless, Tomkins encouraged two young investigators, Paul Ekman and Carroll Izard, to pursue a series of studies on the recognition of emotional facial expressions in a variety of Western and non-Western cultures. These investigations included Ekman, Sorenson, and Friesen's (1969) landmark study of emotion recognition by the Fore people, a preliterate New Guinea tribe. Since that time, a number of studies with adults (reviewed by Matsumoto, Keltner, Shiota, O'Sullivan, & Frank, 2008) have linked emotional expression to other components of emotion responding (in particular, self-reported feelings). At the same time, there are vocal opponents to both the thesis of universality and the notion that facial expressions that are a core component of emotion (e.g., Barrett, 2006; Barrett, Wilson-Mendenhal, & Barsalou, 2015; Fridlund, 1994; Russell, 1994). Nonetheless, many contemporary psychologists still accept the premise that the prototypical emotional expressions described for adults are related in some important way to human emotions as motivational states.

Emotional Expression in Infancy

One plausible extension of the adult-based theories of facial expression is the proposal that a similar relationship between expression and emotion exists throughout the lifespan. Yet the implications of findings from the adult literature for the development of expressive behavior are not straightforward. More than one developmental pathway might lead to the outcomes reported for adults. In fact, as we describe below, a number of investigators hold that infant facial expressions do not correspond to adult-like discrete emotions and have proposed alternative developmental models. One prominent theory proposed by Michael Lewis (2014) holds that facial expressions initially are action patterns tied to specific physical events in the infant's world. Only through a complex developmental process do they eventually become tied to adult-like emotions. The details of this important model are presented elsewhere in this handbook (see Chapters 15 and 45, this volume) and thus are not reviewed herein.

As in the previous version of this chapter, our review of other theoretical models focuses on three questions that are central to understanding the development of emotional expression during infancy and beyond:

1. How do facial expressions become organized during the course of development?
2. What is the relation between facial expressions and emotion-eliciting situations?
3. What is the relationship between facial expressions and other emotion-related behavioral responses (e.g., emotion "action tendencies")?

These three questions are not unrelated. In particular, as described below, investigators often have sought to address the first one by examining evidence regarding the second and third questions across development.

Differential Emotions Theory

Although several related versions of discrete-emotion theories have been proposed in the adult literature, few of these have included an explicit developmental component. One such theory is Izard's differential-emotions theory (DET; Ackerman, Abe, & Izard, 1998; Izard, 1991; Izard & Malatesta, 1987). Following Tomkins (1962), Izard has argued that emotions (rather than drives) are the primary motivators of human behavior. Presumably an individual experiencing an emotion is motivated to pursue goals associated with its adaptive function. Thus, emotions motivate the individual's selection and organization of behaviors around these adaptive goals. Selection and organization of such behaviors are also acknowledged to depend upon situational factors, the individual's personality, and other aspects of his or her developmental history.

In its original formulation, DET proposed that infant expressive behavior is generally not discretionary, but instead is an automatic readout of the emotion system. However, several important caveats to this principle were later recognized, leading Izard (e.g., 2009; Izard, Woodbum, & Finlon, 2010) to revise his views. These caveats are related to our three focal questions regarding expressive development. First, DET proponents acknowledge that some fleeting facial expressions observed in the first 2 months of life may not be expressions of emotion (Izard & Abe, 2004). According to DET, at this very early age the neural circuits involved in facial expressions at maturity are still lacking in infants, and infant expressions such as smiles during sleep or during transitional states (e.g., waking up from a nap) may reflect random central nervous system activity (Ackerman et al., 1998). Thus, in response to our first question concerning how facial expressions become organized, DET proponents propose that expressive reorganization occurs early in development as a result of neurological maturation.

The second exception to the automatic readout hypothesis suggests that expressive impulses sometimes may be too weak to produce observable expressive behavior. Presumably this might result in an absence of the predicted facial expression—but not in the production of a facial configuration corresponding to a different emotion. Last, according to DET, expression production may be regulated by older infants, children, and adults according to social and personal display rules that are acquired over the course of development. This is accomplished by overriding the automatic output of expressive behavior via a voluntary control system that exists separately from emotion. As a result, older infants, children, and adults may not always produce facial expressions corresponding to their true emotions. However, infants past the neonatal stage but younger than approximately 1 year are presumed not to exert such voluntary control over their facial behavior (Izard et al., 1995). Thus, in response to our second question concerning the relationship between expression and emotion-eliciting situations, DET proposes that observable facial expressions produced by infants during their first year of life may not always occur in emotion-eliciting situations, but those that do occur should invariably correspond to the elicited emotion. In contrast, older children and adults may voluntarily produce expressions corresponding to nonexperienced emotions.

Perhaps surprisingly, DET proponents have not specifically addressed our third focal question, concerning the relationship between infant facial expressions and emotion-related action patterns. Although DET acknowledges that emotional expression includes nonfacial behaviors (e.g., vocalizations), instrumental actions are not considered to be a core component of emotion. Thus, relationships between facial expressions and action patterns in infancy have not been specified or subjected to investigation. Instead, as described below, the primary focus in DET-related research with infants has been on the patterning of emotional expression across development and the relationship between expressive behavior and emotion-eliciting incentive events.

To facilitate the study of infants' expressive development, Izard and his colleagues developed the MAX and AFFEX coding systems (Izard, 1995; Izard, Dougherty, & Hembree, 1983) for use in scoring infant expressive behavior and identifying facial configurations that are the expressions of discrete emotions or blends of such emotions. Using these systems, Izard and his colleagues have measured expressive behavior in response to a number of eliciting situations. In several of their studies (Abe & Izard, 1999; Izard & Abe, 2004; Izard, Hembree, & Huebner, 1987), they have reported that infants produce facial expressions representing appropriate emotion responses to the incentive events. Izard et al. (1995) have also examined the relative frequency of full-face versus partial emotional expressions or blends in infants of different ages, as well as the stability of individual differences across infants in the production of various facial configurations. According to Izard's view, younger infants should produce more full-face expressions and fewer partial expressions or blends, because full-face expressions are presumed to be less controlled and regulated. Furthermore, morphological stability of the MAX-specified facial configurations across infancy has been reported (Izard et al., 1995) and is considered evidence for their sharing emotion meaning with the prototypical expressions described for adults. Last, Izard and colleagues have conducted a number of judgment studies in which they report that observers perceive the MAX-specified facial configurations to represent their presumed emotions (Huebner & Izard, 1988; Izard, 1971; Izard et al., 1995; Izard, Huebner, Risser, McGinnes, & Dougherty, 1980).

As reviewed in Camras and Shutter (2010), all of these forms of evidence are controversial. For example, Oster (2005) has pointed to important differences in the morphology of emotional expressions described for adults and those specified in the MAX and AFFEX coding systems. In addition, Oster's own judgment studies (Oster, Hegley, & Nagel, 1992) suggest that several MAX- and AFFEX-specified expressions are perceived as representing distress rather than discrete negative emotions. Other investigators (Matias & Cohn, 1993) have found that blends rather than full-face expressions are predominant during mothers' interactions with young infants. Last, observation of infant expressive behavior in response to a number of different eliciting situations has revealed patterns of expressive responses that do not appear to reflect the discrete negative emotions presumed to be experienced by the majority of infants. We return to these findings below.

Differentiation Theories of Emotional Development

Prior to the advent of contemporary discrete-emotion theories, the most prominent view of infant emotional development portrayed ontogeny as a process of differentiation and integration. In 1932, Katherine Bridges published a highly influential monograph that dominated the literature on infant expressive development for several decades. In this monograph, she described infant emotions as originating in a state of diffuse excitement that differentiates first to generate delight and distress, and then to produce more distinct emotion states such as fear, anger, elation, and affection. More recently, Alan Sroufe as well as Michael Lewis have produced theories of emotional development that retain the notion of specific emotions deriving from less differentiated earlier reactions. According to Lewis (The Emergence of Human Emotions, Chapter 15, this volume), basic action patterns of approach and withdrawal may be the starting point for their later differentiation into discrete emotions. According to Sroufe (1996), the emergence of emotions can be described in terms of three developmental steps: pre-emotion reactions during the newborn period, precursor emotions during the first half year of life, and more mature emotions during the second half year. Although he describes these steps in detail only for joy, fear, and anger, Sroufe contends that the analysis can be extended to other emotions.

Sroufe (1996) implicitly attributes the reorganization of emotional expression during early infancy to maturational processes. Thus, his view of how expressions become organized (and reorganized) over the course of early development (i.e., the mechanisms of developmental change) is similar to that proposed by DET. However, in response to our second two questions, he describes very different patterns of relationships between facial expressions and emotion-eliciting situations, as well as between such expressions and emotion-related behavioral responses. More specifically, Sroufe distinguishes between positive and negative expressions and between positive and negative emotional states occurring early in development. However, beyond these broad-based valence distinctions, he does not propose a consistently tight correspondence between specific emotional expressions and the less differentiated emotional states that precede the development of mature discrete emotions. For example, Sroufe distinguishes between positive and negative facial expressions (i.e., smiles vs. distress expressions), but does not distinguish between distress expressions accompanying wariness (the precursor to fear) and frustration (the precursor of anger). Instead, wariness and frustration are distinguished in terms of both their eliciting circumstances and an infant's nonfacial responses (e.g., avoidance vs. diffuse attack). Thus, facial expressions are systematically related to both emotion-eliciting situations and emotion-related behaviors, but not in the manner proposed by DET (i.e., as involving a one-to-one correspondence between specific expressions and corresponding discrete emotions).

Because Sroufe's (1996) position is not represented elsewhere in this volume, we present a more complete description of his model. According to Sroufe, neonatal pre-emotion reactions (i.e., smiling, distress) are automatic reflexive responses to quantitative, rather than qualitative, aspects of stimulation (e.g., temporal and intensity features of arousal). For example, smiling can be produced by gentle modulated arousal, while distress results from more intense arousal buildup. Because Sroufe believes that eliciting stimuli for these reactions can be identified that are somewhat analogous to the later elicitors of more mature emotions (e.g., physical restraint for anger), he considers these neonatal reactions to be prototypes for later-developing, more discrete emotions. Nonetheless, because Sroufe defines emotions as subjective reactions requiring some degree of cognitive evaluation, these early precognitive reactions are not themselves considered emotions.

Following the neonatal period, precursor emotions (e.g., pleasure, wariness, frustration) emerge. These are considered true emotions, because the infant has begun to develop the cognitive ability to process stimulus content; however, they are still regarded as precursors, because they involve only the simple cognitive process of relating present experiences to past experiences. Thus, pleasure arises from stimulus recognition, wariness from recognition failure, and frustration from inability to execute a familiar (i.e., recognizable) behavioral routine. Of particular relevance to the topic of this chapter, Sroufe (1996) states that some precursor emotions are not distinguishable in terms of their facial or vocal expressive components. For example, wariness and frustration reactions are similarly manifested in crying and distress. After the first 6 months, basic emotions (e.g., joy, fear, and anger) begin to emerge. Sroufe views these as mature emotions, because they involve more complex cognitive evaluation processes. For example, fear is elicited by the perception of a threat, as opposed to a more general failure to recognize a stimulus. Fear and anger are differentially manifested in more specific behavioral responses (e.g., avoidance vs. diffuse attack).

Also of particular relevance for this chapter, Sroufe asserts that reliable differences in the facial expressions for these emotions emerge some time after the emergence of the emotions themselves. Thus, Sroufe's theory is distinct from DET in its contention that there are not distinct facial expressions corresponding to distinct emotions at all ages. For example, according to Sroufe (1996), "few or no elements of the fear face are seen in the distress of wariness" (p. 65). Earlier and later forms of emotions and emotional expressions are related through their developmental history rather than through their morphology.

An Ontogenetic View of Expressive Development

Focusing more specifically on expressive behavior rather than emotional development in general, Oster (2005) considers a broader range of facial expressions than either Sroufe or Izard does. Rather than confining her efforts to a search for the origins of adult emotional facial configurations, Oster seeks to investigate the infant's entire expressive repertoire. According to her ontogenetic view, an infant shows a variety of distinctive facial expressions that have important signal value within the context of the infant's world, going beyond or even regardless of their relationship to discrete emotions. Because the adaptational demands of the environment differ for infants and adults, she argues that it is reasonable to believe that their emotional and expressive repertoires may differ accordingly.

Although Oster (2005) has not articulated a specific position on the question of how facial expressions get organized over the course of development (i.e., our first focal question), her view implicitly suggests that expressions are tied to emotion-related states from the beginning, but that emotion states themselves may change with development. In principle, this position is similar to Sroufe's (1996), although Oster identifies a different set of emotion-related states preceding the development of discrete emotions (e.g., attempts by the infant to regulate negative affect). In response to our second focal question (regarding relations between situations and emotional expressions), Oster's discussion, like Sroufe's, implies that facial expressions are systematically related to situations that elicit these emotional states. Unlike Sroufe, Oster does not discuss relationships between expressions and nonfacial emotion-related actions on the part of the infant (our third focal question). Instead, she relies on analyses of the temporal patterning of facial expressions, their situational occurrence, and observers' interpretations of the expressions to make inferences about the emotion states underlying infants' expressive behavior.

As an example of her perspective in practice, Oster has studied the situational occurrence of "pouting," a mouth configuration that would be identified as a component of sadness according to the MAX and AFFEX coding systems. However, based on her observations, Oster proposes that "pouting" reflects an effort by the infant to regulate distress, and that the label of "sadness" fails to capture its more specific meaning and signal value. Examining infant expressions by means of her fine-grained BabyFACS (an infant-oriented version of Ekman, Friesen, & Hager's [2002] anatomically based Facial Action Coding System [FACS]; Oster, 2012), Oster has also highlighted morphological differences between the discrete negative emotional expressions proposed for infants according to MAX and adult facial configurations corresponding to the same emotions (e.g., adult anger and fear prototypes). These morphological differences suggest that the meanings of adult and infant expressions may not be identical. In addition, Oster notes the broad situational occurrence of MAX-specified pain and anger faces that are often produced in the context of infant crying. Like several other investigators (e.g., Camras, 1991; Sroufe, 1996), she concludes that currently there is no convincing evidence that these

MAX-specified expressions correspond to discrete adult-like emotions. Instead, they may reflect a more generalized distress reaction or a more specific level or type of distress that does not correspond to a discrete-emotion label (e.g., intense distress or modulated distress rather than "anger" or "sadness"). To determine the true meaning of infant emotional expressions, Oster advocates an empirical approach to expressive development that takes infancy itself as its point of origin, seeks to identify infants' repertoire of expressive behaviors, and attempts to determine their adaptive value for infants themselves as well as their ontogenetic relationship to expressive behavior in older individuals. According to Oster, whether or not this relationship involves a true differentiation process remains to be determined.

The Functionalist Framework

The functionalist approach to emotion was proposed by Barrett and Campos (1987) to rectify discrete-emotion theories' tendency to focus narrowly on a set of core components situated within the person. According to the functionalist approach, an emotion is a relational process through which an individual attempts to establish, change, or maintain some significant aspect of his or her relationship to the external or internal environment. Emotions can acquire their significance via several processes. Perhaps the most important of these are social signaling (i.e., observation of others' expressive responses) and appraisal of the event's relevance to one's personal goals. The elicited emotion reflects the nature of that relationship and includes an open class of responses designed to attain (or maintain) a desired goal state. For example, an event appraised as involving a significant loss might evoke responses designed to recoup the loss or to acquire an acceptable substitute. Of importance, the specific responses themselves (e.g., crying, searching for the lost object, seeking comfort) are not predetermined by an innate emotion program, but are drawn from the individual's entire response repertoire in the service of achieving the person's particular goal for that emotion episode—that is, emotion responses are functional rather than fixed or preprogrammed. Nonetheless, the functionalist approach acknowledges that there may be intrinsic links between specific emotions (or emotion families) and particular responses (e.g., action tendencies, facial expressions, physiological patterning). However, these links are not invariant and are subservient to the context-dependent selection of responses designed to achieve the individual's emotion goals.

With respect to how infant expressions become organized (our first focal question), functionalists propose that this occurs in conjunction with infants' social development. Consistent with its overall conceptualization of the emotion process, functionalism views facial expressions primarily as social signals serving to communicate emotions to others, rather than as direct readouts of emotions themselves. Thus, regarding relationships between facial expressions and emotion situations (our second focal question), functionalists assert that facial expressions may or may not be generated, depending on whether they would be serviceable in the particular emotion situation. Importantly, functionalists do not believe that the absence of facial signaling in an emotion episode necessarily reflects the suppression of "naturally" produced expressive behavior. Although expressive behavior indeed may sometimes be altered in accordance with social display rules, this reflects a change in the evaluation of the expression's functionality, rather than the suppression of an inherent automatic readout of the emotion. According to the functionalist perspective, socialization processes are important in establishing the conditions under which emotion signals (including facial expressions) are produced. Developmental changes in expression–emotion relationships reflect an individual's socialization experiences in conjunction with his or her evaluation of the effectiveness of expressive behavior.

In response to our third focal question, functionalists would propose an indirect rather than a direct relationship between facial expressions and other emotion-related behaviors. Because functionalists view all emotion-related behaviors as discretionary, co-occurrences of specific facial expressions and instrumental behaviors would not necessarily be expected. In fact, functionalists have argued that facial expressions and instrumental behaviors may be produced as alternative responses in emotion situations, depending on the individual's assessment of their relative functionality. Thus, in response to our third focal question, functionalists would predict that relationships between facial expressions and other emotion-related behaviors might not be observed within an individual, but might be observed as substitute responses to the same emotion situation.

Functionalism represents an important advance in developmental theorizing about expressive behavior. Although it does not elaborate on the specific mechanisms of expression production (i.e., processes that determine whether expressions are generated, and if so, which ones), the functionalist approach has provided an important alternative to theories that focus on relatively rigid relationships among a set of core emotion components. It encourages investigators to view emotion as a more flexible system of responses oriented toward achieving an individual's goals.

Sociocultural Models

More recently, Holodynski and Friedlmeier (2006) have presented a socioculturally based internalization model of emotional development spanning infancy and childhood. With respect to infancy, they propose, as differentiation theorists do, that infant facial expressions initially reflect precursor emotions (e.g., distress, pleasure, fearful tension) and are not selectively associated with discrete-emotion-specific causes or coordinated with emotion-specific behaviors. However, caregivers interpret these diffuse infant expressions within their contexts of occurrence and thus respond to infants with appropriate actions. At the same time, caregivers shape links between specific facial expressions and discrete emotions through their own behavior. That is, caregivers mirror infants' expressive behavior during their interactions with infants, but do so selectively and in exaggerated form. For example, when an infant cries in circumstances considered sadness appropriate by the caregiver, then that caregiver may respond with an exaggerated sadness expression while offering comfort to the infant—that is, the caregiver displays both exaggerated (i.e., prototypical) facial expressions and emotion-appropriate motive-serving actions. Infants thus acquire these expression–emotion relationships, which are later reflected in their own expressive and emotional behavior. Holodynski and Friedlmeier's model therefore provides a clear proposal for each of the focal questions we address in this chapter. According to their model, socialization is the means through which diffuse expressions of positive affect or distress are organized into the specific facial configurations corresponding to discrete emotions that are selectively associated with emotion-related situations and behavior responses.

Holodynski and Friedlmeier's (2006) model incorporates a number of findings from the developmental literature regarding expressive mirroring during mother–infant interaction. At the same time, their proposals regarding the linking of discrete-emotion expressions and emotion-specific functional actions require further substantiation. In particular, given that early social interactions may differ widely across cultures, further research involving non-Western mothers and infants is required to further substantiate their proposal regarding mechanisms of expressive development. Nevertheless, Holodynski and Friedlmeier present an intriguing model that has the potential to bridge the gap between infant and adult expressive behavior.

A related approach to conceptualizing sociocultural influences on emotional development is Keller's (2007) ecocultural model. This theory differs from Holodynski and Friedlmeier's (2006) model in that it emphasizes cultural influences on the degree of infants' and children's expressivity rather than caregivers' shaping the morphology of discrete-emotion expressions (Kärtner, Holodynski, & Wörmann, 2013). In this model, a culture's valuing of either autonomy or relatedness to others influences the expressivity of culture members, and this influence is mediated by the value placed on emotional expression in that particular culture (Keller & Otto, 2009). For example, in Nso culture, less emotion is shown in order to maintain the value of group cohesion, while in German culture, more emotion is shown to allow for greater autonomy (Keller & Otto, 2009). In collectivistic cultures there is the expectation that children as well as adults will regulate their emotional expression, whereas individualistic cultures encourage expressing emotions to a greater extent (Keller, 2007).

Regarding development, Keller would claim that facial expressiveness is organized during development by parents and other culture members who encourage more or less emotional expressivity (Keller & Otto, 2009). For instance, in Nso culture, crying is shamed and an infant is discouraged from making vocal cries along with crying facial expressions, whereas German mothers attempt to determine the reason the child is crying by listening to pitch and examining their child's expressions (Keller & Otto, 2009). Further recent research motivated by this model is reviewed below.

The Dynamical Systems Perspective

Like the functionalist perspective, the dynamical systems approach to emotional development emphasizes flexibility in the organization of emotion responses and variability from individual to individual (Camras & Witherington, 2005; Haviland-Jones, Boulifard, & Magai, 2001; Magai & Haviland-Jones, 2002). Originating outside the social sciences, the dynamical systems framework has been proposed as a general model that can be used to account for the organization of complex systems of various sorts (see Kelso, 1995). Because it provides a unique and novel perspective on system organization and interrelationships among system components, the dynamical systems approach presents a provocative alternative to the theoretical models described above.

The dynamical systems perspective addresses the question of system organization (our first focal question) by asserting a broader principle of self-organization, rather than narrower principles of either top-down maturational control or shaping via socialization (Fogel & Thelen, 1987; Fogel et al., 1992). With regard to relationships between facial expressions and both eliciting circumstances and emotion-related behavioral responses (i.e., our second and third focal questions), the principle of self-organization implies a flexible relationship among these systems components, as determined by the particulars of the situational context and the individual's developmental history. We expand on these ideas below.

According to the dynamical systems perspective, emotions may be conceived of as "attractor states"—that is, frequently observed organizations of emotion system components (Fogel & Thelen, 1987). However, dynamical systems attractors may themselves involve considerable variability in their details. Thus, in the case of emotion, the dynamical systems approach—like the functionalist approach—asserts that any specific episode may or may not include a particular emotion component (e.g., an emotional facial expression). Furthermore, at a lower level of analysis, emotion components themselves (e.g., facial expressions) may vary in their details. Such variability may also reflect the influence of lower-order contextual factors that influence the formation of an attractor. For example, Fogel, Nelson-Goens, Hsu, and Shapiro (2000) found that different types of mother–infant interactions are related to specific variants of infant smiling. Fogel, Messinger, and their colleagues (e.g., Messinger, Fogel, & Dickson, 1999, 2001) propose that such expressive variability engenders variability in emotional experience, because emotion itself emerges from the interaction of its constituent components.

Dynamical systems approaches are particularly concerned with processes leading to system change both across real time and across development (Fogel & Thelen, 1987; Thelen, 1989). According to this perspective, qualitative shifts in the organization of a system (termed "phase shifts") will occur when some key system component (termed the "control parameter") reaches a critical threshold. For example, Wolff (1987) observed that increasing the intensity of stimulus input sometimes itself produced a qualitative change in an infant's expressive behavior (e.g., from smiling to crying). Across development, a major reorganization of emotion responding may also occur when some developmental variable reaches its critical threshold. For example, a number of investigators (Emde & Koenig, 1969; Fogel & Thelen, 1987; Sroufe, 1996; Wolff, 1987) have noted heterochronicity in the development of infant emotional responses (e.g., the early appearance of smiles dissociated from other components of the presumed corresponding emotion). According to a dynamical systems perspective, such expressive components may become part of an organized emotional response when some (as yet unidentified) component of the system achieves threshold. Importantly, control parameters may differ across episodes occurring both within a narrow time frame and across development. For example, the intensification of either hunger or pain above a certain threshold may lead to infant distress. Across development, a major reorganization of emotion responding may occur when motor development, language development, or some other developmental variable reaches a critical threshold (Campos, Kermoian, & Zumbahlen, 1992; Parladé & Iverson, 2011). Two unique features of dynamical systems models of change are (1) the system demonstrates increased instability as the control parameter reaches its critical threshold; and (2) as it approaches the point of transition, the system becomes more responsive to external perturbations. For example, as hunger increases, an infant may be more likely to cry in response to being accidentally poked by the caregiver.

In many circumstances, emotion attractors (e.g., assemblies of appraisals, expressions, neurophysiological responses) may correspond to what are often considered to be universal discrete emotions—that is, universal environmental circumstances may exist that serve as "control parameters," leading to the organization of a set of responses that have been associated with anger, fear, sadness, and so on (Camras, 2011). In this sense, such emotions might be considered "innate," but not in the traditional sense of the term. Here, the "innateness" of the emotion lies in the universality of environmental "control parameters" that engender the organization of responses as much as in the sets of responses themselves.

Various scholars have applied dynamical systems principles somewhat differently to provide accounts of infant emotional development. For example, Fogel et al. (1992) view emotions as emerging de novo from the self-organized interactions of components, including some that are not emotion specific (e.g., gaze, posture, instrumental actions). In contrast, Marc Lewis retains the notion that discrete emotions are preexisting hardwired assemblies of expressive, physiological, and phenomenological components, but views these assemblies as components within larger self-organized dynamical systems (i.e., emotion–appraisal amalgams; Lewis & Douglas, 1998). With respect to emotional facial expressions, the former position implies that unique relationships between facial configurations and emotional experience should not be expected. The latter position implies that an invariant concordance between certain facial expressions and their corresponding affective experiences should exist.

Because advocates of both these positions can offer plausible (but different) sorts of evidence consistent with their view, we have sought to develop a third position that can accommodate the widest range of findings to date (see Camras, 2011, for details). This effort originated in Camras's (1992) observational study of her daughter's expressive behavior during the first 9 weeks of life. Initially adopting the perspective of discrete-emotion theories as it was originally conceived, Camras made a number of unexpected observations that could not easily be explained by DET's account of infant expressive behavior. Subsequent research (described below), as well as a review of the literature (Camras, Malatesta, & Izard, 1991), similarly revealed phenomena indicating that DET's initial account of infant expressive development required modification.

Several anomalous phenomena were identified, including (1) the systematic occurrence of codable "emotional" expressions in situations unlikely to have elicited the corresponding discrete emotion (e.g., nonemotional neonatal smiling [Emde & Koenig, 1969], "surprise" expressions produced by infants who were unlikely to be experiencing surprise [Camras, Lambrecht, & Michel, 1996]); (2) the nonoccurrence of emotional expressions corresponding to the emotion presumably experienced by infants (e.g., absence of fear expressions in infants judged to be afraid on the visual cliff [Hiatt, Campos, & Emde, 1979], absence of surprise expressions in infants judged to be surprised by an expectancy violation [Camras, 2000; Camras et al., 2002]); and (3) rapid shifts among MAX-designated facial expressions for anger, sadness, and physical distress/pain during bouts of intense crying occurring in response to almost any form of negative elicitor (including MAX-specified pain expressions in circumstances during which pain was unlikely to be experienced; Camras, 1992).

To explain these findings, Camras (2000) has proposed that infant emotions and infant facial expressions constitute overlapping but partly separate dynamical systems. More specifically, to explain the first anomaly described above, Camras and her colleagues (1996; Michel, Camras, & Sullivan, 1992) drew upon dynamical systems research in the area of nonfacial motoric action, and in particular upon the concept of the "coordinative motor structure" (i.e., a grouping of muscle actions that are synergistically linked to one another; see also Fogel, 1985). Thus they proposed that infant facial expressions may sometimes be produced in non-emotion-related circumstances via self-organizing processes of recruitment among "lower-order" facial muscle movements. For example, Camras et al. (1996) showed that 5- and 7-month-old infants will raise their brows as they open their mouths to incorporate an object—that is, opening the mouth recruits a synergistically related raised brow movement producing an expression of "surprise" in nonsurprising situations.

To explain the second set of anomalous findings, Camras (2000; Camras et al., 2002) proposed that facial expressions are nonobligatory components of emotion episodes and are produced only when their corresponding control parameters are present at the necessary threshold. In dynamical systems terms, discrete-emotion attractors (i.e., larger ensembles of emotion components) can be variable, and thus may or may not include a prototypical emotional expression in any one instance. This view is similar to the functionalists' notion that facial expressions are produced only when they serve a communicative function. However, dynamical systems proponents would recognize the potential for a broader set of control parameters to determine whether or not a facial expression is produced. These may include socialization variables and maturational influences but also other factors such as head position and gaze direction. For example, Michel et al. (1992) showed that infants raised their brows when looking upward to view an attractive object, but not when looking downward. In this case, head position and gaze direction served as "control parameters" determining whether or not the infant produced a facial expression codable as "interest" in an interest-relevant situation.

To explain the third set of anomalous findings, Camras (1992) proposed that the facial configurations depicted by DET as reflecting discrete anger, sadness, or physical pain may represent negative affective states that do not correspond to traditional categories of discrete emotions. Like Oster (2005), she suggested that some of these expressions may reflect different intensities of a more general state of "distress"—in other words, negative emotion that is relatively undifferentiated with respect to distinguishable functional goals (e.g., removing an obstacle vs. escaping danger) in very early infancy. Some forms of negative emotional expression may also reflect infants' efforts to modulate that distress (Oster, 2005) and/or the influence of non-emotion-related factors such as head position and gaze direction. For example, Camras et al. (2007) suggested that differences in head position and/or gaze direction during negative emotion episodes may sometimes determine whether infants produce brow configurations associated with prototypical expressions of fear, sadness, or anger.

As indicated above, Camras (2011) extended these views to present a broader proposal regarding emotional development. This proposal seeks to incorporate aspects of the several theoretical perspectives described above, most particularly, the differentiation and the dynamical systems viewpoints. Called the differentiation and dynamical integration (DDI) perspective, its guiding idea is to assert that components of emotion emerge heterochronically and become loosely organized into emotion systems (i.e., dynamical systems attractors) that become more differentiated over the course of development. Initially, these loosely organized emotions may be distinguished only in terms of excitement versus distress(similar—though not identical—to Bridges's 1932 proposal). However, the set of available emotion components increases as language development, cognitive development, motor development, and cultural socialization proceed. New attractor states emerge as these components are organized into more specific subsystems (e.g., anger, sadness, and fear rather than generalized negative affect). For example, consistent with this proposal, Bennett, Bendersky, and Lewis (2005) found more differentiated facial responding to different negative emotion elicitors in 12-month-old in comparison to 4-month-old infants (although considerable overlap still occurred).

Importantly, very different sorts of "control parameters" may catalyze the reorganization of emotion-related responses across development. For example, the development of self-produced locomotion might enable greater differentiation of instrumental responses associated with anger versus fear while a newly acquired emotion vocabulary might come to anchor an association of different behaviors labeled separately as "angry" by adults (e.g., hitting and angry facial expressions; see Barrett, Lindquist, & Gendron, 2007, for a similar view). In dynamical systems terms, the emergence of each new attractor (i.e., assembly of responses) would be considered a phase shift. The development of each emotion might involve several phase shifts as more elaborated forms of an emotion progressively emerge.

Relevant Research on Infant Emotional Expression

Since the last edition of this handbook, several important lines of research have been initiated or have continued to be pursued that are particularly relevant to the theories reviewed above. These include studies of both positive and negative emotion and emotional expressions. We begin with studies of positive emotion, in particular, infant smiling.

In neonates, smiles occur primarily during rapid eye movement (REM) sleep states and are generally considered to be endogenous (i.e., produced by internally generated cycles of arousal and arousal modulation; Emde & Koenig, 1969; Sroufe, 1996; Wolff, 1987). Investigators studying such smiles generally have concurred with Sroufe (1996, as described above) in interpreting them as being "pre-emotional," either because they involve no cognitive evaluation and/or because they are not associated with eliciting stimuli that are generally considered to be linked to pleasure or positive feelings. In subsequent studies, Messinger and his colleagues (2002; Dondi et al., 2007) extended the investigation of neonatal smiles by conducting fine-grained coding of their morphology using Oster's (2012) BabyFACS. Messinger et al. (2002) focused particularly on the presence of cheek raising (i.e., contraction of obicularis oculi or AU6 in

FACS terminology), which has been proposed to distinguish between smiles reflecting genuine positive affect (termed "Duchenne smiles") in contrast to nongenuine smiles (e.g., smiles that reflect no positive emotion but are generated in accordance with cultural or personal display rules in adults). This research showed that Duchenne smiles often are produced by neonates, raising questions about the validity of using the Duchenne smile as a universal marker of genuine positive affect. As such, it is inconsistent with early versions of DET that proposed an invariant link between emotion and facial expression in young infants. Instead, as noted by Messinger (2008, p. 191), "neonatal smiles illustrate the dynamic systems emphasis on heterochronicity; that is, the neonatal smile appears to develop physically before it is integrated into patterns of cognitive engagement and social interaction that provide evidence for joyful emotion."

Social smiling (smiling while gazing at a human face) emerges during the second month of life and becomes integrated into patterns of coordinated face-to-face interactions between infants and their caregivers. A number of highly detailed studies of such interactions have been conducted primarily in Western cultures (e.g., Lavelli & Fogel, 2013; see Messinger & Fogel, 2007, for a review of earlier investigations). These studies suggest that interactive smiling may comprise an important foundation for the development of a positive emotional relationship between mothers and infants. Furthermore, such studies show that smiles both with and without cheek raising are produced during the course of such positive interactions. While both types of smiles occur in situations that would be expected to elicit positive emotions (e.g., various types of play interactions; Messinger et al., 2001), Duchenne smiles are rated higher on joy/happiness than are non-Duchenne smiles, leading Messinger, Mattson, Mahoor, and Cohn (2012) to suggest that the cheek-lifting component communicates the intensity of the positive emotion underlying the smile rather than its veracity (i.e., its expression of genuine as opposed to simulated positive emotion). Messinger makes a similar argument regarding the function of cheek lifting when it serves as a component of negative emotional expressions. While not necessarily inconsistent with several of the theories described above, Messinger and his colleagues (2012) again interpret their data within the context of a dynamical systems framework in which emotions are considered to be self-organized systems that emerge from the self-organization of their constituent components. Different forms of smiling contribute to different forms of positive emotion.

Social smiling has often been described as if it were a purely maturational phenomenon. However, recent cross-cultural studies have suggested that its development is importantly influenced by sociocultural factors. For example, Keller and her colleagues (e.g., Wörmann, Holodynski, Kärtner, & Keller, 2012) have compared the development of social smiling in a Western and non-Western society (i.e., Germany and the Nso people of Cameroon, respectively). Consistent with the cultural values of an independence-oriented society (as described above), German mothers value positive emotional exchanges between mothers and infants. Consistent with the values of an interdependence-oriented society, Nso mothers value contentment and minimization of negative emotion in their infants. Social smiling appeared to emerge at approximately the same age in infants from both cultures. However, its later course of development differs in the two societies in ways that appear to reflect their differing cultural values and normative maternal behavior (Kärtner et al., 2013). More specifically, between 6 and 12 weeks of infant age, mutual gazing and smiling increased for German mothers and infants substantially more than for Nso mothers and infants. The investigators in these studies emphasize their consistency with Keller's (2007) ecocultural model, as well as Holodynski and Friedlmeier's (2006) internalization model. However, their findings are not inconsistent with any of the theoretical perspectives reviewed earlier in this chapter since none of these models precludes the influence of sociocultural factors on the development of emotion communication. Thus, some of the most interesting recent research in the area of infant facial expression is not of the type that critically distinguishes among the theoretical perspectives described above. Instead, it adds to our knowledge regarding particular aspects of development that are the main focus of one or another extant developmental model. On the positive side, the fact that such research is noncontroversial can be seen as reflecting a substantial degree of consensus regarding some important contributors to infant emotional development.

Regarding negative emotional expressions, probably the most controversial line of recent research has been the study of fetal facial expressions. This had been made possible by the advent of sophisticated 4-D ultrasound technology. At present, only a few studies have made use of this opportunity and fewer still have utilized the fine-grained coding systems developed for the study of postnatal infants' facial expressions. However, both Dondi, Gervasi, Valente, Vacca, Borana, et al. (2014) and Reissland, Francis, and Mason (2011, 2013) have used FACS-based coding to analyze facial movements of infants as young as 20 weeks postgestational age. Facial expressions associated with distress in postnatal infants were observed in even the youngest prenatal fetuses. For example, Dondi et al. (2014) identified configurations considered to be both "cry-faces" and "pre-cry faces" according to Oster's (2012) BabyFACS. Of importance, these expressions were produced in a circumstance during which no distress would be expected to occur (i.e., during noninvasive ultrasound scanning that did not involve perturbation of the fetus). In addition, such expressions were brief in duration and interspersed with other expressions not associated with negative emotion (e.g., smiling, mouthing). Such a dissociation between eliciting context and facial configuration is consistent with the dynamical systems principle of heterochronicity as earlier described. More specifically, distress facial expressions may first emerge in dissociation from negative emotion. Readers familiar with our earlier chapter will note that this position represents a change from the view we advocated in the previous edition of this handbook in which we suggested that an invariant relationship between distress expressions and negative emotion might indeed exist at (and presumably before) birth. However, we would now propose that this relationship develops later via a combination of maturational processes and socialization experiences. These remain to be specified at each point of developmental change. However, we continue to assert that dynamical systems concepts such as attractor state, control parameters, and phase shifts can provide an invaluable framework for understanding and conceptualizing the nature of emotional development.

Beyond our theoretically relevant change in position, the possibility of heterochronicity in the development of distress and its indicators may have important implications for the politically charged current debate regarding fetal pain—that is, although studies have shown that very premature infants do show distress expressions in response to invasive procedures performed after birth (e.g., heel lancing as studied by Slater et al., 2009), the reverse may not necessarily be true. Distress expressions alone cannot be considered invariable indicators of fetal pain or distress in the absence of other evidence.

Regarding the postnatal development of negative emotional expressions, Michael Lewis and his colleagues have continued their long-standing productive line of research on MAX-specified anger and sadness expressions using a contingency learning procedure (see Chapter 15, this volume and Lewis, 2014). In this procedure, infants first learn to produce a desirable audiovisual stimulus by movement of their arm. This may be followed by an extinction condition (involving removal of the stimulus) or a contingency removal condition (in which the stimulus event continues to occur but is no longer controlled by the infant's behavior). In several studies, Lewis and his colleagues (see Chapter 15, this volume and Lewis, 2014) have found different patterns of facial responding to extinction versus loss of contingency, as well as differentiated relationships between MAX-specified anger and sadness expressions and other infant responses. For example, in one important investigation, Lewis, Ramsay, and Sullivan (2006) found that MAX-specified anger expressions were associated with increased heart rate, while MAX-specified sadness expressions were associated with increased cortisol responding when 4-month-olds experienced contingency learning followed by extinction. More recently, Crossman, Sullivan, Hitchcock, and Lewis (2009) found evidence that anger expressions and persistent arm pulling were associated with extinction following perceived contingent control over the stimulus, whereas sadness expressions and lesser arm pulling were associated with removal of a desirable stimulus over which the infant never perceived contingent control. Anger expressions and arm pulling showed similar patterns of increase and decrease across the several key episodes of the procedure. The investigators interpreted their findings as supporting a motivational model in which anger expressions index an approach motivational tendency and sadness expressions index a withdrawal motivational tendency. As noted by the authors, this model does not assume one-to-one correspondence of facial expressions with discrete emotion nor is it primarily concerned with the organization of discrete-emotion expressions. Nonetheless, their studies provide important data relevant to this issue. In the context of their procedure, interpreting the MAX-specified anger and sadness expressions as indexing approach and avoidance tendencies appears reasonable. However, extrapolating to other contexts may be problematic. For example, in an earlier investigation, Sullivan and Lewis (2003) found that when contingent learning was followed by extinction, then both arm pulling and MAX-specified anger expressions increased. However, when contingent learning was followed by loss of the contingency (i.e., loss of stimulus control rather than loss of the desirable stimulus entirely), then covariance between potentially instrumental arm pulling and anger expressions was not found. Instead, MAX-specified anger expressions increased while arm pulling decreased as it was discovered to no longer be functional. These findings suggest that by 4–5 months of age, the links between facial expressions and other action patterns are already flexible in that they are responsive to the particulars of environmental circumstances.

Other studies have explored the relationship between negative facial expressions and negative emotion in a wider array of eliciting situations. As described in the previous edition of this handbook, Camras et al. (2007) conducted a collaborative investigation of 11-month-old European American, Japanese, and Chinese infants responding to an anger/frustration-eliciting situation (arm restraint) and a fear-eliciting situation (a disembodied growling gorilla head). MAX-specified anger expressions were found to predominate in both the anger/frustration situation in which infants struggled to be released from arm restraint and also in the fear situation in which infants produced more bodily stilling, suggesting a withdrawal rather than an approach response. Other mismatches between infant facial expressions and their situationally based predicted emotions have also been documented (Bennett, Bendersky, & Lewis, 2002; Bennett et al., 2005). Such findings suggest that anger expressions may sometimes be associated with intense negative emotion of various types. Further research is necessary to shed light on the factors that influence the contextually variable organization of facial and nonfacial responses within different emotion-eliciting contexts. However, at present, it might seem inadvisable to rely on any single indicator (such as facial expression) to serve as a measure of discrete emotions in infants.

Consistent with this idea, other recent research focusing on infants' and young children's emotional responding has tended not to rely solely on facial behavior. For example, Roben et al. (2012) measured both facial and body behavior in their study of relationships among temperament, crawling experience, and infants' responses in the arm-restraint procedure. Similarly, Melinder, Forbes, Tronick, Fikke, and Gredebäck (2010) include both facial and body behavior in their system for scoring infant responses to the still-face procedure (in which mothers abruptly cease face-to-face interaction with their infants). In studies of toddlers and young children, both Buss and her colleagues (e.g., Hutt, Buss, & Kiel, 2013) and Potegal and his colleagues (e.g., He, Qiu, Park, Xu, & Potegal, 2013) included both facial and body behaviors in their scoring systems. In all cases, researchers made contextually based interpretations of the infants' behaviors (anger in the case of Roben et al. [2012], and protest in the case of Melinder et al. [2010]) that might be considered appropriate to the situation. Still, concluding that infants are angry (or protesting) in such situations is not the same as concluding that the facial expression itself is an invariant marker of that emotion.

Concluding Remarks

To summarize our view of expressive development, we concur with other dynamical systems thinkers in asserting that facial expressions and other components of discrete emotions develop heterochronically—that is, they are not initially associated with one another in the fetus or in very young infants. We further propose that during the course of development, these facial configurations eventually become linked more strongly to other components of their corresponding discrete emotions. Like many others, we believe that this occurs via a combination of maturational processes and socialization experiences.

However, we also wish to suggest that a one-to-one invariant relationship between the prototypical facial expressions and other components of discrete emotions may never arise. In dynamical systems terms, discrete-emotion attractors (i.e., larger ensembles of emotion components) may be variable even in adulthood and thus may or may not include a prototypical emotional facial expression in any particular instance. In addition, as dynamical systems thinkers, we believe that prototypical "emotional" facial configurations may also serve as components of non-emotion-related "attractor states." Thus, they may be systematically produced in non-emotion-related contexts (e.g., when women lift their brows and open their mouths to produce a "surprise" expression while putting on mascara).

Future Directions

In the previous edition of this volume, we identified several directions for future research that would further contribute to our understanding of infant emotional and expressive development, and would allow scholars to evaluate the relative merits and limitations of each theoretical approach described above. Since that time, only limited progress has been made toward these goals. We therefore conclude by reiterating these earlier suggestions.

First, we believe that it is critically important for future researchers to more extensively document the factors associated with the production of various emotional expressions across a wide variety of situations and across a broad developmental time period. This is an essential gap that must be filled in order to proceed to create an account of expressive development within any theoretical framework. To provide a specific example from the dynamical systems perspective, once we determine the age and circumstances under which prototypical fear expressions are produced, we can seek to identify developmental phase shifts and determine the relevant "control parameters" for this expression. Similarly, investigators utilizing other approaches can determine whether the eliciting factors for this expression are consistent with their own theoretical perspective.

Second, we wish to reemphasize our belief that a satisfactory account of emotional expression must also explain the variability described for the emotional expression prototypes themselves. For example, as highlighted by Oster (2005), several different facial configurations are included as "sad" expressions within the MAX and AFFEX coding systems, and these may have very different meanings. With respect to smiling, Fogel and his colleagues (2000) have conducted exemplary work in identifying contextual factors systematically associated with variants of this expression. Further studies should focus on explaining variability within the prototypical expressions described for other discrete emotions. One unique contribution of the dynamical systems approach to the development of emotional expression is to conceptualize both expressions and emotions as variable attractor states rather than fixed entities, and thus to motivate efforts to understand their variability.

In conclusion, we also feel it is important to emphasize that none of the developmental perspectives described above are necessarily inconsistent with findings in the adult literature of various correspondences between emotional expressions and self-reported feeling states. However, we also call for studies that further explore the relationship between facial expression and emotion in older children and adults. By generating more extensive data on children's and adults' production of facial expressions in a wide range of circumstances, we can best ensure that our models accurately reflect the true relationship between expression and emotion throughout the lifespan.

References

Abe, J. A., & Izard, C. E. (1999). A longitudinal study of emotion expression and personality relations in early development. *Journal of Personality and Social Psychology, 77*(3), 566–577.

Ackerman, B. P., Abe, J. A., & Izard, C. E. (1998). Differential emotions theory and emotional development: Mindful of modularity. In M. F. Mascolo & S. Griffin (Eds.), *What develops in emotional development?* (pp. 85–106). New York: Plenum Press.

Barrett, K. C., & Campos, J. J. (1987). Perspectives on emotional development: II. A functionalist approach to emotions. In J. Osofsky (Ed.), *Handbook of infant development* (2nd ed., pp. 555–578). New York: Wiley.

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science, 28*(1), 28–58.

Barrett, L. F., Lindquist, K., & Gendron, M. (2007). Language as a context for emotion perception. *Trends in Cognitive Sciences, 11*, 327–332.

Barrett, L. F., Wilson-Mendenhall, C. D., & Barsalou, L. W. (2015). The conceptual act theory: A road map. In L. F. Barrett & J. A. Russell (Eds.), *The psychological construction of emotion* (pp. 83–110). New York: Guilford Press.

Bennett, D., Bendersky, M., & Lewis, M. (2002). Facial expressivity at 4 months: A context by expression analysis. *Infancy, 3*(1), 97–113.

Bennett, D., Bendersky, M., & Lewis, M. (2005). Does the organization of emotional expression change over time?: Facial expressivity from 4 to 12 months. *Infancy, 8*, 167–187.

Bridges, K. M. B. (1932). Emotional development in early infancy. *Child Development, 3*, 324–341.

Campos, J., Kermoian, R., & Zumbahlen, M. (1992). Socioemotional transformations in the family system following infant crawling onset. In N. Eisenberg & R. Fabes (Eds.), *New directions for child development: Vol. 55. Emotion and its regulation in early development* (pp. 25–40). San Francisco: Jossey-Bass.

Camras, L. A. (1991). Conceptualizing early infant affect: View II and reply. In K. Strongman (Ed.), *International* *review of studies on emotion* (pp. 16–28, 33–36). New York: Wiley.

Camras, L. A. (1992). Expressive development and basic emotion. *Cognition and Emotion, 6*(3/4), 269–283.

Camras, L. A. (2000). Surprise!: Facial expressions can be coordinative motor structures. In M. Lewis & I. Granic (Eds.), *Emotion, development and self-organization* (pp. 100–124). New York: Cambridge University Press.

Camras, L. A. (2011). Differentiation, dynamical integration and functional emotional development. *Emotion Review, 3*(2), 138–146.

Camras, L. A., Lambrecht, L., & Michel, G. (1996). Infant "surprise" expressions as coordinative motor structures. *Journal of Nonverbal Behavior, 20*, 183–195.

Camras, L. A., Malatesta, C., & Izard, C. (1991). The development of facial expressions in infancy. In R. Feldman & B. Rimé (Eds.), *Fundamentals of nonverbal behavior* (pp. 73–105). Cambridge, UK: Cambridge University Press.

Camras, L. A., Meng, Z., Ujiie, T., Dharamsi, S., Miyake, K., Oster, H., et al. (2002). Observing emotion in infants: Facial expression, body behavior and rater judgments of responses to an expectancy-violating event. *Emotion, 2*, 178–193.

Camras, L. A., Oster, H., Bakeman, R., Meng, Z., Ujiie, T., & Campos, J. J. (2007). Do infants show distinct negative facial expressions for different negative emotions?: Emotional expression in European-American, Chinese, and Japanese infants. *Infancy, 11*(2), 131–155.

Camras, L. A., & Shutter, J. M. (2010). Emotional facial expressions in infancy. *Emotion Review, 2*(2), 120–129.

Camras, L. A., & Witherington, D. C. (2005). Dynamical systems approaches to emotional development. *Developmental Review, 25*, 328–350.

Crossman, A., Sullivan, M., Hitchcock, D., & Lewis, M. (2009). When frustration is repeated: Behavioral and emotion responses during extinction over time. *Emotion, 9*(1), 92–100.

Darwin, C. (1998). *The expression of the emotions in man and animals*. New York: Oxford University Press. (Original work published 1872)

Dondi, M., Gervasi, M. T., Valente, A., Vacca, T., Borana, G., Bellis, I., et al. (2014). Spontaneous facial expressions of distress in fetuses. In C. De Sousa (Ed.), *Proceedings of the 14th European Conference on Facial Expression* (pp. 34–47). Lisboa, Portugal.

Dondi, M., Messinger, D. S., Colle, M., Tabasso, A., Simion, F., Dalla Barba, B., et al. (2007). A new perspective on neonatal smiling: Differences between the judgments of expert coders and naïve observers. *Infancy, 12*, 235–255.

Ekman, P. (1972). Universals and cultural differences in facial expressions of emotion. In J. Cole (Ed.), *Nebraska Symposium on Motivation* (pp. 207–283). Lincoln: University of Nebraska Press.

Ekman, P. (1982). *Emotion in the human face* (2nd ed.). Cambridge, UK: Cambridge University Press.

Ekman, P. (1994). All emotions are basic. In P. Ekman & R. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 15–19). New York: Oxford University Press.

Ekman, P. (2003). *Emotions revealed: Recognizing faces and feelings to improve communication and emotional life*. New York: Holt.

Ekman, P., Friesen, W. V., & Hager, J. C. (Eds.). (2002). *Facial action coding system*. Salt Lake City, UT: Research Nexus, Network Research Information.

Ekman, P., Sorenson, E., & Friesen, W. (1969). Pan-cultural elements in facial display of emotion. *Science, 164*, 86–88.

Emde, R. N., & Koenig, K. (1969). Neonatal smiling and rapid eye movement states. *American Academy of Child Psychiatry, 11*(2), 117–200.

Fogel, A. (1985). Coordinative structures in the development of expressive behavior in early infancy. In G. Zivin (Ed.), *The development of expressive behavior* (pp. 249–267). New York: Academic Press.

Fogel, A., Nelson-Goens, G., Hsu, H., & Shapiro, A. (2000). Do different infants smiles reflect different positive emotions? *Social Development, 9*(4), 497–520.

Fogel, A., Nwokah, E., Dedo, J., Messinger, D., Dickson, K., Matusov, E., et al. (1992). Social process theory of emotion: A dynamic systems approach. *Social Development, 1*(2), 122–142.

Fogel, A., & Thelen, E. (1987). The development of early expressive and communicative action. *Developmental Psychology, 23*, 747–761.

Fridlund, A. (1994). *Human facial expression*. San Diego, CA: Academic Press.

Haviland-Jones, J. M., Boulifard, D., & Magai, C. (2001). Old–new answers and new–old questions of personality and emotion: A matter of complexity. In H. A. Bosma & E. S. Kunnen (Eds.), *Identity and emotion: Development through self-organization* (pp. 151–171). Cambridge, UK: Cambridge University Press.

He, J., Qiu, P., Park, K. Y., Xu, Q., & Potegal, M. (2013). Young Chinese children's anger and distress: Emotion category and intensity identified by the time course of behaviors. *International Journal of Behavioral Development, 37*(4), 349–356.

Hiatt, S., Campos, J., & Emde, R. (1979). Facial patterning and infant emotional expression: Happiness, surprise, and fear. *Child Development, 50*, 1020–1035.

Holodynski, M., & Friedlmeier, W. (2006). *Development of emotions and their regulation: A socioculturally based internalization model*. Boston: Kluwer Academic.

Huebner, R. R., & Izard, C. E. (1988). Mothers' responses to infants' facial expressions of sadness, anger, and physical distress. *Motivation and Emotion, 12*, 185–196.

Hutt, R., Buss, K., & Kiel, E. (2013). Caregiver protective behavior, toddler fear and sadness, and toddler cortisol reactivity in novel contexts. *Infancy, 18*(5), 708–728.

Izard, C. E. (1971). *The face of emotion*. New York: Appleton-Century-Crofts.

Izard, C. E. (1991). *The psychology of emotions*. New York: Plenum Press.

Izard, C. E. (1995). *The Maximally Discriminative Facial Movement Coding System*. Unpublished manuscript.

Izard, C. E. (2009). Emotion theory and research: Highlights, unanswered questions, and emerging issues. *Annual Review of Psychology, 60*, 1–25.

Izard, C. E., & Abe, J. A. (2004). Developmental changes in facial expression of emotions in the strange situation during the second year of life. *Emotion, 4*(3), 251–265.

Izard, C. E., & Ackerman, B. P. (2000). Motivational, organizational, and regulatory functions of discrete emotions. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed., pp. 253–264). New York: Guilford Press.

Izard, C. E., Dougherty, L., & Hembree, E. (1983). *A system for identifying affect expressions by holistic judgments (AFFEX)*. Newark: Instructional Resources Center, University of Delaware.

Izard, C. E., Fantauzzo, C. A., Castle, J. M., Haynes, O. M., Rayias, M. F., & Putnam, P. H. (1995). The ontogeny and significance of infants' facial expressions in the first 9 months of life. *Developmental Psychology, 31*(6), 997–1013.

Izard, C. E., Hembree, E. A., & Huebner, R. R. (1987). Infants' emotion expression to acute pain: Developmental changes and stability of individual differences. *Developmental Psychology, 23*(1), 105–113.

Izard, C. E., Huebner, R. R., Risser, D., McGinnes, G. C., & Dougherty, L. M. (1980). The young infant's ability to produce discrete emotion expressions. *Developmental Psychology, 16*, 132–140.

Izard, C. E., & Malatesta, C. (1987). Perspectives on emotional development: I. Differential emotions theory of early emotional development. In J. Osofsky (Ed.), *Handbook of infant development* (2nd ed., pp. 494–554). New York: Wiley.

Izard, C. E., Woodbum, E. M., & Finlon, K. J. (2010). Extending emotion science to the study of discrete emotions in infants. *Emotion Review, 2*, 134–136.

Kärtner, J., Holodynski, M., & Wörmann, V. (2013). Parental ethnotheories, social practice and the culture-specific development of social smiling in infants. *Mind, Culture and Activity, 20*, 71–95.

Keller, H. (2007). *Cultures of infancy*. Mahwah, NJ: Erlbaum.

Keller, H., & Otto, H. (2009). The cultural socialization of emotion regulation during infancy. *Journal of Cross-Cultural Psychology, 40*(6), 996–1011.

Kelso, J. (1995). *Dynamic patterns*. Cambridge, MA: MIT Press.

Lavelli, M., & Fogel, A. (2013). Interdyad differences in early mother–infant face-to-face communication: Real-time dynamics and developmental pathways. *Developmental Psychology, 49*(12), 2257–2271.

Lewis, M. (2014). *The rise of consciousness and the development of emotional life*. New York: Guilford Press.

Lewis, M., Ramsay, D. S., & Sullivan, M. W. (2006). The relation of ANS and HPA activation to infant anger and sadness response to goal blockage. *Developmental Psychobiology, 48*, 397–405.

Lewis, M. D., & Douglas, L. (1998). A dynamic systems approach to cognition–emotion interactions in development. In M. F. Mascolo & S. Griffin (Eds.), *What develops in emotional development?* (pp. 159–188). New York: Plenum Press.

Magai, C., & Haviland-Jones, J. M. (2002). *The hidden genius of emotion*. Cambridge, UK: Cambridge University Press.

Matias, R., & Cohn, J. (1993). Are MAX-specified infant facial expressions during face-to-face interaction consistent with differential emotions theory? *Developmental Psychology, 29*(3), 524–531.

Matsumoto, D., Keltner, D., Shiota, M. N., O'Sullivan, M., & Frank, M. (2008). Facial expressions of emotion. In M. Lewis, J. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 211–234). New York: Guilford Press.

Melinder, A., Forbes, D., Tronick, E., Fikke, L., & Gredebäck, G. (2010). The development of the still-face effect: Mothers do matter. *Infant Behavior and Development, 33*(4), 472–481.

Messinger, D. (2008). Smiling. In M. M. Haith & J. B. Benson (Eds.), *Encyclopedia of infant and early childhood development* (Vol. 3, pp. 186–198). Oxford, UK: Elsevier.

Messinger, D., Dondi, M., Nelson-Goens, G., Beghi, A., Fogel, A., & Simion, F. (2002). How sleeping neonates smile. *Developmental Science, 5*, 48–54.

Messinger, D., & Fogel, A. (2007). The interactive development of social smiling. In R. Kail (Ed.), *Advances in child development and behavior* (Vol. 35, pp. 327–366). Oxford, UK: Elsevier.

Messinger, D., Fogel, A., & Dickson, K. (1999). What's in a smile? *Developmental Psychology, 35*(3), 701–708.

Messinger, D., Fogel, A., & Dickson, K. (2001). All smiles are positive, but some smiles are more positive than others. *Developmental Psychology, 37*(5), 642–653.

Messinger, D., Mattson, W., Mahoor, M., & Cohn, J. (2012). The eyes have it: Making positive expressions more positive and negative expressions more negative. *Emotion, 12*, 430–436.

Michel, G., Camras, L., & Sullivan, J. (1992). Infant interest expressions as coordinative motor structures. *Infant Behavior and Development, 15*, 347–358.

Oster, H. (2005). The repertoire of infant facial expressions: An ontogenetic perspective. In J. Nadel & D. Muir (Eds.), *Emotional development* (pp. 261–292). Oxford, UK: Oxford University Press.

Oster, H. (2012). *BabyFACS: Facial Action Coding System for Infants and Young Children*. Unpublished monograph and coding manual, New York University, New York.

Oster, H., Hegley, D., & Nagel, L. (1992). Adult judgments and fine-grained analysis of infant facial expressions: Testing the validity of a priori coding formulas. *Developmental Psychology, 28*, 1115–1131.

Parladé, M. V., & Iverson, J. M. (2011). The interplay between language, gesture and affect during communicative transition: A dynamic systems approach. *Developmental Psychology, 47*(3), 820–833.

Reissland, N., Francis, B., & Mason, J. (2011). Do facial expressions develop before birth? *PloS ONE*, 6(8), e24081.

Reissland, N., Francis, B., & Mason, J. (2013). Can healthy fetuses show facial expressions of "pain" or "distress"? *PloS ONE, 8*(6), e65530.

Roben, P., Caroline, K., Bass, A. J., Moore, G. A., Murray-Kolb, L., Tan, P. Z., et al. (2012). Let me go: The influences of crawling experience and temperament on the development of anger expression. *Infancy, 17*(5), 558–577.

Russell, J. A. (1994). Is there universal recognition of emotion from facial expression?: A review of the cross-cultural studies. *Psychological Bulletin, 115*, 102–141.

Slater, R., Cantarella, A., Yoxen, J., Patten, D., Potts, H., Meek, J., et al. (2009). Latency to facial expression change following noxious stimulation in infants is dependent on postmenstrual age. *Pain, 146*(1), 177–182.

Sroufe, L. A. (1996). *Emotional development*. New York: Cambridge University Press.

Sullivan, M., & Lewis, M. (2003). Contextual determinants of anger and other negative expressions in young infants. *Developmental Psychology, 39*, 693–705.

Thelen, E. (1989). Self-organization in developmental processes: Can systems approaches work? In M. R. Gunnar & E. Thelen (Eds.), *Minnesota Symposium on Child Psychology: Vol. 22. Systems and development* (pp. 77–118). Hillsdale, NJ: Erlbaum.

Tomkins, S. (1962). *Affect, imagery, consciousness: Vol. 1. The positive affects*. New York: Springer.

Weinberg, K., & Tronick, E. (1994). Beyond the face: An empirical study of infant affective configurations of facial, vocal, gestural, and regulatory behaviors. *Child Development, 65*, 1503–1515.

Wolff, P. (1987). *The development of behavioral states and the expression of emotions in early infancy*. Chicago: University of Chicago Press.

Wörmann, V., Holodynski, M., Kärtner, J., & Keller, H. (2012). A cross-cultural comparison of the development of the social smile: A longitundinal study of maternal and infant imitation in 6- and 12-week-old infants. *Infant Behavior and Development, 35*(3), 335–347.

CHAPTER 15

THE EMERGENCE OF HUMAN EMOTIONS

Michael Lewis

Here in this chapter, the emergence of the emotional life of humans is considered. In spite of some interest in age differences in emotional expression, there has been relatively little focus on the developmental process itself. Rather, specific emotions, such as fear, joy, anger, and sadness, have been studied, with claims focusing either on the innate features and processes or on socialization factors each most often studied in isolation. Even methodology differs, with some studies exploring enduring states such as moods, using maternal or child reports, as well as actual measurement of the infant's/child's behavior. Different contexts for different emotions have been studied. Fear, for example, has been examined by looking at the visual cliff paradigm or in the approach of a stranger (Lewis & Rosenblum, 1974). The claim that these contexts and the behaviors examined represent fear is now being challenged (Adolph, Kretch, & LoBue, 2014). From their analysis, we can gather that rather than fear, what has been examined is the infant's/toddler's attention to changes in his or her physical and social worlds. Changes bring attention, and with it, orientation toward the change, cessation of ongoing activity, and physiological responses such as changes in heart rate or cortisol (Lewis, Kagan, Kalafat, & Campbell, 1966). The idea is that the determination of the valence of the change, a cognitive-evaluative process, appears to allow for more specific responses including fearfulness, wariness, and interest, a multiple emotional response (Lewis, 2011; Lewis, Goldberg, & Rausch, 1967; Lewis & Rosenblum, 1974; Sroufe & Wunsch, 1972). Other emotions such as sadness or anger have also been examined, with greater agreement as to what behaviors might represent these emotions, although there is still no consensus in regard to anger.

While the study of individual emotions provides valuable information, what will be proposed here, as elsewhere,[1] is that what is needed to advance our understanding of emotional development is a framework for the developmental process itself, as well as a more complete understanding of the importance of action patterns and the role of consciousness and other cognitions in the creation of human emotional life. This requires an articulation and integration of what has been learned about development in the last 30 years. The framework for the model I propose is both biological and constructional, as well as their interaction. I look at both the evolutionary-derived givens that define human beings, including early structures that allow the child to enter and engage his or her physical and social world—action patterns—as well as the uniqueness of each child both in his or her temperament, another biological feature, as well as the child's unique social and cognitive experiences and their interaction. In addition, a cognitive-attributional approach is required as the child's cognitive development proceeds.

This bioconstructivist framework cannot exist without consideration of the rise of consciousness as a developmental process and the role it plays in the life of the child as he or she engages in a reciprocal interaction with his or her world. Most developmental models lack such a view, leaning on models of either innate evolutionary-derived features and processes or on learning, the cauldron of such learning being the mother–infant interaction. Although more of this will be made later, it seems clear enough that the social interaction of mother and infant cannot produce the feelings of, say, anger, only what situations evoke it, how often, and how they are expressed. The feeling per se, anger, is likely a given, much like our seeing "red," or an early reflex such as the Moro response. While we know which cones fire at a certain wavelength, the experience of redness is not learned. The same is true for the Moro reflex. Consider another case, that of walking: the reflex for this is available at birth and exists as a feature of humanness. This model is similar to Kant's (1781/1958) proposal in that experience is assimilated into innate structures, although it is possible that experience can produce structures (Hume, 1739/1888). More likely it is some mixture, but nevertheless, there are some innate structures so that the newborn can survive long enough for experience to have an effect. Although these may be biological givens, individual differences as a function of temperament and interaction with the social world can modify them and utilize them for a variety of functions other than the reflex itself. Both evolutionary givens and a constructivist process have merit and here I do not pit one against the other, but rather utilize the development of consciousness as a bridge between the two (Lewis, 2014).

Figure 15.1 displays the model to be articulated; it suggests a major developmental transition that has as its center the emergence of consciousness, prior to which emotional features such as innate action patterns, made up of facial, vocal, and body movement, as well as physiological processes in context, are transformed by consciousness into ideas, mostly ideas about the self and therefore, feelings. While action patterns in context are open to socialization as well as individual differences like temperament, the processes, but not the content, of consciousness is made up mostly by maturation of specific brain regions. These early action patterns, as well as new action patterns of self-consciousness, are transformed by ideas and are therefore *most* open to socialization processes.

Perhaps the best example of this process can be seen in the study of disgust. Consider this example:

> Soon after birth, Maron is given a sour tasting food. His nostrils flare, his upper lip raises, and his tongue protrudes from his mouth. "He really doesn't like it," his father says, "What a disgusted face." In fact, the facial coding systems of Izard or Ekman would measure his facial expression as one of disgust. Five years later, after Maron sees his younger brother throw up, he says, "How disgusting," while at the same time lifting his upper lip and flaring his nostrils. His facial and motor behaviors again would be scored as disgust. He is disgusted by the look of the vomit. At age 13, Maron watches a TV news report where a Vietnamese army officer raises a pistol to a prisoner's head and shoots him dead. "That's disgusting," he says as he flares his nostrils and raises his upper lip.

We can see in this vignette, the developmental process that any theory of emotional development has to attend to. While the action pattern of the facial expression of disgust remains relatively consistent over time, the same face can have many meanings. On the other hand, even the facial expression might have changed for many reasons. For

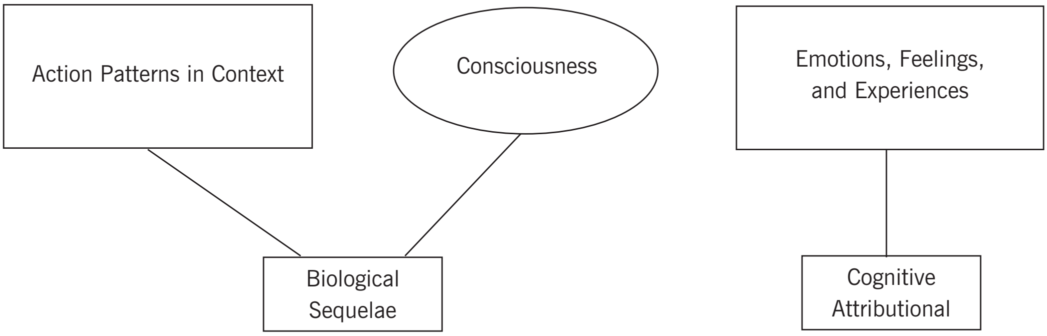

FIGURE 15.1. The development of the emotional life of the human child.

example, in any culture where such facial expressions are frowned upon, the facial movement could be suppressed. Or if Maron thought that showing a disgust face might hurt his brother's feelings, he might not show it, either by hiding his face or by transforming it into some other facial expression. Later, as an adolescent he may react to the killing with an exaggerated face of disgust in order to impress others as to his feelings about such inhuman behavior as the killing of another person. In a study of nurses, Ekman (1985) suggested that in order to properly care for patients, nurses needed to suppress their disgust looks. While he claimed that they could do so, he claimed that small disgust movements were still detectable.

This facial expression that we see occur during Maron's early life will be called action patterns. At the beginning of life these are elicited by specific physical events in the infant's world. However, with maturation and with the effects of the child's social niche, the action pattern is transformed. His facial movement, as well as other features of his action pattern, are not learned; they are the consequences of the evolved adaptive process, but are highly flexible and are influenced by his history of transactions within his particular social environment. We humans have many of these action patterns, and as has been shown, they can be found in our emotional, social, and cognitive domains. We have used a variety of names for these action patterns: instincts, innate releasing mechanisms, genotypic behavior, procedural rules, and the machinery of the self, among others. It is now appreciated that the human newborn arrives with a multitude of complex behavioral patterns that connect him or her to his or her physical world (Gopnik, Meltzoff, & Kuhl, 1999).

The difficulties with observing these unique action patterns are many. They include our inability to understand how to parse events in the world in order to look at the infant's response to them. Following Darwin's (1872) suggestion that anger is an approach emotion to overcome a specific barrier, my colleagues and I have attempted to study anger by looking at a highly specific event such as the blocking of a previously attained goal (Lewis, Alessandri, & Sullivan, 1990). Although elsewhere we have spent considerable time talking about the anger action pattern, we have in the past looked at other action patterns and found that for the very young infant the action pattern of interest is not learned and consists of receptor orientation, cessation of bodily motion, and heart rate decreases when looking or listening to sounds in the physical world (Kagan & Lewis, 1965; Lewis, Kagan, & Kalafat, 1966; Lewis, Kagan, Kalafat, & Campbell, 1966). Moreover, the newborn shows a disgust-like action pattern to something tasting bitter, but as has been shown by Mennella (2012), early exposure to bitter tastes is quite capable of affecting individual differences in the disgust action pattern. While disagreement about these biologically derived action patterns exists, it seems there is sufficient evidence of their existence to use them within a theory of development. The problem of most concern has to do with individual differences in an action pattern that are temperamentally based. Because one child has an easy temperament, his or her disgust face is likely to occur less often than a child who has a difficult temperament. These temperament differences can hold for any action pattern, and we need to study this variation.

Now, let us look at the developmental pattern that the vignette about Maron's disgust reveals. His early disgust face was to the bitter taste and reflected an unlearned action pattern. All information about the precipitating event and his reaction to it exists for him only at the machine level of self. Maron's action pattern at 5 years of age when seeing his brother's upset stomach has the same facial features as when he was a newborn, but now there has been considerable development. He has had many experiences of disgust. Smells and tastes originally produced them but now he can be disgusted by such things as seeing a bug or a snake. Even pictures are capable of producing disgust, for example, a picture of a dead or mutilated body, or even feces. The list of events now capable of eliciting disgust has expanded and includes representations of physical events such as pictures of things (see Disgust, Chapter 46, this volume).

By this age, Maron has also acquired information about the causes of disgust reactions. He knows that vomiting means that his brother is sick, either from something he has eaten, or some thought that might have caused him discomfort, even like looking at a picture of something he thinks is horribly disgusting like a running nose. He also knows what may happen after he is no longer sick. In addition, he knows about his disgust, and can remember how he felt when he had been sick. His disgust, still an action pattern, is now full of ideas including words for it in his language.

Without doubt the most important developmental change that has taken place is that Maron feels—that is, he has the ability to experience his disgust. He can also give to this feeling all sorts of meaning, including causes and consequences (see Understanding Emotion, Chapter 16, this volume). He knows that he is disgusted, and if he chooses, he can mask his facial expression or even exaggerate it, depending on whether he wants to make his brother feel better or worse. *For Maron, the action pattern and his experiences of it in context have become for him the unit of his emotional life, and these are inseparable.*

Important developmental events have occurred that are in need of further study. For example, what was Maron's history of disgust elicitors? Has he experienced many situations of disgust? What is his temperament like, and how easily is he disgusted? How readily does he recover from a disgust elicitor? What did his parents do or say to him when he was disgusted? Did they use the term "disgusting" in any other context? For example, did they say to him, "Your behavior is disgusting"? We also need to know what Maron knows about disgust. Does he know what events produce it for him? What does he think about others' expression of disgust? It is also important for any theory of development to study whether individual differences in the disgust action pattern in infancy are maintained after consciousness emerges. The relation among individual differences in early disgust, socialization rules, and the emergence of consciousness are in need of study. To answer these questions requires much more knowledge of the developmental trajectories for individuals in their particular family and culture.

Maron at 13 years of age exhibits moral disgust. For him, the observation of a moral violation elicits disgust. While someone being shot itself may elicit Maron's disgust because of body disfigurement, it is more likely that the cruelty of the action of someone killing another has become the elicitor of his disgust. What is remarkable is that at 13 he shows us the same action pattern that is now elicited by his ideas of right and wrong. The developmental process appears to utilize this action pattern for a different elicitor—knowledge about rules, goals, and standards that are ideas about what is right or wrong. The utilization of the same action pattern conserves this innate pattern while adding to the physical elicitors ideas as elicitors. It is as if the energy or motive power of the original action pattern has become functionally independent of its original elicitor and can now be used by the culture to enforce its moral codes.

The child's trajectory over age allows us to study the possible models of development. We can observe that while new elicitors produce disgust, many of the original ones continue to do so. The model suggested by such a case is one we have called an "additive growth model," wherein the old elicitors are not replaced but new ones are added to them (Lewis, 1997). There is little transformation in the nature of the action pattern. What is transformed is mediated by the emergence of consciousness. With self-reflection Maron knows that he is disgusted and he knows that if he behaves in a certain way, others like his brother will know he is disgusted. The recursive idea of "he knows that he knows that he is disgusted by his vomit" takes place only after the emergence of his consciousness.

This transformation may help our understanding of phylogenetic change. While disgust may be an action pattern existing for many animals besides humans, it is only humans with consciousness who can utilize such ideas. While we have been discussing the disgust action pattern, we could have just as easily considered others. For all action patterns, consciousness brings new elicitors in addition to specific events of the physical world. Sadness over the loss of a desired object becomes sadness over the idea of the potential loss; fear over uncertainty becomes fear over the idea of uncertainty, or its opposite, excitement over what might come next. We know little about these transformations and there is much to learn. What we do know is that these transformations have something to do with the emergent ability to have ideas, ideas about the self and how the world works. Individual differences in this transformation have to do with both the culture in which the child is embedded and his or her temperament.

Problems of Language

For purposes of clarity we need to consider several commonly used words, such as "emotion," "experience," "consciousness," and "feelings." Emotions are what have been defined above. Feelings indicate our thoughts about ourselves. "Feelings," "thoughts about ourselves," and "experiences" are all terms having similar meaning; they are my experience of me, or what is meant by consciousness. The task in studying the development of emotions is not only to find ways to observe these action patterns in context and to measure them, but of equal importance, to study the child's experience of them.

Darwin (1872) suggested that emotions were action patterns, having external signs as well as internal states that could be found in expressions in the face, voice, and posture of humans and beasts. Certainly, in everyday life we seem to believe that facial expressions and internal states are likely to go together. When someone cries at a funeral, we tend to assume that he or she is sad. Yet, we humans are capable of masking our behavior. Deception in terms of facial expression is as real a feature of emotional life as facial expressions reflecting what we are really experiencing. While internal changes may exist, the history of the study of emotion over the last 100 years reveals that we have not been able to measure them very well (Bard, 1934; Cannon, 1927; Lewis, 2011). This lack of measurement has led to the belief that there are no internal changes and that all there is are thoughts. Such a belief holds that the discrete emotions are nothing more than different ways of thinking about things. Emotion only as thought relegates emotion to second-class status by making it an epiphenomenon of thought. The model argues against these strong forms that suggest that emotions are action patterns or that they are only thoughts; rather, emotions involve both.

In the theory of emotional development presented here, Darwin's (1872) thoughts about action patterns are that they are shared by many animals including humans. However, biological properties interact with human consciousness in specific cultures. Consider the example we call "sadness." Sad behavior over loss seems likely to be either innate or readily learned. However, one child may have more sadness than another as a function of his or her temperament and environmental differences in the amount of loss that occurred, and these will affect and produce individual differences.

The problem of the nature of emotion also makes the study of development that much harder. For example, do children have the same emotions as adults? Does the child's sadness over his or her mother leaving him or her at the babysitter's represent the same sadness that the child's mother feels when she leaves the child? When we address the question of whether human adults have the same action patterns and thoughts that children do, we are immediately met by the same question in an adult. For example, when I say I am fearful of a hornet stinging me, do I mean that I have the same feeling as when I say I am fearful that there is someone following me down a dark street? Is fear in one situation the same as fear in another? These questions lead to the belief that my experiences of myself and my action patterns are only loosely related and that they may be different things. We assume that our experiences, our thoughts about our action patterns in context, are not the same as the action patterns themselves. Thus, my experience of my fear is likely to differ as a function of the causes that elicit it.

Emotional life is made up of a set of three features. The first is *emotional elicitors*, physical events in the world and later in the infant's development of his or her thoughts or ideas. The second feature is the *action patterns*, including expressions that have evolved and that are located somewhere in the body. The third is *the ability of the child to experience his or her action patterns*, the ability to think of him- or herself. By dividing the term "emotion" into these features, the development of emotional life becomes clearer.

Also, there is probably no advantage in using the common term "emotion" to cover what we may mean since the term has a surfeit of meanings. As in both Lewis and Michalson's (1983) and Frijda's (1986) classification system, the term "emotion" was deconstructed into several of its component parts as just mentioned.

Thus, action patterns are innate responses based on our evolutionary past that are adaptive behaviors designed for action in response to specific environmental events; these events are called *elicitors*. However, because innate responses are inherently plastic, they are affected by individual differences in children's temperaments, their concurrent environmental conditions, and the cultural rules that we call "socialization." Because of this inherent flexibility, the difficulties in finding a close association between an elicitor and an action pattern should not be taken to negate the assumption that there are such innate responses. In addition to this inherent flexibility, two other difficulties exist that make the association between physical events and action even more difficult to observe. One has to do with the nature of the elicitor itself. For the most part the elicitors used in research to date tend to be multiple (e.g., holding down an infant's arms and restraining him or her is made up of multiple elicitors including movement toward the child, physical contact, smiling, and unexplained action that is not in keeping with the preceding events). Since multiple elicitors are involved, the association between them and a single action pattern would be hard to observe. One solution to this problem is to very carefully select the elicitor to be used. In our work, we used a single specific elicitor, the blockage of a learned response to a desired goal, to study anger since from Darwin (1872) on it has been argued that such a blockage should elicit anger, which is just what we observed in infants as young as 2 months old (Lewis et al., 1990). When careful choices of elicitors are made, we are more likely to find a greater association between them and specific action patterns.

Multiple Emotions

Another issue that is likely to prevent our ability to examine innate response is the real possibility that multiple emotions, even to a specific elicitor, are more likely the rule than single emotions. At least our adult sense suggests that at the funeral of a friend we may likely experience both sadness and fear, or at the wedding of a daughter both joy and sadness. The nature of emotional life may be made up of a fugue, with the flow of emotions and thoughts entwined so that multiple emotions rather than *an* emotion may be what our lives are made up of. It is only when we try to study them in the laboratory that we break the flow apart.

If we reject the idea of an innate response to a specific context, we are left with the unanswered question of how action patterns, including facial and bodily expressions as well as physiological responses, are organized (see The Development of Facial Expressions, Chapter 14, this volume). The idea that these complex coherences are socialized, that is, they are learned, is difficult to imagine and there is no direct evidential support that they are acquired. It is mostly the fact that there is difficulty in finding specificity between facial expression and contexts that moves us toward accepting the acquired theoretical viewpoint. At the moment we need to accept the idea that action patterns such as fear, joy, and sadness are part of the human condition, but at the same time these action patterns are inherently flexible.

Feelings

We all use the term "feeling" in describing our emotions. I can say to you that I am feeling happy, and it is because of both our common language and mentalism, that is, your knowledge that you and I share internal states such as thoughts, desires, motives, and the like, that you can find in yourself what I am feeling. In fact, my feeling of happiness may make you feel happy. But what, then, does feeling happy mean? As suggested, the terms "feelings," "thoughts about myself," "experience of me," and "consciousness" all speak to the process that assesses something about me.

The child's ability to access either his or her bodily states or thought about him- or herself is dependent on the child's ability to be able to know about him- or herself; first, that there is a self, a me, and second, that there is some unique combination between the self and action patterns in context. It is this self-referential ability that is used to denote the term "consciousness." Consciousness is not about the aboutness of what is accessed, the content; it is the process of accessing itself.

But there is another use of the word "feeling" and for that matter the word "self-experiencing," and it is this usage that gets us into difficulties when we discuss emotional development. Consider how we might think about these two different meanings of the word "feeling." I am at the dentist's office and he wants to fill a cavity. He gives me a shot of Novocain and after a moment or two he pricks my gums and asks, "Do you *feel* this?," meaning, "Does it hurt?" My answer is that I do not *feel* it. He then begins to perform a procedure. If we had a meter that was capable of measuring pain at the pain receptors in my gums or along the neural pathway from the receptors to some central processor, it would register as pain. From a physiological perspective I have pain, but I do not *feel* pain. It does not mean that the body does not experience the pain in some way, nor does it mean that much pain will not have a powerful effect later in life. What it does mean is that I am not conscious of the pain; I do not feel it.

Another example does not involve pain, since some might say that pain is a special case. A patient with her corpus callosum severed because of her epileptic attacks is asked to haptically finger a wooden number under a blanket so that she cannot see her fingers move nor see the number, and by raising her fingers, she tells the experimenter what number she felt, a question that she can answer easily. However, when the experimenter asks her to tell out loud what the number was, she cannot tell him; "I don't know," she says. She clearly knows since she raised her fingers correctly but yet she does not know what it is that she knows (Gazzaniga, 1988). But isn't this what we mean by consciousness?

Our bodies have a life of their own; they know many things that we, our consciousness, do not know. Our bodies know that when we eat too much sugar, they need to secrete insulin. This is something known by ourselves, that is, by our bodies, but not known by our consciousness. We cannot readily access many things that are happening in us. In all these examples we can see that some part of us, our body, is experiencing something that enables other parts of our body to act. But we, our conscious selves, do not know of it, and therefore we cannot feel it.

This claim, therefore, is that before we can think about ourselves, before there is self-referential behavior, and therefore before consciousness, the infant may have or be in a particular state as a consequence of a particular elicitor; however, the infant is not able to think about or experience that state as we adults do. Thus, if we restrict feeling to the body, then, of course, we can say a newborn feels pain. But if we mean that the infant can access this bodily state and know that it is his or her pain, then no, he or she does not feel pain. The infant does not have the privilege of the first person, reflected in the statement, "I am in pain." To avoid the problem with the word "feeling" I use the terms "experience" or "consciousness" to speak not of bodily action, but of ideas about the self.

Consciousness

The issue of consciousness is tied to feelings and plays an important role in any theory of emotional development (see Lewis, 2014). Since the development of consciousness is central, ways to measure it are important. Looking at self-referential measures, such as touching the marked nose while looking in the mirror, enables us to understand that the child knows that the image *there* in the mirror is located *here* in space, the same here in which I stand; this is also demonstrated in self-referential language such as in the use of personal pronouns like "me" and "mine," and in pretend play in which the child reveals that he or she knows that something he or she is doing is not literal. When we talk about consciousness we are not making reference to a consciousness that is not conscious since in effect this is what Freud tried to do.

However, if we stop for a moment and think about all the different things we do that we are not conscious of, from solving a problem to rote physical activity, or from speaking sentences without knowing what will come next to suddenly remembering, it seems clear that there is something in there, and that something is likely to be sets of processes, habits, and the like. Some who are interested in this problem have called the thing inside *procedural rules*, others have called them *action patterns*, *instincts*, or *innate releasing mechanisms*, and still others *preconsciousness* or even *unconsciousness*. This thing or things inside us are not unconscious but rather not conscious. Perhaps it is useful to think of them as *the machinery of the self* or core bodily processes; this machinery is a highly organized, complex, evolutionary-adapted set of processes that control both the internal workings of our bodies and much of our dealings with the outside world. This machinery is innate but highly plastic and capable of learning. But what is it? Is it a modular system made up of many parts that are organized in some fashion, or some highly interactive system in which the activity of the whole system is what determines the outcome?

So when does consciousness emerge in the human child or, for that matter, when does it emerge in the evolution of life on earth? To ask this question is to suppose that there is a way to measure consciousness. I have proposed and tried to show that there are measures that are related to consciousness and that is self-referential behavior. The ability to make reference to oneself is a reasonable measure of consciousness that can be measured by self-recognition in mirrors as well as in the use of personal pronouns and in pretend play. I do not go into the argument here since a considerable amount of time has been spent on it elsewhere (Lewis & Ramsay, 2004), however, the coherence between these measures and the subsequent development of the self-conscious emotions such as embarrassment, shame, and pride suggest that these self-referential measures are a good approximation. Our studies suggest that consciousness develops in the human child sometime in the middle of the second year of life and that it can be seen in self-referential behaviors. The rise of consciousness has a profound effect on the development of a child's emotional life (Lewis, Sullivan, Stanger, & Weiss, 1989).

There is a claim that consciousness is only an idea and that for other cultures this consciousness either does not occur or that it is a collective consciousness (Keller et al., 2004; Markus & Katayama, 1991). However, such an argument has to do with the aboutness of consciousness and that is not what I am referring to. The aboutness is a cultural artifact. However, consciousness, the self-referential ability, is more likely a function of the nature of the human brain. Shweder (1985) has shown that in some cultures there is a we–self aboutness. However, even in we–self cultures there is no question that when a woman is menstruating, and therefore considered to be polluted, it is the woman herself who is not touchable. Even in we–self cultures the idea of a person bounded and separated from other such selves plays some role.

Having consciousness creates the challenge of maintaining our identity in the face of change. The function of the self-concept is to construct identity—that is, to maintain the cognition that all of this is me (Lewis, 1997). Sometimes it means adding pieces together, sometimes it requires a separation of parts. Sometimes the elimination of one or more parts and sometime the distortion of parts or even a distortion of the composition of the whole is necessary. All of the thoughts about ourselves are designed to maintain the idea of "me."

Toward a Theory of Emotional Development

> And the Lord God planted a garden . . . in Eden . . . and caused to grow out of the ground every tree . . . and the tree of life in the midst of the garden and the tree of knowledge of good and evil. . . . God commanded the man, saying that "Every tree in the garden now mayest freely eat but of the tree of knowledge of good and evil thou shall not eat of it for if on the day thou eateth thereof thou shalt surely die.". . . . And the serpent [to encourage evil, said,] "Ye shall surely not die for God doth know that on the day ye eat thereof your eyes will be open ye will be as God knowing good and evil. . . ."
>
> She [Eve] took of its fruit and did eat and give also onto her husband with her and he did eat and the *eyes of both of them were open and they felt that they were naked.* And they *did hide* from the Lord God and when he called to them they did not answer. And he said to them, "Why are you hiding from me?" And they answered, "*Because we are naked*," and he knew therefore that they had eaten of the tree of knowledge (Genesis 2:8–3:11 King James Version).

This story provides a framework for the theory of emotional development that has been proposed. In the beginning, Genesis argues for the existence of the early action patterns such as interest, joy, happiness, and curiosity, which can be seen in Adam and Eve's behavior in the Garden of Eden. The particular action pattern talked about was curiosity, which we know is an approach emotion—that is, it leads toward action in the world. In this case, it was the eating of the apple. The eating of the apple from the tree of knowledge made them wise. From our point of view, this gaining of wisdom was about themselves: "They did eat and the eyes of both of them were open and they *felt* that they were naked." The consequence of this acquisition of knowledge, the story tells us, resulted in a new set of emotions, in particular, the self-conscious emotion of shame. They knew they were naked and were ashamed. This story suggests a progression: Early emotions lead to knowledge, what we call cognitions, in particular cognitions about the self, which in turn lead to the self-conscious emotion of shame. This creation story matches the developmental theory that we follow.

In the issue of development, it needs to be emphasized that while the early emotions may have biological roots, emotional life is embedded in the child's social and cognitive development and that this embeddedness gives to the basic biological form its content and meaning. In humans, the earliest development of emotional life resembles what we see in other animals, the common action patterns in context between animals and us. Later, emotional development is dependent on the emergence of consciousness. These have been called the self-conscious emotions. Thus, to begin with, emotions are tied to a behavior–environment connection. Darwin (1872) described this connection well when he suggested that emotions in man and animals are action patterns that are tied to particular situations because these action patterns proved to be adaptive, and therefore were likely to survive. Many of these action patterns are common across species, differing as a function of the different physical features and environmental niches each species possesses and inhabits. Here we have chosen the term "action patterns" because it is broad enough to encompass emotional, social, and cognitive behaviors.

In the second and third year of life, these action patterns interact with the emergent consciousness, consciousness here being taken to mean the idea of "me." It is a mental state best captured by the phrase "I am [emotion word]." While the emergence of consciousness has a biological basis, it does not concern the nature of the child's aboutness. Rather, it is the idea that the human child and then the adult has the capacity to consider its aboutness. Once consciousness appears in the human child there emerges as a consequence a transformation, in part of which a new set of emotions, those that involve the self in action, emerge. Unlike the earlier emotions, these self-conscious emotions are elicited by cognitions that involve the self and are less elicited by the literal world; thus, "I am proud" because I achieved a sought-after goal by my own efforts. These new emotions are based on ideas and like the earlier emotions exist because of their adaptive significance.

Our emotional lives are first characterized by the existence of these early action patterns, then by the emergence of consciousness, which in turn gives rise to the self-conscious action patterns. Both the early and later action patterns are innate responses tied both to the literal world and to the world of ideas. Even so, they are readily affected by environments. These environmental influences are what constitute the familial and cultural rules that surround the child from birth, and perhaps even from before birth. As I have already shown, disgust is an example of this development since it captures well what is proposed.

Figure 15.2 shows in schematic form the theory proposed. As can be seen, emotional development over the first 3 years of life is divided into the early action patterns, called the primary emotions by some; the rise of consciousness; creation of emotions, both primary and the exposed self-conscious emotions; and, finally, the full emotional life, including all the human emotional repertoire. It is an additive model of development. The first 3 years of life have been focused on since much of this process of development similar to adult humans is present.

One major problem with articulating a model of the emergence of emotional life has to do with the appropriate markers for the emotions. Are we making reference solely to emotional expressions

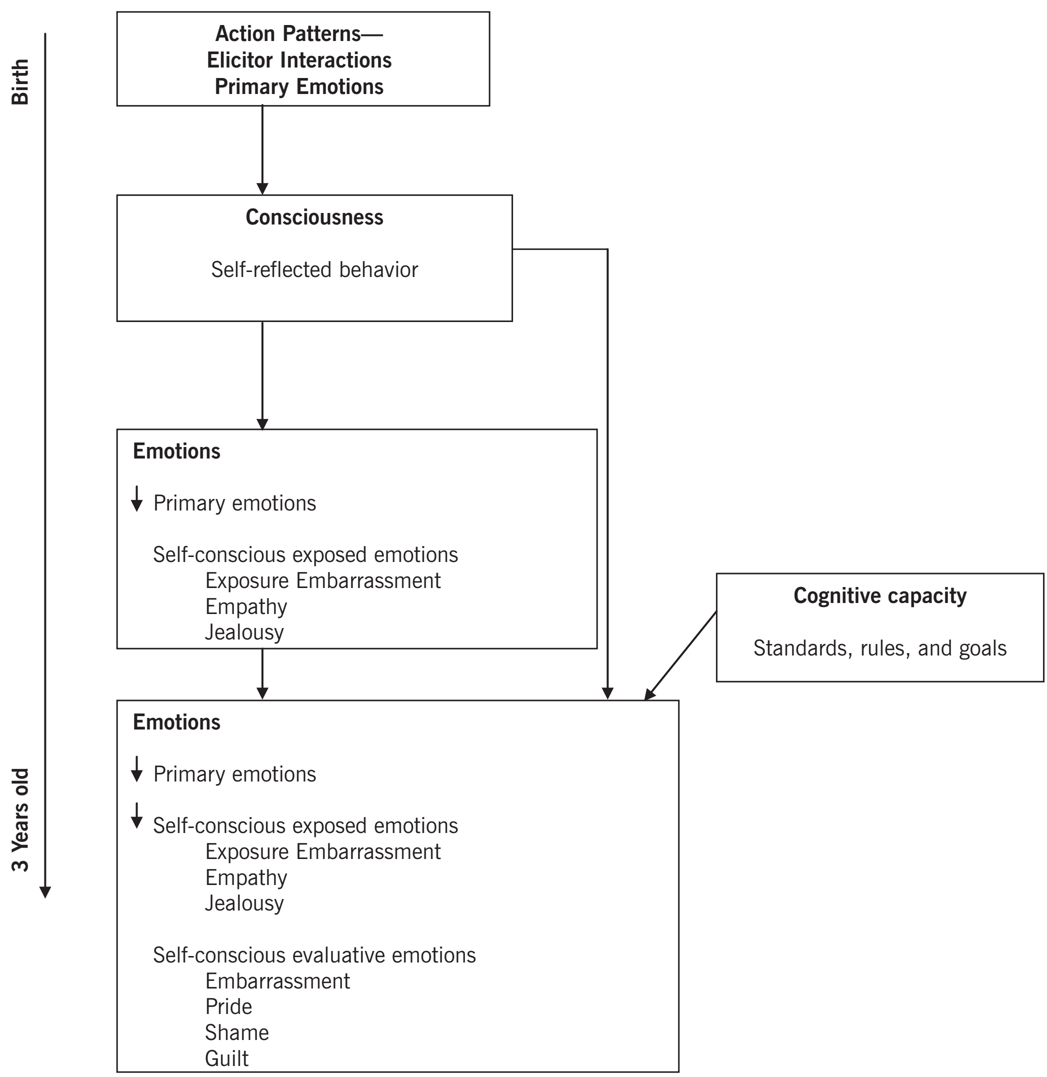

FIGURE 15.2. An additive model of the developmental model in emotional life.

and elicitors or to emotional experiences? The ability to do more than observe the emitted behaviors of the child is all that is possible. In order to get at emotional experiences, we need language in the form of "I am sad" or "I am ashamed." Since during much of the first 3 years the language of the child is quite limited, the study of emotional experience is difficult. Likewise, the study of internal emotional state development is difficult because there has been little success to date in finding a unique configuration of a neurophysiological measure that marks unique emotions in adults, children, or infants (Lewis, 2011).

What we are left observing are emotional expression and behavior in context. Observation of behavior in context allows us, at least from the adult meaning system, to assume that the child's expression reflects an emotion. Observation of anger over frustration, or joy when a mother appears, allows us to accept that an internal state of anger or joy exists. With these limitations in mind, the following discussion and mapping of emotional development can take place.

Bridges (1932), and more recently Sroufe (1996), proposed that at birth the infant shows a bipolar emotional life. On the one hand, there is general distress marked by crying and irritability. On the other hand, there is pleasure marked by satiation, attention, and responsivity to the environment. Attention to and interest in the environment appears from the beginning of life, and we can place this in the positive pole; or we can separate this, thus suggesting a tripartite division with pleasure at one end, distress at the other, and interest as a separate dimension (Lewis & Michalson, 1983).

However, other early dimensions of emotional life can be made. This scheme relies on the idea that at the very beginning of life there are two primary action patterns, which here I call the approach and withdrawal patterns. In the 1950s, Schneirla (1959), like many before him—including Darwin, Cannon, Watson, and Allport, to name but a few—was intrigued by the concept of a biphasic behavioral pattern. As Schneirla wrote, "The aspect of towardness or awayness is common in animal behavior" and these are "applicable to *all* motivated behavior in *all* animals" (pp. 1, 2; see also Allport & Allport, 1921; Cannon, 1927; Darwin, 1872; Watson, 1914).

If it is indeed the case that the basic pattern is one of approach and withdrawal, these could be the starting point in the early undifferentiated action patterns of the newborn. Figure 15.3 presents the scheme utilizing these two behavioral action patterns, and although there are some data on differential brain hemisphere differences to support such a scheme, it is presented here for heuristic reasons. It is interesting to note that both anger and joy have been associated with activation in the left frontal area of the brain. Studies of the right and left hemispheres suggest that anger and joy approach emotions can be found on the left side, while the withdrawal emotions of sadness and disgust can be found on the right side. That hemisphere's reaction appears to support such a view (Davidson, 1994; Harmon-Jones, 2003).

To begin with, infants show general approach behavior, an engagement with the social and object environment. This engagement or approach mode soon differentiates into three of the primary action patterns: joy, anger, and interest. I include interest as an emotional behavior, although some might not. The joy action pattern is related to contexts involving social stimuli such as faces and voices, and also to contexts of control or mastery on objects as well as people. The anger action pattern is related to the overcoming of a blocked goal. The interest action pattern is related to attending

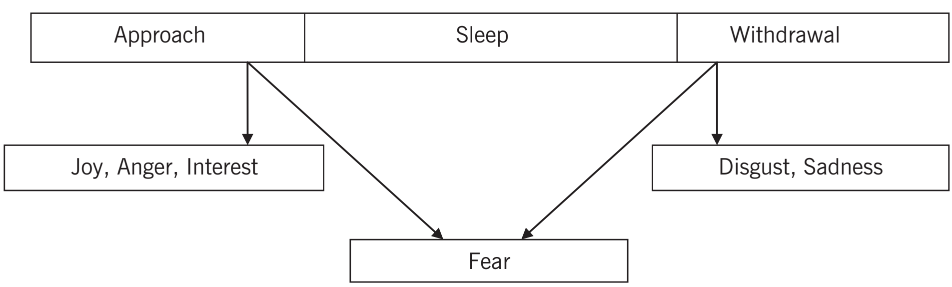

FIGURE 15.3. Development of the differentiated early action patterns. From Lewis (2014, p. 73). Copyright 2014 by Michael Lewis. Reprinted with permission from The Guilford Press.

to novel and familiar events, both social and nonsocial; it is mostly controlled by context change, although there may be some innate elicitors.

The basic withdrawal action pattern is designed to remove the infant from active engagement with the world. The two primary emotions that are derived from this pattern are disgust and sadness. Disgust is an action pattern adapted to remove from the mouth noxious tastes and smells and thus acts to disengage the infants' appetitive behavior. Sadness is an action pattern evoked by the loss of both people and objects.

In these cases the withdrawal pattern removes the infant from active engagement and turns action into inaction. At the beginning it is associated with sleep, which is also a mechanism for disengagement with the outside world. The literature on early sleep patterns suggests that the newborn spends a high percentage of time sleeping, and of experiencing rapid-eye-movement (REM) sleep, which rapidly decreases over the first 3 months. This disengagement from the outside world appears to be necessary for the development of normal brain function as well as for the reinstatement of information obtained from the approach action patterns. The approach and withdrawal patterns are likely to work in some synchronous fashion.

I have left fear, one of the early action patterns, for last. Although one might believe that fear too is a withdrawal action pattern, it seems that it is a consequence of a combined approach and withdrawal pattern. Fear is a response to either an unfamiliar context or to some prewired-like mechanism, similar to what ethnologists describe as innate releasing mechanisms (IRMs). While the work of Mineka, Keir, and Price (1980) reveal that some animals, like snakes or spiders, may not innately elicit fearful behavior in children, they appear to be prewired in some way and therefore need minimum experience to turn the animals into feared creatures.

If unfamiliar or innate stimuli only elicited fear, with withdrawal tendencies, there would be no trouble classifying them as part of the withdrawal pattern. However, consider that if unfamiliarity only elicited fear, how could the child learn about new things? If there was no movement toward, nothing new could be added to the child's repertoire. Clearly, the child has to both withdraw for safety, and approach, as in interest, to learn and profit from novelty. Indeed, that is just what we see when we examine children's behavior, both toward the visual cliff as well as to the approach of a stranger. In both cases the infant shows what has been called "wariness," which may be part of the interest action pattern including eye openness (Lee, Susskind, & Anderson, 2013), while also showing a cessation of activity and movement away (Adolph et al., 2014). In fact, if the infant is allowed to crawl on the floor with his or her mother present, when the stranger approaches, the child will move away from the unfamiliar person, go toward his or her mother, and hide behind her, all of which fits into a fear-like action pattern, while at the same time looking out at the stranger. This behavior combines the approach with the withdrawal patterns of action.

This view of the emergence of the primary emotions grows out of the two basic action modes of approach and withdrawal. At the beginning of life, these two modes are undifferentiated but quickly develop as maturation takes place, into the action pattern-context-specific patterns that we see by 2–3 months. While not enough data are available, there is some reason to believe that these two basic action modes are connected to hemisphere differences in the brain, as well as to the autonomic nervous system (ANS), in particular heart rate changes, and through these changes to changes in the vagus nerves that increase information by acting on the perceptual/cognitive system of the child (Lacey, Bateman, & VanLehn, 1953; Porges, 1986, 2011). Thus, while the description here is somewhat similar to Bridges' (1932), it places the emergence and differentiation of these early emotions within the more general framework of general approach–withdrawal action modes that rapidly develop into the Darwinian idea of differential action patterns associated with specific contexts.

With this in mind the model of emotional development can be seen in its complete form. While our discussion of the various problems associated with studying these early action patterns has been considered, it is to their early development that we now turn our attention. There is considerable information available, mostly around facial expression in context, although some bodily activity is also available, to demonstrate that they emerge in the first 8–9 months of life, especially if the context for their elicitation is taken into account. Sroufe (1996), while also differentiating a smile from distress, does not consider them emotions but instead, automatic reflexes in response to quantitative rather than qualitative aspects of stimuli—that is, to the temporal and intensity features of arousal. They are not emotions since they do not contain a cognitive component. By 6 months they emerge as basic emotions given the onset of some cognition. These six primary facial patterns appear in the early months of life when we look at context specificity. While these six emotions are mentioned by most researchers, others have considered other emotions in this early grouping, including some of what have been called self-conscious emotions. When discussing the self-conscious emotions, Lewis (see Chapter 45, this volume) discusses why these emotions are likely not to be present in the early months of life, mostly because considerable cognitive capacities are necessary for their elicitation, cognitions that are not available to the infant in the first year of life.

In the first 8 or 9 months of life, children's emotional behavior reflects the emergence of the six early emotions, or as Darwin (1872) called them, action patterns, and they are not learned, although they are affected by the environment in which the child is raised. Moreover, there is no reason to assume that mentalism is necessary for their appearance.

Sometime in the second half of the second year of life, the emergence of consciousness, the mental representation of "me"—seen in self-referential behavior—occurs. When it does, it gives rise to the self-conscious exposed emotions, which include embarrassment, empathy, and jealousy. Finally, with the child's acquisition of socialization rules about standards, rules, and goals, the evaluative self-conscious emotions such as guilt, pride, and shame emerge (see Lewis, Chapter 45, this volume). Next, the work on these early emotions is considered.

Interest

Whether we consider interest an emotion or a cognitive action pattern depends on our perspective. If we call interest "attention," then it is quite clear that from the very beginning of life infants show this emotion. In the early 1960s, Kagan and I, as well as others, demonstrated that infants could attend to external stimuli including visual, auditory, and tactile events. Attention was measured by receptor orientation, including eye gaze and turning toward the source of the stimulus, as well as by physiological responses including heart rate and respiration rate changes. There is little doubt that from the beginning of life infants show interest in the world around them. The details of the studies have been discussed elsewhere, and the reader is referred to them for further information in regard to this emotional action pattern (Kagan & Lewis, 1965; Lewis, Kagan, & Kalafat, 1966; Lewis, Kagan, Zavala, & Grossberg, 1964; Lewis, Meyers, Kagan, & Grossberg, 1963).

Fear

The interest in infant fear originally centered around the attempt to understand the infant's early social life. Capitalizing on the animal data on imprinting, Bowlby (1969), as well as others, argued that infants' fear response to a stranger reflects the child's attachment to his or her mother. Since fear develops in order to terminate the child's indiscriminate approach to all other people, it reflects the child's imprinting on the familiar. Thus, fear has an adaptive function: protection of the child from strangers who might do him or her harm.

A second area of interest in fear had as it source an interest in the child's perceptual–cognitive development and used the fear response as a measure of the child's cognitive ability. For example, Gibson's visual cliff experiment used fear as a measure of the child's ability to distinguish spatial depth (Gibson & Walk, 1960). In this experiment the infant, prior to walking but able to crawl, is placed on a platform that creates an illusion in which one half of the platform seems to drop off by several feet. The fear response was reported to show that the infant had gained the perceptual–cognitive ability through interaction with its physical world, and thus recognized the potential of falling. The approach of a stranger and the visual cliff are still used to elicit a fear response. Although these two experiments sometimes reveal the facial action pattern of fear as measured by any of the facial coding systems, what is seen most is bodily hesitation and movement at times away, in addition to an attentive face, sometimes called "wariness."

Earlier, it was suggested that fear has both a withdrawal and an approach component. It is clear that stimuli that elicit fear can also elicit approach behavior. For example, incongruity or discrepancy is thought to elicit fear, but can also elicit smiling and laughter. While most theories, especially those using fear as a marker of the child becoming imprinted or attached to its mother, view fear as a consequence of discrepancy, discrepancy itself is not a sufficient cause for fear. In a series of studies we have been able to show that the specific context in which the discrepancy appears determines to a considerable extent whether there is a fear-like or a joy-like response (Dodd & Lewis, 1969). Sroufe showed that many events that can potentially produce laughter, such as gently tossing the baby in the air or playing peek-a-boo with the infant, can also produce fear and upset (Sroufe & Wunsch, 1972). Fear also appears in contexts where there are sudden changes in the physical features of the environment or when experiencing pain.

Individual differences in temperament may also play an important role in what elicitors produce fear behavior. Perhaps the simplest example of this is observing individual differences in infants when they are tossed in the air: one infant laughs and smiles at this unusual stimulation, while the other is frightened and may even cry. Context and temperament are deeply involved in the fear response. As a working hypothesis, I suspect that difficult temperaments are likely to increase the withdrawal component of fear, while easy temperaments are likely to increase the approach component.

From a developmental perspective there is a connection between maturing cognitive processes and the contexts that elicit fear. While there was a strong belief that fear required cognitive capacities, which do not emerge until after the first half of the first year of life (Sroufe, Waters, & Matas, 1974), there are now data to support the idea that simple associations with pain can cause fear. Thus, Izard has reported fear faces in infants being inoculated, and we have shown that a fear face is part of what Pavlov (1960) and Simonov (1964) have called a "defensive reflex," the response to the sudden onset of something unexpected (Izard, Hembree, & Huebner, 1987; Ramsay & Lewis, 1994; Sullivan, Lewis, & Alessandri, 1991).

While fear may appear early, cognitive factors need to play a more important role in the second half of the first year of life. What is clear is that such cognitive capacities as memory and the ability to make comparisons underlie fearfulness (Schaffer, 1974). Moreover, Decarie (1974) suggests that object permanence may be another important cognitive factor. If this theory is correct, it may explain some of the individual differences in the timing of the onset of fear (e.g., Bronson [1974] has shown stranger fear in 3-month-old infants, and I have reported that gifted children are likely to show stranger fear prior to 6 months [Schaffer, 1974; Spitz, 1965]). If cognitive capacities emerge earlier in some infants than in others, the children with precocious cognitive development are likely to show fear responses earlier. We need to keep in mind that cognitive maturation also must interact with children's temperament.

However we consider the emergence and development of fear, the discrepancy factor continues to be implicated in studying the difference between familiar and unfamiliar people, with unfamiliar people sometimes eliciting fear-like responses, certainly after 3 months. Even here, though, there are some interesting contextual factors in responses to strangers. In a series of studies, we have examined whether the nature of the unfamiliar person might play a role in infant and toddler fearfulness. We had male and female young children and male and female adults, all strangers, approach infants ages 7–19 months in a stranger-approach situation. Infants show wariness at the approach of the unfamiliar adult but joy and attention at the approach of the unfamiliar child (Lewis & Brooks, 1974). This phenomenon can be seen in public places like airports where stranger infants and toddlers will approach each other but avoid or move away from stranger adults. Such findings as these support our view that unfamiliarity and discrepancy are an insufficient explanation as elicitors producing the fear response since the unfamiliar adult is more like the mother—less discrepant—than the strange child. These findings suggest that either past experiences or biological factors like IRMs play some role in determining the early fear action pattern. Many different experimental paradigms have been used to elicit fear in young children besides stranger approach and the visual cliff, including loud and sudden noises and robot toys moving toward the child. To some degree all appear to elicit mostly a wary response. Even so, large individual differences are shown. One might assume that a fearful child would show high fear to any one of these different elicitors, and at the extreme ends of the spectrum of fearfulness that may be the case, yet the results of several studies reveal only weak consistency in children's fear across different elicitors (Campos & Stenberg, 1981).

Anger

When asked, most parents report that their infants show anger. They report that this can be seen in the infant when being fed: the infant turns his or her head away and raises his or her hands to push the spoon away. Research, too, seems to support our everyday observations**.** Part of our problem is in the reporting. American mothers report more anger in their infants than do Japanese mothers (Otaki, Durreit, Richards, Nyquist, & Pennebaker, 1986). Such a finding either means that (1) American babies actually show more anger responses than do Japanese babies or that (2) American mothers are more likely to see more angry behavior than Japanese mothers because of their varying interpretations of the child's behavior. Parental reports of anger, perhaps just like most of the other early action patterns, have multiple meanings, including embedded cultural meanings. For example, anger as an attempt to overcome a blocked goal is often confused with aggression or hate and linked to acting-out or violent behaviors.

Nevertheless, it has been argued that infants' anger is, in general, and for adults some of the time, an approach emotion (Harmon-Jones, 2004), and its evolutionary adaptive significance is in its motivating property of action toward overcoming a barrier. While angry faces have been reported when 8-month-olds' hands are held and constrained, anger is seen earlier in life when an infant's learned response to a goal is blocked (Lewis et al., 1990).

Joy

Joy has been studied primarily in terms of a smiling face, with much of the research conducted in the early 1960s and 1970s. Smiling is present from the beginning days of life and is likely state dependent during the neonatal period—that is, a smile occurs almost reflexively and does not seem to be related to any specific contexts. Smiling even appears during sleep in the newborn. However, smiling behavior as a response to social objects including other infants, children, adults, and animals with human-like faces appears between 6 and 8 weeks and is more likely to occur in these contexts than others; however, gentle tactile stimulation also appears to elicit enjoyment behavior in 8-week-olds (Ambrose, 1961, 1963). Expressions of enjoyment in very early life are closely tied to the physical quality of stimulation, which can be auditory, tactile, or visual. However, enjoyment of social events and stimulation increases dramatically by 4 months of age, with social smiling peaking between 12 and 14 weeks of age in home-reared infants in Western culture. Infants at this age seem to enjoy people and will smile readily at most children and adults who interact pleasantly with them. After 16 weeks, however, most infants can discriminate among faces. Then, familiarity and the behavioral style of the interactive partner become important factors in smiling behavior, suggesting that smiling and enjoyment are now being influenced by the infant's growing cognitive development. By age 12 months infants vary in their social smiling, reflecting not only temperament differences but possible differences in their quality of enjoyment within social situations (Fogel, Nelson-Goens, Hsu, & Shapiro, 2000; Jones, Raag, & Collins, 1990).

While smiling is present early, laughter appears somewhat later. Blurton-Jones (1971) characterizes laughter or a play face as a wide-open mouth expression with sounds adults associate with laughter. The play face seems to make its appearance by 4 or 5 months in normally developing infants and occurs at first to vigorous auditory and tactile stimulation, seen in the infant's response to tickling. After 7 months, visual stimulation becomes more effective in eliciting this laughter expression. By 12 months incongruency and novelty, especially if it involves the infant's own participation, elicit laughter and the play face—for example, in games such as peek-a-boo.

Finally, what we know about atypical development may be of use in understanding joy. Studies of infants with Down's syndrome show that while social smiling peaks at the same mental age, that is, 4–5 months, as it does for typically developing infants, the intensity of enjoyment appears to be less. Moreover, infants with Down's syndrome are not able to sustain social enjoyment in spontaneous interactions to the same degree as infants without the syndrome and they may also be less likely to initiate smiling (Carvajal & Iglesias, 1997; Kasari & Sigman, 1996).

Of interest in the development of joy is the work on blind infants. Visual input for the first 3 months does not appear to be necessary for smiling to occur since blind children produce recognizable spontaneous smiling, an early action pattern. The argument that one needs to see the expression of another in order to organize one's own expression does not find support here in the case of the blind (Galati, Miceli, & Sini, 2001). However, after this period children who are blind begin to show different patterns of smiling, suggesting that the interaction with the visual world begins to have an effect on these early patterns.

While smiling and enjoyment have been studied for the most part in the context of social interactions, there has been considerable neglect in studying enjoyment (with or without a smiling face) in contexts that are not social. In particular, there is relatively little study of infants' responses to mastery. This is somewhat surprising but in keeping with the overestimation of the theoretical linking of emotional development with social contexts and social development. There is every reason to assume that in the development of enjoyment, the organism's interaction with its physical world, a necessity for survival, requires enjoyment

(Watson, 1972). The overestimation of the child's emotional expressions as only signals to others has led to the study of the role of emotions as motives. As such, enjoyment around action on objects (as well as people) is an important action pattern necessary for exploring, learning, and remembering and has a significant adaptive function as the child interacts with his or her physical world.

Work in our laboratory around learning as well as in response to goal blockage demonstrates that when infants as young as 2 months are provided the opportunity, through pulling a string to cause a picture to appear, enjoyment occurs. In other words, enjoyment is associated with learning that their action causes something to happen. Moreover, we have also demonstrated that when 4-month-old infants learn the contingency between their arm pull and an outcome, those who show more enjoyment (smile more) are more likely to remember that their arm pull caused something to happen (Hitchcock, 2002).

While these studies are quite clear in showing that smiling and enjoyment can be seen in both social interaction and object mastery contexts, more study is necessary to explore the mastery aspect of enjoyment. It is necessary to also explore how smiling behavior in social interactions may differ from smiling mastery in the object world. Given that there is some evidence that there are different kinds of smiles (at least in adults), we may be able to make some distinctions within the emotion of joy/enjoyment, depending on the particular context.

"Duchenne smile" refers to a smile that engages both the mouth and the eye muscles. Ekman (1985) considers the Duchenne smile to be a true expression of joy. A smile that involves only the mouth and not the eyes is considered to be a pretend or false expression of joy. Given the importance of smiling behavior in social commerce, the ability to distinguish between false smiles and true smiles becomes important for the detection of deception.

Sadness

Sadness is often associated with loss but can occur for other reasons as well. Sadness typifies the withdrawal aspect of the original modes of approach and withdrawal patterns. Its adaptive significance is unclear, but its association with crying behavior suggests that it serves as a powerful signal to the caregiver of the child's discomfort. The action pattern, when it includes crying, is complex as it both causes a cessation or reduction of action and at the same time the cry feature constitutes an active response for others to help.

Perhaps crying, while being a component of sadness at the beginning of life, is an action pattern designed as a powerful signal calling for care. It seems that at least in the early weeks of life, crying (usually interpreted as sadness) is not elicited by loss but by discomfort. Loss requires sufficient cognitions such as a sense of object permanence in order to remember that there existed something or somebody who is now lost.

While crying is the most visible aspect of the emotion of sadness, it is important to remember that some of the other features as described by Darwin (1872) may lead us to a better understanding of the adaptive significance of the action pattern. Recall that Darwin suggested the cessation of activity, repetitive motions such as gentle rocking, "languid circulation," and decreases in respiration, as well as particular facial expressions, are other aspects of sadness. While crying is often used to mark sadness, adults who cry for joy or even when angry are examples that suggest that crying alone is an insufficient marker of sadness.

Perhaps an example of sadness without crying is the cessation of action and movement, as demonstrated in the work of Suomi (1991) with monkeys, who has shown that when a monkey mother leaves her baby, the baby shows a decrease in its activity, including vocalizations, as well as an increase in its cortisol stress response. He argues that this reduction of motor activity is adaptive for the infant for two reasons. First, the cessation of activity decreases metabolism and thus the need for food, necessary since its mother's absence means the infant is not being fed. Second, decreased activity decreases noise, and thus limits the possibility of discovery by a predator that without the protection of its mother endangers the baby.

Our problem with studying the early emergence of sadness rests on the use of the crying response to signal the action pattern. So, for example, in studies of crying, a behavior seen at the very beginning of life, different types of cries can be used by caregivers to differentiate the different types of discomfort—for example, cries of pain have a different pattern than cries of hunger (Bachorowski & Owren, 2008). However, we need to remember that it is possible to differentiate a sad face from a crying face. The sad face has brows that are raised and angular with narrowing of the eyes. The mouth is drawn down, often with the lower lips protruding and covers the upper lip in a pouting-like expression. Most important, crying does not have to occur (Oster, 1978).

The study of sadness is like that of the other action patterns: it is often explored in the mother–infant interaction, and in particular in what has been called the *en face* experimental paradigm. In this paradigm, mother and infant sit across from each other and engage in social and affective exchanges. When signaled, the mother, without warning, suddenly drops her head and stops engaging the child. Among the many possible responses of the child, some infants show sadness. The sadness shown by the infant is thought to reflect the infant's loss of its mother. Since the behaviors are studied in 3-month-olds, the infant's response of sadness appears to reflect the loss of its mother and therefore is considered to be part of the ongoing establishment of an attachment between the infant and his or her mother. While the findings are impressive, the sadness seen may reflect the loss of the interaction rather than a measure of attachment to a specific person and may reflect the sudden change and loss of something enjoyable; using the paradigm with a stranger might help resolve the problem (Lewis, 2010).

Another way to look at sadness is through the learning and goal-blockage paradigm that we previously discussed. While most infants respond to the loss of the picture with arm pulling and an angry action pattern, at least 15% of them show a sadness action pattern at the loss. Sad facial expression, cessation of activity, and little change in heart rate fit the action pattern as described by Darwin (1872). While we see the sad response as nonadaptive in this situation, it is clear that the elicitor of this action pattern is the loss either of control or of the picture presented as a consequence of the pulling. However, in another study, for one group we did not terminate the pictures' appearance as the blockage, but only terminated the control of their appearance in an attempt to examine whether it was the loss of control or loss of the picture. To study this, the group that lost control saw the pictures at the same level as the other group, but their arm pull did not control the picture onset. Sadness was still observed, indicating that sadness was produced by the loss of control (Bendersky & Lewis, 1998; Sullivan & Lewis, 2003).

It should be noted that the sadness action pattern is seen in response to the loss of control of objects as well as to the loss of control of people. These findings strongly suggest, and reinforce the idea, that individual differences related to temperament may play an important role in the action pattern displayed. They also point to the problem already mentioned, namely, that the same context may elicit multiple action patterns. Later in life the same context but with different interpretations as to the meaning of the elicitor may do the same thing. Our learning paradigm studies show that the action pattern of sadness can occur in both social and nonsocial contexts. However, we must keep in mind that the crying response, most often used to indicate sadness, is not seen in the nonsocial context; we do not use crying as part of our definition of a sad action pattern. Rather, we see crying behavior as a general response to any sort of discomfort, including pain, the physical discomfort of a soiled diaper, or ever hunger and gas. Crying may elicit sadness and concern on the part of the caregiver but caution should be used in labeling it as a marker of sadness.

Disgust

Of all the early emotions, disgust appears to be the one that is most immediate and likely to require the least cognitive capacity. It is an adaptive response designed for dispelling from the mouth objects that do not taste or smell good. The disgust action pattern is immediately obvious: it consists of opening the mouth and raising the nose, which causes the upper lip to rise. The tongue can protrude from the mouth but does not do so in all cases. The disgust action pattern has much in common with the contempt or shame patterns and can in infancy be mistaken for them. Certainly, the disgust action pattern can be seen in various forms throughout life and has an interesting developmental course (see Disgust, Chapter 46, this volume; Rozin, Haidt, & McCauley, 2008).

Even newborns show this action pattern: their responses to bitter and sour tastes are distinct from their responses to water and sweet solutions (Rosenstein & Oster, 1988). Quinine and other bitter tastes are potent and rapid elicitors of disgust. The developmental course of the disgust action pattern has been little studied, mostly because the action pattern is so clear in the newborn period and therefore a developmental pattern is not likely to be seen. Moreover, disgust seems to be part of the withdrawal pattern and needs little cognition. Support for this conclusion comes from Steiner's (1979) extensive studies of disgust and enjoyment taste reactions in a variety of infants with disabilities. The disgust expression was recognizable in all populations studied despite their considerable variation in cognitive and motor control. Because of this finding Steiner argued that disgust expressions across a wide range of cognitive and motor dysfunctions are controlled by the brainstem and therefore need little cognitive ability. While there are large individual differences in the stimuli that elicit disgust, no work on individual differences early in life have been reported. In our studies of individual differences in 4-month-olds' responses to lemon applied to their tongues, we observed large individual differences, although no consistent individual differences over time were noted.

Perhaps the most interesting aspect of disgust expressions, and the one about which little is known, is how the subtle variations in responsiveness observed even in newborns are related to individual differences in nervous system functioning or other factors, such as temperament. Another question of interest is: When does this expression begin to occur in response to nontaste stimuli, and to representation? The presumption is that disgust occurs later to new elicitors and representations rather than to actual tastes or smells. Nontaste stimuli that might be sufficient to produce a disgust response in infants have not yet been reported, but can be imagined since disgust signals stimulus rejection or withdrawal. Although data are lacking, a too-rapid or too-sudden occurrence of a stimulus might elicit disgust expressions if the stimulus overwhelms the infant's ability to process it. We have observed this response on some occasions in the learning paradigm. Sometimes an infant pulls the string so rapidly that the stimulus appears within a second of its previous appearance and *before* the infant's reaction to the first appearance has subsided. When this occurs, we have seen nose wrinkling or asymmetrical mouth and lip movements in response, suggesting a kind of recoil reaction to the overwhelming, too-rapid reoccurrence of the elicitor. Such observations suggest that prior to 6 months of age components of disgust may occur in response to visual and auditory stimulation, setting the stage for their later function in social situations. Nevertheless, the forms of disgust observed in this case do not involve the intense, gaping reactions observed in response to bitter tastes.

Clearly, the disgust action pattern is a withdrawal response, with the infant rejecting the unacceptable taste and/or smell. Because of the significance for adults of the disgust emotional expression, the child's disgust response is often seen as rejection of what the parents are doing, such as feeding the child. The child's disgust therefore often elicits a strong negative feeling in the caregiver since it may be interpreted as a rejection of him or her. As we have seen, disgust in one person often elicits shame and anger in another. For example, Gottman (1994) has argued that the disgust expression in one marital partner is often the elicitor of anger and depression in the other.

Because the disgust action pattern is easily observed at the beginning of life and continues across the lifespan, we have used it as a prototype of a more general developmental pattern. Clearly, disgust facial patterns are observed very early, and therefore little learning is needed for the development of disgust. To begin with, it is clear that tastes and smells are the literal elicitors of disgust. However, with development, disgust can be elicited by ideas (e.g., moral disgust), or by seeing mauled bodies or bodily discharges. With the development of new cognitive capacities as well as the effects of socialization, the biologically based action pattern of disgust can be used for the rejection of bad ideas and images. It is also used to describe rejecting interpersonal interactions such as "You are disgusting."

Perhaps this is the fate of all of the early action patterns? I suspect that this may be so. What we need to understand is how these early adaptive action patterns interact with the maturing cognitive and social capacities as well as the knowledge the child gains to produce new patterns and new elicitors. It may be that the biological underpinnings of these early action patterns reflect their motivational power, which with maturity produces action patterns associated with thoughts and ideas.

Although not usually discussed as one of the early action patterns, it would be remiss not to mention prosocial-like action patterns. While this is not discussed here (see de Waal, 2008; Warneken & Tomasello, 2009; and Zaki & Mitchell, 2013, for more details), the early existence of these early action patterns are also transformed by self-consciousness (see Chapter 45, this volume).

The Emergence of Self-Conscious Emotions

Figure 15.4 indicates that a new cognitive capacity emerges somewhere in the second half of the second year of life. The emergence of consciousness or self-referential behavior gives rise to a new class of emotions. These have been called *self-conscious emotions* and include embarrassment, empathy, and envy. Although little work exists in the development of these emotions, several studies support the emergence of embarrassment at this point in development. Lewis et al. (1989) have shown that the emergence of embarrassment only takes place after consciousness or self-recognition occurs. Empathy, too, emerges in relation to self-recognition (Bischof-Kohler, 1991).

Two points are to be noticed about this class of emotions. First, the observation of these emotions requires measuring not only a facial expression but bodily and vocal behaviors as well. Whereas the earlier emotions can be observed readily in specific facial configurations, these new emotions require measurement of bodily behavior. Embarrassment, for example, is best measured by nervous touching, smiling, gaze aversion, and return behaviors. The second important point related to the emergence of these emotions is that while they reflect self-consciousness, they do not require self-evaluation. The emergence of these self-conscious emotions is related uniquely to the cognitive milestone of paying attention to the self.

Figure 15.4 shows a second cognitive milestone that occurs sometime between 2 and 3 years of age. This ability is characterized by children's capacity to evaluate their behavior against a standard; the standard can be either external, as in the case of parental or teacher sanction or praise, or internal, as in the case of children developing their own standards. This capacity to evaluate personal behavior relative to a standard develops in the third year of life. The ability to compare personal behavior to a

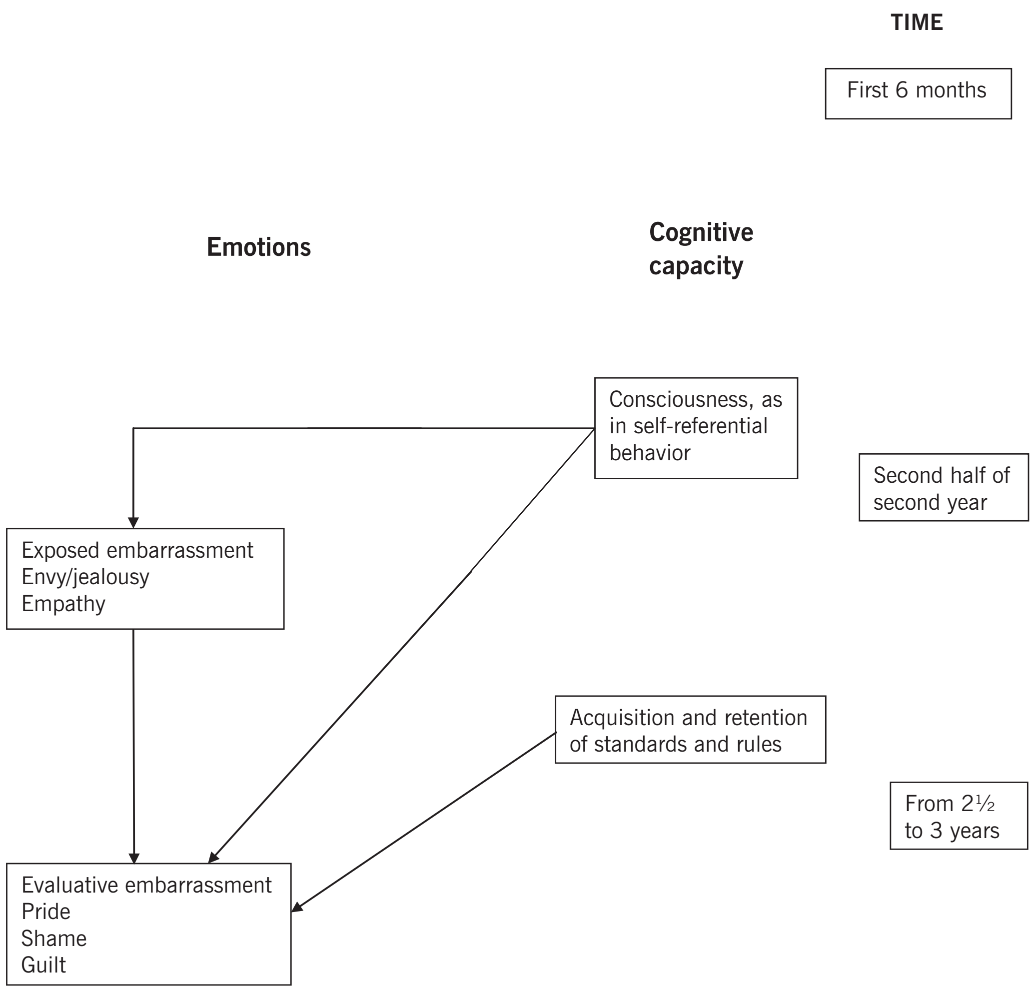

FIGURE 15.4. Cognitive capacities as they relate to the self-conscious emotions.

standard gives rise to another set of emotions. We have called these *self-conscious evaluative emotions*; they include pride, shame, and guilt, among others. These emotions require that children have a sense of self and be capable of comparing their own behavior against standards. If children fail vis-à-vis the standard, they are likely to feel shame, guilt, or regret. If they succeed, they are likely to feel pride (Lewis, 1992a). It is important to note that pride and shame are quite different from happiness and sadness. For example, we can win a lottery and feel quite happy about winning the money; however, we would not feel pride, because we would not view the winning of the lottery as having anything to do with our behavior. The same is true for failure: we might feel sad if we were not able to do something, but if it was not our fault, then we would not feel shame or guilt. These complex social evaluative emotions make their appearance at about 3 years of age (Lewis, 1992b; Stipek, Recchia, & McClintic, 1992; see also Chapter 45, this volume, for more details).

Thus, by 3 years of age, the emotional life of a child has become highly differentiated. From the original set of action patterns, the child comes within 3 years to possess an elaborate and complex emotional life. While the emotional life of the 3-year-old will continue to be elaborated and will expand, the basic structures necessary for this expansion have already been formed. New experiences, additional meaning, and more elaborate cognitive capacities will all serve to enhance and elaborate the child's emotional life.

Note

1. Portions of this chapter appear in Lewis, M. (2014). *The Rise of Consciousness and the Development of Emotional Life*. New York: Guilford Press.

References

Adolph, K. E., Kretch, K. S., & LoBue, V. (2014). Fear of heights in infants? *Current Directions in Psychological Science, 23*(1), 60–66.

Allport, F. H., & Allport, G. W. (1921). Personality traits: Their classification and measurement. *Journal of Abnormal Psychology and Social Psychology, 16*, 6–40.

Ambrose, A. (1961). The development of the smiling response in early infancy. In B. M. Foss (Ed.), *Determinants of infant behavior* (pp. 103–105). London: Methuen.

Ambrose, A. (1963). The age of onset of ambivalence in early infancy: Indications from the study of laughing. *Journal of Child Psychology and Psychiatry, 4*, 167–181.

Bachorowski, J., & Owren, M. J. (2008). Vocal expressions of emotion. In M. Lewis, J. M. Haviland-Jones, & L. Feldman Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 196–210). New York: Guilford Press.

Bard, P. (1934). The neuro-hormonal basis of emotional reactions. In C. Murchinson (Ed.), *Handbook of general experimental psychology: 1. Emotion* (pp. 264–311). Worcester, MA: Clark University Press.

Bendersky, M., & Lewis, M. (1998). Arousal modulation in cocaine-exposed infants. *Developmental Psychology, 34*(3), 555–564.

Bischof-Kohler, A. (1991). The development of empathy in infants. In M. E. Lamb & H. Keller (Eds.), *Development: Perspectives from German-speaking countries* (pp. 245–273). Hillsdale, NJ: Erlbaum.

Blurton-Jones, N. G. (1971). Criteria for use in describing facial expressions of children. *Human Biology, 43*(3), 365–413.

Bowlby, J. (1969). *Attachment and loss: Vol. 1. Attachment*. New York: Basic Books.

Bridges, K. M. B. (1932). Emotional development in early infancy. *Child Development, 3*, 324–334.

Bronson, G. W. (1974). General issues in the study of fear: Section II. In M. Lewis & L. A. Rosenblum (Eds.), *The origins of behavior: Vol. 2. The origins of fear* (pp. 254–258). New York: Wiley.

Campos, J. J., & Stenberg, C. R. (1981). Perception, appraisal, and emotion: The onset of social referencing. In M. E. Lamb & L. R. Sherrod (Eds.), *Infant social cognition: Empirical and theoretical considerations* (pp. 273–314). Hillsdale, NJ: Erlbaum.

Cannon, W. B. (1927). The James–Lange theory of emotions: A critical examination and an alternative theory. *American Journal of Psychology, 39*, 106–124.

Carvajal, F., & Iglesias, J. (1997). Mother and infant smiling exchanges during face-to-face interaction in infants with and without Down syndrome. *Developmental Psychobiology, 31*(4), 277–286.

Darwin, C. (1872). *The expression of the emotions in man and animals*. London: Murray.

Davidson, R. J. (1994). Complexities in the search for emotion-specific physiology. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 237–242). New York: Oxford University Press.

De Waal, F. B. (2008). Putting the altruism back into altruism: The evolution of empathy. *Annual Review of Psychology, 59*, 279–300.

Decarie, T. G. (1974). *The infant's reaction to strangers*. New York: International Universities Press.

Dodd, C., & Lewis, M. (1969). The magnitude of the orienting response in children as a function of changes in color and contour. *Journal of Experimental Child Psychology, 8*, 296–305.

Ekman, P. (1985). *Telling lies*. New York: Norton.

Fogel, A., Nelson-Goens, G. C., Hsu, H.-C., & Shapiro, A. F. (2000). Do different infant smiles reflect different infant emotions? *Social Development, 9*(4), 497–520.

Frijda, N. H. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.

Galati, D., Miceli, R., & Sini, B. (2001). Judging and coding facial expression of emotions in congenitally blind children. *International Journal of Behavioral Development, 25*(3), 268–278.

Gazzaniga, M. S. (1988). Brain modularity: Towards a philosophy of conscious experience. In A. J. Marcel & E. Bisiach (Eds.), *Consciousness in contemporary science* (pp. 218–238). New York: Oxford University Press.

Gibson, E. J., & Walk, R. D. (1960). The "visual cliff." *Scientific American, 202*, 67–71.

Gopnik, A., Meltzoff, A. N., & Kuhl, P. K. (1999). *The scientist in the crib: Minds, brains, and how children learn*. New York: Morrow.

Gottman, J. M. (1994). *What predicts divorce?: The relationship between marital processes and marital outcomes*. Hillsdale, NJ: Erlbaum.

Harmon-Jones, E. (2003). Clarifying the emotive functions of asymmetrical frontal cortical activity. *Psychophysiology, 40*(6), 838–848.

Harmon-Jones, E. (2004). Contributions from research on anger and cognitive dissonance to understanding the motivational functions of asymmetrical frontal brain activity. *Biological Psychology, 67*, 51–76.

Hitchcock, D. F. A. (2002). *The influence of emotional and physiological reactivity on infant memory*. Unpublished doctoral dissertation, Rutgers University, New Brunswick, NJ.

Hume, D. (1888). *A treatise of human nature* (L. A. Selby-Bigge, Ed.). Oxford, UK: Clarendon. (Original work published 1739)

Izard, C. E., Hembree, E. A., & Huebner, R. R. (1987). Infants' emotion expressions to acute pain: Developmental change and stability of individual differences. *Developmental Psychology, 23*(1), 105–113.

Jones, S. S., Raag, T., & Collins, K. L. (1990). Smiling in older infants: Form and maternal response. *Infant Behavior and Development, 13*(2), 147–165.

Kagan, J., & Lewis, M. (1965). Studies of attention in the human infant. *Merrill–Palmer Quarterly, 11*, 95–127.

Kant, I. (1958). *Critique of pure reason* (N. Kemp Smith, Trans.). New York: Macmillan. (Original work published 1781)

Kasari, C., & Sigman, M. (1996). Expression and understanding of emotion in atypical development: Autism and Down syndrome. In M. Lewis & M. W. Sullivan (Eds.), *Emotional development in atypical children* (pp. 109–130). Mahwah, NJ: Erlbaum.

Keller, H., Yovai, R., Borke, J., Kartner, J., Jensen, H., & Papaligoura, Z. (2004). Developmental consequences of early parenting experiences: Self-recognition and self-regulation in these cultural communities. *Child Development, 75*, 1745–1760.

Lacey, J., Bateman, D., & VanLehn, R. (1953). Autonomic response specificity. *Psychosomatic Medicine, 15*, 8–21.

Lee, D. H., Susskind, J. M., & Anderson, A. K. (2013). Social transmission of the sensory benefits of eye widening in fear expressions. *Psychological Science, 24*(6), 957–965.

Lewis, M. (1992a). The self in self-conscious emotions: A commentary. In D. Stipek, S. Recchia, & S. McClintic (Eds.), Self-evaluation in young children. *Monographs of the Society for Research in Child Development, 5785–5795*.

Lewis, M. (1992b). *Shame, the exposed self*. New York: Free Press.

Lewis, M. (1997). *Altering fate: Why the past does not predict the future*. New York: Guilford Press.

Lewis, M. (2010). Loss, protest, and emotional development. In S. Hart & M. Legerstee (Eds.), *Handbook of jealousy: Theory, research, and multidisciplinary approaches* (pp. 27–39). Malden, MA: Blackwell.

Lewis, M. (2011). Inside and outside: The relation between emotional states and expressions. In M. Lewis (Ed.), *Special Issue: Infant Emotional Development, Emotion Review, 3*(2), 189–196.

Lewis, M. (2014). *The rise of consciousness and the development of emotional life*. New York: Guilford Press.

Lewis, M., Alessandri, S., & Sullivan, M. W. (1990). Violation of expectancy, loss of control, and anger in young infants. *Developmental Psychology, 26* (5), 745–751.

Lewis, M., & Brooks, J. (1974). Self, others and fear: Infants' reactions to people. In M. Lewis & L. Rosenblum (Eds.), *The origins of fear: The origins of behavior* (Vol. 2, pp. 195–227). New York: Wiley.

Lewis, M., Goldberg, S., & Rausch, M. (1967). Attention distribution as a function of novelty and familiarity. *Psychonomic Science, 7*(6), 227–228.

Lewis, M., Kagan, J., & Kalafat, J. (1966). Patterns of fixation in infants. *Child Development, 37*, 331–341.

Lewis, M., Kagan, J., Kalafat, J., & Campbell, H. (1966). The cardiac response as a correlate of attention in infants. *Child Development, 37*, 63–71.

Lewis, M., Kagan, J., Zavala, F., & Grossberg, R. (1964). Behavioral and cardiac responses to auditory stimulation in the infant. *American Psychologist, 19*, 737.

Lewis, M., Meyers, W., Kagan, J., & Grossberg, R. (1963). *Attention to visual patterns in infants*. Paper presented at a Symposium on Studies of Attention in Infants: Methodological Problems and Preliminary Results at the American Psychological Association meetings, Philadelphia.

Lewis, M., & Michalson, L. (1983). *Children's emotions and moods: Developmental theory and measurement*. New York: Plenum Press.

Lewis, M., & Ramsay, D. (2004). Development of self-recognition, personal pronoun use, and pretend play in the second year. *Child Development, 75*(6), 1821–1831.

Lewis, M., & Rosenblum, L. (Eds.). (1974). *The origins of fear: The origins of behavior, 2*. New York: Wiley.

Lewis, M., Sullivan, M. W., Stanger, C., & Weiss, M. (1989). Self-development and self-conscious emotions. *Child Development, 60*, 146–156.

Markus, H., & Katayama, S. (1991). Culture and the self: Implications for cognition, emotion and motivation. *Psychological Review, 98*, 224–253.

Mennella, J. (2012, March). *Sensitive periods in flavor learning*. Paper presented at the Roger Fine and George Heinrich Brown Bag Series at the Institute for the Study of Child Development, Department of Pediatrics, UMDNJ-RWJMS, New Brunswick, NJ.

Mineka, S., Keir, R., & Price, V. (1980). Fear of snakes in wild- and laboratory-reared rhesus monkeys (Macacamulatta). *Animal Learning and Behavior, 8*, 653–663.

Oster, H. (1978). Facial expression and affect development. In M. Lewis & L. Rosenblum (Eds.), *The genesis of behavior: Vol. 1. The development of affect* (pp. 43–76). New York: Plenum Press.

Otaki, M., Durreit, M., Richards, P., Nyquist, L., & Pennebaker, J. (1986). Maternal and infant behavior in Japan and America. *Journal of Cross-Cultural Psychology, 17*, 251–268.

Pavlov, I. P. (1960). *Conditioned reflexes*. New York: Dover.

Porges, S. W. (1986). Respiratory sinus arrhythmia: Physiological basis, quantitative methods, and clinical implications. In P. Grossman, K. Janssen, & D. Vaitl (Eds.), *Cardiorespiratory and cardiosomatic psychophysiology* (pp. 101–115). New York: Plenum Press.

Porges, S. W. (2011). *The polyvagal theory: Neurophysiological foundations of emotions, attachment, communication, and self-regulation*. New York: Norton.

Ramsay, D. S., & Lewis, M. (1994). Developmental change in infant cortisol and behavioral response to inoculation. *Child Development, 65*, 1483–1494.

Rosenstein, D., & Oster, H. (1988). Differential facial responses to four basic tastes in newborns. *Child Development, 59*(6), 1555–1568.

Rozin, P., Haidt, J., & McCauley, C. R. (2008). Disgust. In M. Lewis, J. M. Haviland-Jones, & L. Feldman Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 757–776). New York: Guilford Press.

Schaffer, H. R. (1974). Cognitive components of the infant's response to strangeness. In M. Lewis & L. A. Rosenblum (Eds.), *The origins of behavior. The origins of fear* (Vol. 2, pp. 11–24). New York: Wiley.

Schneirla, T. C. (1959). An evolutionary and developmental theory of biphasic processes underlying approach and withdrawal. In M. R. Jones (Ed.), *Nebraska symposium on motivation* (Vol. 7, pp. 1–42). Lincoln: University of Nebraska Press.

Shweder, R. A. (1985). Menstrual pollution, soul loss, and the comparative study of emotions. In M. A. Kleinman & B. Good (Eds.), *Culture and depression* (pp. 182–215). Berkeley: University of California Press.

Simonov, P. V. (1964). *On the ratio of the motor and vegetative components in the conditioned defensive reflex in man* (in Russian). International Symposium on Central and Peripheral Mechanisms of Motor Activity in Animals and Man, Moscow.

Spitz, R. A. (1965). *The first year of life*. New York: International Universities Press.

Sroufe, L. A. (1996). *Emotional development: The organization of emotional life in the early years*. New York: Cambridge University Press.

Sroufe, L. A., Waters, E., & Matas, L. (1974). Contextual determinants of infant affective response. In M. Lewis & L. A. Rosenblum (Eds.), *The origins of fear: The origins of behavior* (Vol. 2, pp. 49–72). New York: Wiley.

Sroufe, L. A. & Wunsch, J. P. (1972). The development of laughter in the first year of life. *Child Development, 43*(4), 1326–1344.

Steiner, J. E. (1979). Human facial expressions in response to taste and smell stimulation. In H. W. Reese & L. P. Lipsitt (Eds.), *Advances in child development and behavior* (Vol. 13, pp. 257–295). New York: Academic Press.

Stipek, D., Recchia, S., & McClintic, S. (1992). Self-evaluation in young children. *Monographs of the Society for Research in Child Development, 57*(1, Serial No. 226).

Sullivan, M. W., & Lewis, M. (2003). Contextual determinants of anger and other negative expressions in young infants. *Developmental Psychology, 39*(4), 693–705.

Sullivan, M. W., Lewis, M., & Alessandri, S. (1991). Interface between emotion and cognition. In R. M. Downs, L. S. Liben, & D. S. Palermo (Eds.), *Visions of aesthetics, the environment, and development: The legacy of J. F. Wohlwill* (pp. 241–261). Hillsdale, NJ: Erlbaum.

Suomi, S. (1991). Primate separation models of affective disorders. In J. Madded (Ed.), *Neurobiology of learning, emotion and affect* (pp. 195–213). New York: Raven Press.

Warneken, F., & Tomasello, M. (2009). Varieties of altruism in children and chimpanzees. *Trends in Cognitive Sciences, 13*, 397–402.

Watson, J. B. (1914). *Behavior: An introduction to comparative psychology*. New York: Holt.

Watson, J. S. (1972). Smiling, cooing, and "the game." *Merrill–Palmer Quarterly, 18*(4), 323–339.

Zaki, J., & Mitchell, J. P. (2013). Intuitive prosociality. *Current Directions in Psychological Science, 22*(6), 466–470.

CHAPTER 16

UNDERSTANDING EMOTION

Paul L. Harris, Marc de Rosnay, and Francisco Pons

Awareness of Emotion

In this chapter, we offer an account of children's emotional development that highlights some of its distinctively human characteristics. Darwin's (1998) emphasis on the continuity between men and animals in their expression of emotion and subsequent research on the nonverbal expression of emotion have tended to obscure those distinctively human characteristics. In particular, the ways in which human beings talk about their emotions and reflect upon them in the context of conversation has been neglected as a key aspect of emotional development.

We begin by describing children's developing ability to put their feelings—and those of other people—into words. Next, we consider how children's emotion concepts become more complex with development. We emphasize that children increasingly understand how a person's emotional reaction depends on how he or she interprets a given situation and not on the situation itself. We provide two illustrations of this claim: children's emerging understanding of belief-based emotions and their understanding of the links between emotion and transgression. We then turn to a discussion of individual differences in children's developing understanding of emotions. We conclude by emphasizing another important link between language and emotion. Thus, we review the increasingly solid evidence that children who are given frequent opportunities to engage in conversation about emotions generally end up with a more accurate and comprehensive understanding, both of their own emotional lives and those of other people.

Talking about Emotion

Psychological theories of emotion, whether focused on children or adults, have been strongly influenced by Darwin's (1998) emphasis on the continuities between human beings and nonhuman primates with respect to both the function and the communication of emotions (Ekman, 1982). However, human beings, unlike other primates, can put their emotions into words. This linguistic mode of expression might serve only to amplify a preexisting mode of nonverbal communication. However, it is more likely that it produces a psychological revolution. After all, it allows human beings to communicate what they feel not just about ongoing situations but also about past, future, recurrent, or hypothetical situations. It also allows them to hear about and contemplate the emotionally charged experiences of other people in situations that they may not have encountered for themselves. These conversations and narratives—which begin in early childhood—provide our species with a unique opportunity to reactivate and explore a wide range of emotional experiences, carrying us well beyond the confines of our own current or firsthand emotional experience.

When do children start to deliberately communicate about emotion? There is intriguing evidence that preverbal toddlers can be taught to use manual gestures to comment on emotions (Vallotton, 2008). For example, 11-month-old Cathy looked at a stuffed toy spider, pounded her fist on her chest (the gesture that she had been taught for fear), and then looked at her caregiver. The caregiver commented on her fear of the spider, eliciting a nod from Cathy. Fifteen-month-old Ellie, hearing another child crying nearby, drew her forefinger down her cheek (the gesture for sad) and, looking at a caregiver, made the gestures for bottle and sleepy/nap. These observations suggest that even before they have any words for emotions, toddlers can report intentionally and appropriately on their own feelings as well as those of someone else.

Children start to talk about emotions at approximately 2 years of age. To analyze such talk, Wellman, Harris, Banerjee, and Sinclair (1995) studied a small group of children whose language production had been recorded on an intensive, longitudinal basis from 2 to 5 years. Wellman et al. (1995) concentrated on all those utterances in which children referred to either an emotion or, for comparison purposes, to a mental state that is not an emotion, namely, pain. The analysis showed that even 2-year-olds talk systematically about emotion. They refer to a small set of emotional states—both positive (feeling happy or feeling good, laughing, and feeling love or loving) and negative (feeling angry or mad; feeling frightened, scared, or afraid; and feeling sad or crying).

Children talk most often about their own emotions but they also talk about the emotions of other people. Moreover, consistent with the proposals made by Widen (see The Development of Children's Concepts of Emotion, Chapter 17, this volume), children's attributions of emotion are not exclusively triggered by the recognition of animate facial expressions. They also attribute emotions to dolls, stuffed animals, and made-up characters. Moreover, as just noted, 2-year-olds talk about emotional states—feeling good or feeling love—that have no obvious facial signature.

Arguably, when young children put their own feelings into words, they are not engaged in any self-conscious reporting of their experience. Rather, as Wittgenstein (1953) suggested, such early emotion utterances could be seen as vocal substitutes—on a par with exclamations such as "Ouch" or "Yuck"—for the nonverbal expression of emotion. However, close examination of 2-year-olds' utterances shows that this interpretation is ill founded. If children's references to emotion were simply a substitute for the ordinary facial and behavioral expression of emotion, we would expect them to be produced more or less exclusively in the context of ongoing or current emotions. However, about half of 2-year-olds' references to emotions are concerned with past, future, and recurrent feelings, and the same pattern is found among 3- and 4-year-olds.

By implication, we can think of children's utterances about emotion as referential reports, not as lexical substitutes for scowls and smiles. Indeed, Wittgenstein's (1953) analysis is not even appropriate for children's pain utterances. Here too, children talk not only about current pains, they also refer to pains that they might experience in the future or have experienced in the past. More generally, many of children's utterances about emotion can be categorized as descriptive utterances. Instrumental utterances, aimed at obtaining sympathy or influencing the emotional state of another person (Dunn, Brown, & Beardsall, 1991; Wellman et al., 1995), are less frequent. Indeed, this bias toward descriptive commentary is evident even below 2 years of age. Dunn, Bretherton, and Munn (1987) found that children between 18 and 24 months used conversation about feelings primarily to offer a descriptive comment about their own feelings or those of another person. That said, it is worth emphasizing that their mothers—to whom most of these comments were directed—used such conversations in a more didactic or pragmatic fashion. Clancy (1999) reported similar findings for Japanese mothers; they also frequently use talk about emotion for didactic purposes, for example, to affirm or counter their 2-year-olds' suggestion that a particular person or creature is scary.

Talking about Past Emotion

Lagattuta and Wellman (2002) looked in more detail at how children talk about negative as compared with positive emotions. Like Wellman et al. (1995), they examined the utterances of a small group of children whose language production had been studied on an intensive, longitudinal basis from 2 to 5 years. Overall, children and their parents tended to talk about current emotions, with a bias toward positive rather than negative emotions. Nevertheless, when past emotions were discussed there was a tendency to focus on negative rather than positive emotions. This bias toward the negative was true for both children and adults. Talk about negative emotions also included about three times as many causal elaborations as compared with talk about positive emotions, and again this bias emerged among children as well as adults. Moreover, when children and adults posed an open-ended, as opposed to a closed question about emotion, such questions were about three times more frequent for negative than positive emotions. Overall, then, Lagattuta and Wellman (2002) found that conversations about past emotional experiences are especially frequent, elaborate, and open-ended in the case of negative emotions.

Ordinarily, our emotional reactions are especially intense immediately after a precipitating event. They gradually become weaker as that event recedes in time. Given the ubiquity of this waning process, it is not surprising that even 4-year-olds understand that it occurs (Harris, 1983; Harris, Guz, Lipian, & Man-Shu, 1985). However, despite its ubiquity, this waning process is not inevitable. Past emotions can be reactivated by reminders—events or cues that trigger memories of earlier emotionally charged encounters.

Lagattuta and Wellman (2001) examined the understanding of that reactivation process by young children ages 3–5 years. Consider, for example, the following story about a negative emotion that is subsequently reactivated in otherwise positive circumstances: "Suzie feels sad when the neighbor's black spotted dog scares away her rabbit. Many days later, the neighbor's dog slowly walks over, sits down and wags its tail real friendly. Suzie starts to feel sad." Children listened to such stories and were then asked about the feelings of the protagonist: "Why does Suzie start to feel sad right now?" and were scored for the frequency with which they produced so-called cognitive-cuing explanations, involving references to a cue in the present situation that made the protagonist think about a past event, for example: "The dog makes her think about the lost rabbit." Children were especially likely to produce such cognitive-cuing explanations for stories involving a prior negative emotion, as exemplified by the story about Suzie's dog. They were less likely to provide such explanations for stories involving a prior positive emotion.

Arguably, conversations about past emotions help children to understand the reactivation process. When children engage in a conversation about a past event, they might experience a reactivation of the emotion that they felt earlier. Indeed, to the extent that conversations about past negative emotions tend to be especially probing and elaborate, children might become particularly alert to the ways in which negative—as opposed to positive emotions—can be reactivated by such conversational reminders. Alternatively, when ruminating about a past event children might display the emotion associated with that event and thereby puzzle their parents with a demeanor that is not consonant with their current circumstances. Concerned parental questioning ("What's the matter?") might then prompt children to think about their emotional state and its cause. Such questioning is especially likely to occur when the child appears upset in otherwise positive circumstances. Thus, according to either of these two analyses, we might plausibly expect conversation to help children understand how reminders of the past, especially reminders of negative events, can reactivate otherwise dormant feelings.

Taken together, the various findings on children's conversations about emotion highlight the extent to which children's emotional experiences and their reflection on such experiences are not tied to the current moment. Language allows children to put their current feelings into words but it also allows them to talk about future emotions and to revisit past emotions. Probably by virtue of such conversations, children are especially aware of the fact that past emotions can be reactivated by reminders.

Desires, Beliefs, and Emotion

In the previous section, we discussed the child's ability to talk about emotions in global terms. In this section, we consider in more detail how children conceptualize the emotions that they talk about and the way in which their conception of those emotions changes in the course of development. One simple and attractive proposal is that children develop an increasingly elaborate set of scripts for particular emotions. Thus, they identify the type of situations that elicit various emotions—fear, sadness, anger, happiness, and so forth—as well as the typical actions and expressions that accompany a particular emotional state (Barden, Zelco, Duncan, & Masters, 1980; Harris, Olthof, Meerum Terwogt, & Hardman, 1987; Trabasso, Stein, & Johnson, 1981; Widen, Chapter 17, this volume; Widen & Russell, 2008).

This notion of script-based knowledge has several advantages. It assimilates children's understanding of emotions to a wider body of research on children's recall and understanding of sequentially organized events (Nelson & Gruendel, 1979). It highlights the fact that an understanding of emotions calls for a causal understanding of the connections among its sequential components. It is also sufficiently flexible to be of service if we look outside of the Western world to children's understanding of emotions in cultures where different emotional themes are prominent. For example, Lutz (1987) used this approach in her analysis of the emotion concepts of children on the island of Ifaluk in the Western Pacific. Finally, the notion of an emotion script fits comfortably with the possibility, raised in the previous section, that children's understanding might be elaborated not just in the context of emotionally charged encounters but in the context of discussions in which past emotionally charged episodes are likely to be rehearsed and organized into a coherent, narrative sequence.

However, it is important to recognize some important challenges for the script metaphor. The same objective situation can elicit different emotions depending on the appraisal that a given protagonist makes of that situation. This means that if the child attempts to store a list of scripts for emotion in which situations are conceptualized as the major elicitors of emotion, it will be necessary to store different scripts for different people even with respect to the same situation. An alternative, and more economical, solution is to define the eliciting situation in more psychological terms. For example, it is possible to define situations that provoke happiness as "situations that are judged by an actor to bring about the fulfillment of his or her goals." This definition acknowledges that emotions are not scripts in any ordinary sense of the term. More specifically, they do not begin with the kind of objective and visible event that we normally associate with scripts (e.g., the action of sitting down at a table might be seen as the first move in the dinner script). Rather, they begin with a causal event that is inherently psychological, namely, a person appraising a situation. Thus, a fruitful approach to children's understanding of emotion is to acknowledge that children may indeed construct scripts for given emotions but key elements of those scripts will include a psychological cause—a diagnosis, not of the objective situation that faces the protagonist but rather an analysis of how the protagonist appraises that situation. Making the same point differently, it is not just psychologists who have to recognize the role of appraisal processes in emotion. Young children should do the same. Indeed, as we describe below, they increasingly do so in the course of development.

The limitations of a focus on objective events as causes can be highlighted in another way. Children with autism are often good at remembering recurrent sequences of events. Indeed, part of the clinical picture of autism is a disposition to become upset at an unexpected departure from a routine sequence. In some ways, their script-sensitive memory serves children with autism quite well with respect to understanding emotions. They appropriately judge that certain situations (getting nice things to eat, birthday parties) make people happy, whereas other situations (having to go to bed early, falling over) make people unhappy (Baron-Cohen, 1991; Tan & Harris, 1991). Similarly, Ozonoff, Pennington, and Rogers (1990) showed that children with autism could select the appropriate facial expression to go with the depiction of various emotionally charged situations. For example, they chose a sad face for a picture of a child looking at a broken toy and an angry face for a picture of two children fighting. Yet despite this apparent familiarity with routine scripts for various emotions, children with autism perform poorly, in comparison to nonautistic controls, when a correct attribution of emotion requires them to go beyond the objective situation and consider how a protagonist's beliefs influence his or her appraisal of that objective situation (Baron-Cohen, 1991; Harris, 1991). The clear implication is that typically developing children realize that it is not situations in themselves that cause emotions but the way in which they are appraised.

Accepting this argument, we can ask in more detail how children come to understand the appraisal process. First, even toddlers appreciate the role that desires or preferences play in determining a protagonist's appraisal and the ensuing emotion. For example, they understand that someone may want to be given more crackers or more broccoli depending on whether they have expressed a liking for one or the other (Repacholi & Gopnik, 1997). Similarly, preschoolers understand that a toy elephant might feel happy to be given milk if it wants milk, whereas a toy horse may feel upset, if it preferred juice instead (Harris, Johnson, Hutton, Andrews, & Cooke, 1989; Yuill, 1984).

However, it is only around 5–6 years that children recognize the impact of beliefs on emotion. Several studies support this conclusion. For example, Hadwin and Perner (1991) found that even if virtually all 5-year-olds could appreciate a story character's mistaken expectation, it was only at 6 years of age that a significant majority made correct attributions of surprise, consistent with the story character's misplaced expectation about what was about to happen. Bradmetz and Schneider (1999) examined children's understanding of the Little Red Riding Hood story. Younger children often realized that Little Red Riding Hood did not know that a wolf was waiting for her inside her grandmother's cottage. Yet they would still claim that she was afraid—and they often invoked the wolf to explain her fear: "Because the wolf wants to eat her." Older children were more likely to respond correctly by attributing a positive emotion to her given her mistaken appraisal of what lay in store. De Rosnay and Harris (2002) observed a similar pattern when children watched a video of a child protagonist hearing a knock at the door and mistakenly thinking that her mother is about to enter the room. Younger children frequently erred by identifying the protagonist's emotion as negative, even though they acknowledged that she did not yet know that it was a stranger, and not her mother, who was knocking at the door. Older children, by contrast, realized that the protagonist would be happy to hear the knock at the door, mistakenly taking it to be her mother.

These various studies examined children's ability to figure out what someone else—a story protagonist or a child in a video—is feeling given his or her beliefs. Do children also have trouble in identifying their own belief-based emotions? Bender and his colleagues (Bender, Pons, Harris, & de Rosnay, 2011) interviewed 5½-year-olds and 7-year-olds using a variant of the classic Smarties task. Children were shown a box of Smarties candy and asked to indicate how they felt about getting its contents to eat; needless to say, they almost invariably reported positive feelings. They were then shown that, sadly, the box contained only inedible beads. Next, the beads were returned to the box and children were asked about their initial belief, what they had thought was inside the box, and also about their initial emotion, how they had felt about getting to eat its supposed contents. A considerable proportion of children acknowledged that they had mistakenly thought there were Smarties in the box. Yet they often claimed that they had felt sad about eating the prospective contents. Apparently, these children did not figure out how they had felt by searching their memory and retrieving the positive feelings they had experienced and reported earlier. Their self-report was contaminated by what they discovered later. Apparently, what Birch and Bloom (2007) aptly describe as "the curse of knowledge" applies to children's self-attributions of emotion.

How can we explain the pervasive difficulty of younger children in understanding belief-based emotions? Granted children's early grasp of the link between desire and emotion, it is likely that they attribute positive or negative emotion to someone depending on whether the person in question is approaching an outcome that fits or frustrates his or her desire. Recall that even toddlers acknowledge individual preferences in this fashion (Repacholi & Gopnik, 1997). If so, some kind of inhibitory process would be needed for that outcome-based attribution to be suspended. Realizing that the person is wrongly appraising the impending outcome could, in principle, trigger such an inhibitory process. However, as the above evidence implies, it may fail to do so especially among younger children. It appears that children's attributions become more accurate, not simply because they get better at analyzing the protagonist's mistaken belief, but because they get better at using their analysis of that mistaken belief to override a simpler analysis based only on the perceived desirability—or undesirability—of the impending outcome.

If this interpretation is correct, we might expect children to be more accurate in their attributions of emotion if that override process is made less onerous. Ronfard and Harris (2014) tested this idea by asking children how Little Red Riding Hood would feel, not just when the impending outcome was imminent—for example, as she stood at the door of her grandmother's cottage—but also when she was starting off on her journey to her grandmother. As predicted, children displayed a linear pattern: incorrect attributions of fear to Little Red Riding Hood steadily increased as the override process became more onerous (i.e., as Little Red Riding Hood got closer to the cottage and the impending outcome became more salient). These incorrect attributions increased even though, at each point along her journey, children acknowledged that she knew nothing about the wolf.

Summing up these various findings, we can say that children soon realize that the same situation can elicit different emotions depending on the particular desires that an individual brings to it. They have much more difficulty in realizing that it is someone's belief-based appraisal of an impending situation—accurate or inaccurate—that determines how he or she feels, not the situation itself (Harris, de Rosnay, & Ronfard, 2013).

The Appraisal Process and Transgression

We can learn more about children's developing appreciation of the appraisal process by looking at children's attributions in the context of transgression. In a pioneering study, Nunner-Winkler and Sodian (1988) found a surprising age difference. Four- and 5-year-olds consistently claimed that a story protagonist who had committed a relatively serious transgression (e.g., deliberately lied, or pushed another child, or stolen something) would feel happy. The children justified this by noting that the protagonist had achieved his or her goal—successfully stolen something or pushed another child off the swing. Older children, around the age of 8 years, were more likely to claim that the protagonist would feel bad and in explaining that attribution they referred to the story character's transgression. So, here again we see a shift from a desire- or goal-based attribution of emotion to something more complex.

A plausible explanation for this shift is that older children increasingly expect that a transgression will provoke a bad conscience—they have acquired an understanding of what it means to think about, and feel badly about, a wrongdoing. Still, before focusing in more detail on that interpretation, it is worth considering various alternatives. One possibility is that younger children regard the transgressions as minor. However, a long tradition of research on moral development shows that preschoolers actually think of lying, pushing, and stealing as serious transgressions (Smetana, 1981). Not surprisingly, therefore, Keller, Lourenço, Malti, and Saalbach (2003) could find no age difference in children's castigation of such basic transgressions.

A second possibility is that older children expect the protagonist to feel bad because they are more alert to the risk of punishment. Indeed, being older and arguably expected to "know better," older children might anticipate more severe punishment for such transgressions than younger children. However, children's justifications for their attributions of emotion lend little support to this explanation. They rarely refer to punishment or fear of punishment when explaining why the perpetrator feels bad.

A third possibility is that older children are more likely to interpret the question in terms of the emotion that the perpetrator *should* feel, whereas the younger children focus on what the perpetrator actually *does* feel. However, when Keller et al. (2003) asked children how they themselves would feel after such a transgression—a question format that should presumably help younger children to focus on socially appropriate feelings—the familiar age difference still emerged.

A fourth possibility is that younger children are "happy victimizers." As compared with older children, they are less likely to acknowledge the suffering experienced by the victim of a transgression, and less likely to attribute bad feelings to the person who has caused that distress. However, when Arsenio and Kramer (1992) explicitly asked children of various ages about the feelings of the victim, all age groups acknowledged his or her distress. Indeed, the familiar age difference in the attribution of bad feelings to a wrongdoer emerged even when children were asked about transgressions that did not involve any suffering on the part of a victim. Thus, when Lagattuta (2005) presented children from 4 to 7 years with stories involving a conflict between the protagonist's desire and various nonmoral rules concerning, for example, safety ("Don't run into the street") or nutrition ("Don't eat cookies before dinner"), older children were more likely to acknowledge that the protagonist would feel bad after breaking the rule. Equally important, older children were also more likely to acknowledge that the protagonist would feel good about being a "rightdoer" (i.e., someone who had resisted the temptation to break the rule). Clearly, it is not feasible to explain these age differences in terms of increased empathy for a victim because in neither case was there any victim.

The most plausible explanation of the findings is that, in the course of development, children increasingly conceive of protagonists as engaging in a particular kind of appraisal process. More specifically, younger children are inclined to assume that protagonists focus mainly on their goals and feel happy or sad depending on whether their actions have fulfilled those goals or not. So, for example, a protagonist who wants to steal something and successfully does so will feel good about it. Older children, by contrast, acknowledge that protagonists appraise their actions in terms of their fit with various rules and obligations. They feel good if they have done what they should do and bad if they have done what they ought not to do. In probing children's explanations for the emotion felt by the story characters, Lagattuta (2005) obtained support for this interpretation. Older children were more likely to focus on rules and obligations than younger children. They said, for example, "She feels a little bad because she shouldn't have done that" or "Because his Mom said he had to stay out of the street."

Does this mean that younger children are completely oblivious to rules and obligations in assessing what someone feels? In that case, someone who overtly expresses negative feelings by apologizing for a wrongdoing should be quite puzzling for younger children. Recent findings, however, suggest that, in fact, they are not completely oblivious to the negative feelings that can follow transgression. Smith, Chen, and Harris (2010) gave 4- to 9-year-olds two different stories, one in which the protagonist grabbed something belonging to another child, a bag of marbles, and one in which the protagonist was physically aggressive—pushed another child off the swing. At the end of one story, the protagonist said, "I'm sorry," but at the end of the other, the protagonist was unapologetic. When the protagonist failed to apologize, 4- and 5-year-olds showed the familiar attribution pattern. They expected the transgressor to have positive feelings despite his or her transgression and they explained those feelings in terms of what the transgressor had gained—the opportunity to play with the marbles or to go on the swing. Children's attribution pattern was quite different when the protagonist apologized. They said that the apologetic transgressor would feel bad and in their explanations they called attention to the transgressor's misdeed and its impact on the victim. They also displayed some insight into the impact of an apology on the emotions of the victim, claiming that the victim who received an apology would not feel as bad as the one who received no apology.

These findings offer reassurance to parents who might worry that preschool children think of an apology as a vacuous statement that parents oblige them to make. On the contrary, preschoolers understand that an apology conveys regret on the part of the transgressor and that it will go some way to repair the victim's hurt feelings. By implication, the elicitation of an apology is an effective way to help young children shift their attention away from the dubious goal that they have just achieved to the transgression that they committed in pursuing that goal. This analysis implies that children who are frequently prompted to reflect upon their misdeeds and to apologize for them will be more likely to attribute negative feelings to a wrongdoer—and positive feelings to a rightdoer—than children who are not so prompted. Chinese mothers are more likely than their U.S. counterparts to recall and review past wrongdoings by their children (Wang & Fivush, 2005). In line with these findings, Chen found that 4- to 8-year-old Chinese children growing up in Shanghai were more likely to attribute negative feelings to a wrongdoer, and positive feelings to a rightdoer than their U.S. peers growing up in Boston (Chen, 2009).

Does this developing insight into the link between transgression and bad feelings—into the workings of a guilty conscience—have any impact on children's behavior? More specifically, is there any evidence that children who readily anticipate that wrongdoing will provoke bad feelings in the perpetrator are better able to stop themselves from doing something wrong? Two studies, especially when considered in combination, point to such a link between emotion understanding and behavior. Smith, Blake, and Harris (2013) gave children ranging from 3 to 8 years of age four stickers. Some children were invited to say how many stickers they should give to another child if invited to divide their stickers with him or her. Other children were given two envelopes, one for themselves and one for another child, and invited to divide the four stickers in whatever way they saw fit. Older children, ages 7–8 years, responded consistently to these two invitations. Thus, they said that they should give two of the four stickers to the other child and they actually did so when handed the envelopes. Younger children also said that they should give two stickers. Nevertheless, many of them, especially at 3–4 years, kept all four stickers for themselves. When asked to explain their responses to the question about what they should do, most children, regardless of their age, offered norm-based explanations (e.g., "Then it will be equal") but there was a marked age difference when children explained what they had actually done. Older children again gave mostly norm-based explanations, whereas younger children often gave desire-based explanations (e.g., "It's my favorite color and I want to keep them all"). This pattern is, of course, familiar; it echoes the age difference that we have seen when children think about how a story protagonist will feel after a wrongdoing: Younger children tend to focus on the desires of the protagonist rather than on normative considerations, whereas older children do the reverse. By implication, the older children were likely to act in terms of normative considerations (namely, equal shares for all), whereas younger children could articulate those norms but failed to act on them.

Further analysis also showed that younger children's indifference to the equal sharing norm when actually sharing was not easily explained by a lack of inhibitory control. Children's performance on a standard measure of inhibitory control—the day–night task—improved with age but this improvement did not mediate the link between age and sharing. Earlier work points instead to the likely impact of a growing ability to anticipate the emotional consequences of transgression. Lake, Lane, and Harris (1995) told children a story in which the protagonist took some candy at a friend's house without permission. Children were invited to diagnose how the protagonist felt immediately afterward, as well as later on that day, when the protagonist wondered whether to confess this misdeed to his mother but refrained from doing so. Alongside this attribution task, children were also tested in a resistance-to-temptation paradigm. They could increase their chance of winning a prize if they cheated by peeking while the experimenter was absent. A relationship between children's tendency to cheat and their story attributions was observed. Noncheaters proved to be especially different from cheaters in their responses to a question about how the protagonist felt about not confessing. Noncheaters were more likely to say that the story protagonist felt bad, whereas even after a countersuggestion, cheaters often said that he felt fine. Thus, children who were more alert to the possibility of a guilty conscience were more likely to resist the temptation to cheat.

Taken together, these two studies imply that, as they get older, children increasingly abide by moral norms, not because they have gained any greater knowledge of the norms in question, or because they are better at inhibiting the impulse to transgress, but because they realize that wrongdoing will make them feel bad.

Individual Differences in Understanding Emotion

So far, we have emphasized age differences in children's understanding of emotion. That emphasis reflects a research program that has been dominant for the past 30 years. Investigators have aimed to identify a succession of conceptual insights that children come to master in the course of development (Harris, 1989). However, recently, increasing attention has been paid to individual differences in children's mastery of those insights. Investigators have developed psychometric tools to assess how far children have progressed in their understanding of emotion and to assess how far some children are advanced in their understanding, whereas others lag behind.

Pons, Harris, and de Rosnay (2004) describe a Test of Emotion Comprehension (TEC) composed of nine different components: (1) the recognition of facial expressions of emotion, (2) understanding situational causes, (3) understanding the effect of reminders on emotion, (4) understanding the link between desire and emotion, (5) understanding the link between belief and emotion, (6) understanding the potential discrepancy between felt and expressed emotion, (7) understanding guilt, (8) understanding the regulation of emotion, and (9) understanding mixed or ambivalent emotions. They tested children between 3 and 11 years for their mastery of each component. The main findings were that children displayed a clear improvement with age on each component and the components themselves could be plausibly grouped into three developmental phases. The first period is characterized by the understanding of key public aspects of emotions: their mode of expression, their situational causes, and the effect of reminders. The second period is characterized by mastery of mentalistic aspects of emotion: the role of desires and beliefs and the distinction between felt and expressed emotion. The third period is characterized by an understanding of how the same individual can reflect on a situation in different ways or in terms of different criteria and thereby evoke different feelings, either at the same time or successively. Pons et al. (2004) observed a hierarchical relationship among these three phases. By implication, the understanding of key external aspects of emotion is a prerequisite for understanding the more mentalistic aspects. In turn, understanding these mentalistic aspects is a prerequisite for understanding the impact of reflection on emotion.

Follow-up studies have confirmed that the test has good test–retest reliability over a period of 1–3 months (Pons, Harris, & Doudin, 2002; Tenenbaum, Alfieri, Brooks, & Dunne, 2008). Pons and Harris (2005) examined the scope and stability of individual differences in a longitudinal study of three age groups. Children ages 7, 9, and 11 years were tested at Time 1 and then retested 13 months later at Time 2. More than half of the 7- and 9-year-olds showed gains at retest (although the majority of 11-year-olds remained the same—likely reflecting the absence of challenging components for this older group). Individual differences were marked at both Times 1 and 2 for all three age groups. For example, children in the youngest group varied by as much as six components and children in the two older groups varied by as much as four components. Moreover, when adjacent age groups were compared, the highest-scoring children in the younger group scored higher than the lowest-scoring children in the older group by two to three components depending on which two age groups were compared. Indeed, some of the 7-year-olds had an overall level of emotion understanding that was higher than some of the 11-year-olds. These individual differences remained quite stable over the 13-month period. Thus, despite the gains made by many children in their understanding of emotion, their relative level of understanding at Time 1 was a good predictor of their relative level of understanding at Time 2.

Children's level of understanding can be improved by educational interventions. Pons et al. (2002) administered the TEC to 9-year-olds on two occasions, with an interval of 3 months between each administration. During the interval, children in the experimental group engaged in daily classroom reading and discussion concerning various aspects of emotion, including the origins of particular emotions, the distinction between real and expressed emotion, and strategies for coping with emotion. Control children, by contrast, followed the standard curriculum. Most of the experimental children improved their scores on the TEC, whereas only a minority of control children did so. Strikingly, children's level of understanding at the pretest was correlated with their level of understanding at the posttest, whether they were in the experimental or the control group. By implication, the intervention helped most of the children in the experimental group but it did not eliminate preexisting individual differences in children's relative level of understanding.

Similar results were obtained by Tenenbaum et al. (2008). Following a pretest with the TEC, children ranging from 5 to 8 years listened to vignettes about mixed and hidden emotions and were allocated to one of three groups. They were invited to (1) identify an explanation for the protagonist's emotion that had been mentioned in the story, (2) listen to a similar explanation from the experimenter, or (3) recall aspects of the story not connected to the protagonist's emotion. Children in the first two groups—who had been prompted to think about why the protagonist had displayed mixed feelings or had concealed his or her feelings—showed gains on the TEC in a posttest, whereas children in the third group did not. In line with the findings of Pons et al. (2002), performance at pre- and posttest was correlated for all three groups, again suggesting that an intervention can boost understanding but does not eliminate preexisting individual differences.

Do such marked and stable individual differences in children's understanding of emotion have any impact on their social relationships, especially their relationships with peers? Several studies have explored this possibility. Denham, McKinley, Couchoud, and Holt (1990) tested preschoolers (mean age = 44 months) for their ability to identify a puppet's emotion (of happiness, sadness, anger, or fear) both when the puppet exhibited a prototypical reaction (e.g., fear during a nightmare) and an atypical reaction (e.g., sadness at going to preschool). In addition, using a sociometric measure, children were assessed for their acceptance as a playmate among their peers. Children with higher scores on the emotion test proved to be more popular among their peers, even when the contributions of age and gender were removed. Cassidy, Parke, Butkovsky, and Braungart (1992) obtained very similar results with first-grade children. Children's overall score in an interview about the causes, consequences, and associated expression of emotion was correlated with their popularity. In a longitudinal study of 4- and 5-year-olds, Edwards, Manstead, and MacDonald (1984) found that children who were accurate at identifying facial expressions of emotion proved to be more popular 1–2 years later (even when their initial popularity was taken into account). Finally, in a longitudinal study of somewhat older children, Caputi, Lecce, Pagnin, and Banerjee (2012) found that children's understanding of belief and emotion at 5 years of age was associated with prosocial behavior at 6 years of age, which was in turn related to peer acceptance versus rejection at 7 years of age. By implication, children's understanding of belief and emotion regulates the extent to which they enter into collaborative and sympathetic relationships with their peers—and thereby gain acceptance or face rejection.

However, it would be wrong to draw the conclusion that children with good insight into emotion inevitably have healthy and positive relationships with their peers. As Hughes (2011) emphasizes, children's understanding of mental states, including emotion, is neutral with respect to social behavior. It can lead to either prosocial or antisocial behavior. Consider the following thought-provoking study of bullying carried out by Sutton, Smith, and Swettenham (1999). Bullies are sometimes characterized as awkward children who resort to aggression because of their limited social skills. Yet it is also conceivable that bullying calls for an astute analysis of whom to victimize and how bystanders will react. With this in mind, Sutton et al. (1999) administered a set of stories designed to assess the understanding of emotions and cognitions among 7- to 10-year-olds. Children who were "ringleader" bullies scored higher than several other groups. They scored higher than "follower" bullies (i.e., those who helped or supported the bully) and victims, as well as defenders of the victim.

Summarizing across these studies, the implication is that insight into other children's emotional and mental states is associated with social adroitness. It is linked to popularity and acceptance but it can also be linked to leadership in the context of bullying. It is tempting to assume that a more advanced or precocious understanding of emotion invariably yields positive social outcomes but that assumption is probably too optimistic.

The Origins of Individual Differences

Why do children vary so markedly in their understanding of emotion? One plausible reason is that the development of emotion understanding, indeed the development of children's psychological understanding more broadly, is a reflection of variation in their linguistic competence. In keeping with that possibility, children who are linguistically more advanced are also better able to predict and explain emotions (e.g., Pons, Lawson, Harris, & de Rosnay, 2003). Recent evidence also points to a key role for family conversation. Consider a child whose parent frequently discusses emotions and other psychological states, by drawing out the child's own feelings and desires, by calling attention to the way that his or her actions may have emotional implications for other members of the family, or by elaborating on the thoughts and feelings of story characters. Consider, on the other hand, a parent who is more constrained in talking about such psychological states, whether with respect to the child, or other people. Beyond the contribution that a child's linguistic competence makes to emotion understanding, two such different conversational partners might be expected to have a differential impact on the extent to which the child understands the causes and consequences of emotion.

We know that there is marked variation among families in the frequency with which emotions and other aspects of mental life are discussed. In a pioneering study, Dunn, Brown, and Beardsall (1991) found that some children never made any mention of emotion during an hour-long home visit, whereas others made more than 25 such references; variation among the mothers was equally great. This type of variation in the frequency with which preschool children engage in family discussion about emotions is correlated with their later ability to identify how someone feels. The link has been found over a relatively short period, straddling the third birthday (i.e., from 33 to 40 months; Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991), as well as a more extended period from 3 to 6 years (Dunn, Brown, & Beardsall, 1991; Brown & Dunn, 1996).

Such correlational data are, of course, open to various interpretations. One possibility is that the correlation reflects some stable attribute of the child that manifests itself both in psychological talk and in sensitivity to emotion. For example, some children may, because of their natural empathy, have a proclivity to both discuss emotions and also to attend to others' feelings. Another possibility is that some caregivers, because of their underlying sensitivity or attunement, may speak more about emotion and thereby engender in the child a heightened awareness of people's emotional lives. Although both of these underlying mechanisms remain plausible, the extant literature strongly suggests that conversational interactions do serve a didactic function, so that the manner in which caregivers speak about psychological states has a direct influence on children's understanding of mind and emotion (de Rosnay & Hughes, 2006).

Evidence that certain kinds of family discussions may prompt children to speak about emotion and increase their understanding and perspective taking comes from various directions. For example, Garner, Jones, Gaddy, and Rennie (1997) found that 3- to 5-year-olds' emotional perspective taking is correlated with family discussions of emotion that focus not simply on what the person feels but rather on *why* someone feels a given emotion. Similarly, Laible (2004) showed that, among 2- to 3-year-olds, emotion understanding was related to mother–child conversations that were high in clarity and stayed on topic, rather than related to references to emotion per se. Taken together, these two studies suggest that children's emotion understanding is cultivated in a conversational environment that encourages them to think about why someone might feel a certain way.

Two recent longitudinal investigations show how the conversational support that mothers offer shifts as their children get older. Taumoepeau and Ruffman (2006, 2008) analyzed structured conversations between mothers and their children while reading psychologically evocative picture books at

15, 24, and 33 months of age. Mothers' utterances were coded for various features of mental state talk (desires, emotions, thoughts, knowledge, etc.), as well as other salient, descriptive, and functional features. Children's vocabulary development was assessed at each age, and measures of mothers' (15 months) and children's (24 and 33 months) emotion understanding were similarly assessed, so that the unique contribution of mothers' conversational input for the development of children's emotion understanding could be determined. The results showed that mothers' mental state discourse uniquely predicted children's later emotion understanding. Nevertheless, the contribution of maternal mental state discourse shifted as children got older—references to desires were important earlier on, whereas references to thoughts and knowledge were more prominent later on. Importantly, at no time did mothers' simple references to emotion directly predict children's emotion understanding, a result that is consistent with studies of mother–child discourse at slightly later ages (Ensor & Hughes, 2008; Ruffman, Slade, & Crowe, 2002). Although this conclusion might seem counterintuitive, it is instructive. The simple identification and labeling of emotion does not seem to help children understand the idiosyncratic appraisal processes that lead to emotions. However, when the thoughts and desires underpinning such appraisal processes are enunciated and emotions are contextualized in terms of their psychological causes, the didactic function of conversational interaction becomes clearer. These data concerning the impact of maternal discourse dovetail nicely with the earlier emphasis on children's developing sensitivity to appraisal processes, and also with the findings from the two educational interventions discussed earlier, which each emphasized the impact of discussion and explanation.

From the evidence presented above, a picture emerges of profound variation in the socialization of emotion understanding via ordinary family conversations. Against this backdrop, it is important to consider the source of such variation more carefully. While direct conversational measures show that mothers' discourse predicts children's psychological understanding, there is little evidence to show that individual differences in children's understanding of mental states predicts maternal discourse. Mothers do adjust their use of psychological terms to their children's developmental level (see Taumoepeau & Ruffman, 2008, for a discussion). Nevertheless, other sources of evidence indicate that a mother's proclivity to think of her child in psychological terms is a relatively stable feature of the caregiver that can be seen in verbal interactions with her preverbal infant (Meins et al., 2002), or indeed when she is simply asked to describe her child (de Rosnay, Pons, Harris, & Morrell, 2004). In each of these two settings, even though the mother was not engaged in conversation with her child, characteristics of her discourse style were nevertheless predictive of the child's understanding of emotion.

Findings such as these suggest that variation in mothers' mental state discourse may depend on how she sees her child as a conversation partner. Ensor and Hughes (2008) used naturalistic observations of family discourse when children were 2, 3, and 4 years of age to examine family discussions of psychological states and the manner in which family members spoke to one another. As they predicted, a relatively high proportion of references to mental states (notably desires, cognitions, and emotions) occurred in the context of connected utterances (i.e., utterances that were semantically related to the interlocutor's previous utterance rather than initiating a new topic or issuing a prescription or insult). Indeed, it was the so-called *connectedness* of the conversational interactions rather than frequency of mental state references that emerged as the best predictor of children's later understanding of mental states, including emotion.

Summarizing across these different studies, it is clear that coherent psychological discourse serves a didactic function for children, supporting and nurturing their developing psychological understanding from early childhood to at least 6 years of age (Harris, de Rosnay, & Pons, 2005; Ruffman et al., 2002). Such conversational interactions occur more often when caregivers are attuned to the child's psychological perspective. Note that these findings are consistent with twin research indicating a large influence of the shared environment on children's understanding of mind and emotion (Hughes et al., 2005).

Conclusions

In this chapter we have examined several interrelated aspects of children's understanding of emotion: their ability to talk about emotions and to understand the way that past emotions can be reactivated; their sensitivity to key components of the appraisal processes that modulate a person's emotional response to a given situation, namely the person's desires, beliefs, and evaluation of their standing in relation to various norms and obligation; and individual differences in emotion understanding, their links with peer relationships, and the key role of family conversation in promoting children's understanding of emotion.

It is conceivable that children's developing understanding of emotion is simply an epiphenomenon of the underlying emotional process. According to this perspective, the understanding of emotion operates at a "meta" level, sealed off from the underlying emotional process that is its subject matter. To take a concrete example, it is possible to assert that the child functions at two separate levels: on one level, there is the child's experience and display of negative feelings after a transgression; at a separate level, there is the child's capacity for attributing, reporting on, and ruminating about such negative feelings. Increased sophistication at this meta level might have few or no repercussions on processing at the former level.

Such a clear-cut separation between levels of processing might simplify our scientific analysis but it probably distorts some fundamental aspects of human emotion. It effectively predicts that a disruption or delay in the development of the understanding of emotion need have no repercussions on the basic emotional processes themselves. Yet, there are several reasons for thinking that such repercussions do exist. First, there is a therapeutic tradition suggesting that when intense emotional experiences are reworked in the context of communication and rumination, they have different sequelae from those that are not. Such reworking need not be in the context of discussion with a trained therapist—it can also occur in the context of a privately written narrative (Pennebaker, 1996). One plausible extrapolation of these findings is that the emotional lives of children who grow up in homes where there is open discussion of emotionally charged encounters will be different from those where such discussion does not occur. They are likely to be prompted to engage in the type of insightful thinking about the causes of their emotions that has been shown to be beneficial for adults' physical and mental health (Pennebaker, Barger, & Tiebout, 1989).

Second, children's capacity for rumination and communication about their emotions dramatically alters the contexts in which they can seek support and reassurance. Attachment theorists have emphasized the way that a caregiver may or may not provide reassurance at moments of distress. Typically, they have focused on those moments when the precipitating factor is fairly easy to discern: the toddler is unnerved by a stranger, distressed by the caregiver's absence, or fretful about the caregiver's imminent departure. In such cases, the toddler's emotion is likely to be expressed via facial, vocal, or bodily cues. However, the emotional horizon of the older child is much larger—he or she can be fearful or distressed about events that might happen in the future or happened in the past. In these cases, signs of distress or worry can be overlooked by caregivers so that children who can articulate their emotional state are better placed to receive reassurance and engage in the kind of causal thinking that has been shown to be helpful for adults (Pennebaker et al., 1989).

Finally, it is likely that children's ability to understand and predict their own emotions affects their decisions about how to act. In its turn, the course of action that they choose will lead to—or avoid—emotionally charged consequences. One example of such self-regulation was discussed earlier. The ability to anticipate negative feelings can serve as a warning signal when a transgression is contemplated (Lake et al., 1995). That warning signal is sufficient to help children to resist temptation and forestall subsequent regret. It is also not difficult to imagine feedback loops in which anticipated emotion can play a disruptive role. Children's ability to anticipate their anxiety (e.g., when facing difficult problems in mathematics) is likely to further undermine their performance unless they are helped to reframe their feelings in a more positive fashion (Maloney & Beilock, 2012). Stated in more general terms, children's insight into their emotional lives does not simply enable them to foresee the inevitable; it also enables them to choose particular actions—actions that have consequences for what they feel.

References

Arsenio, W. F., & Kramer, R. (1992). Victimizers and their victims: Children's conceptions of the mixed emotional consequences of moral transgressions. *Child Development, 63*, 915–927.

Barden, R. C., Zelko, F. A., Duncan, S. W., & Masters, J. C. (1980). Children's consensual knowledge about the experiential determinants of emotion. *Journal of Personality and Social Psychology, 39*, 968–976.

Baron-Cohen, S. (1991). Do people with autism understand what causes emotion? *Child Development, 62*, 385–395.

Bender, P. K., Pons, F., Harris, P. L., & de Rosnay, M. (2011). Do young children misunderstand their own emotions? *European Journal of Developmental Psychology, 8*, 331–348.

Birch, S. A. J., & Bloom, P. (2007). The curse of knowledge in reasoning about false beliefs. *Psychological Science, 18*, 382–386.

Bradmetz, J., & Schneider, R. (1999). Is Little Red Riding Hood afraid of her grandmother?: Cognitive vs. emotional response to a false belief. *British Journal of Developmental Psychology, 17*, 501–514.

Brown, J. R., & Dunn, J. (1996). Continuities in emotion understanding from three to six years. *Child Development, 67*, 789–802.

Caputi, M., Lecce, S., Pagnin, A., & Banerjee, R. (2012). Longitudinal effects of theory of mind on later peer relations: The role of prosocial behavior. *Developmental Psychology, 48*, 257–270.

Cassidy, J., Parke, R. D., Butkovsky, L., & Braungart, J. M. (1992). Family–peer connections: The roles of emotional expressiveness within the family and children's understanding of emotions. *Child Development, 63*, 603–618.

Chen, D. (2009). *Culture, parent–child conversation, and children's understanding of emotions.* Unpublished doctoral dissertation, Harvard Graduate School of Education, Cambridge, MA.

Clancy, P. M. (1999). The socialization of affect. *Journal of Pragmatics, 31*, 1397–1421.

Darwin, C. (1998). *The expression of the emotions in man and animals* (3rd ed.). London: Harper Collins.

de Rosnay, M., & Harris, P. L. (2002). Individual differences in children's understanding of emotion: The roles of attachment and language. *Attachment and Human Development, 4*, 39–54.

de Rosnay, M., & Hughes, C. (2006). Conversation and theory of mind: Do children talk their way to socio-cognitive understanding? *British Journal of Developmental Psychology, 24*, 7–37.

de Rosnay, M., Pons, F., Harris, P. L., & Morrell, J. M. B. (2004). A lag between understanding false belief and emotion attribution in young children: Relationships with linguistic ability and mothers' mental state language. *British Journal of Developmental Psychology, 22*, 197–218.

Denham, S. A., McKinley, M., Couchoud, E. A., & Holt, R. (1990). Emotional and behavioral predictors of preschool peer ratings. *Child Development, 61*, 1145–1152.

Dunn, J., Bretherton, I., & Munn, P. (1987). Conversations about feeling states between mothers and their young children. *Developmental Psychology, 23*, 132–139.

Dunn, J., Brown, J., & Beardsall, L. (1991). Family talk about feeling states and children's later understanding of others' emotions. *Developmental Psychology, 27*, 448–455.

Dunn, J., Brown, J., Slomkowski, C., Tesla, C., & Youngblade, L. (1991). Young children's understanding of other people's feelings and beliefs: Individual differences and their antecedents. *Child Development, 62*, 1352–1366.

Edwards, R., Manstead, A. S., & MacDonald, C. J. (1984). The relationship between children's sociometric status and ability to recognize facial expressions of emotion. *European Journal of Social Psychology, 14*, 235–238.

Ekman, P. (1982). *Emotion in the human face* (2nd ed.). Cambridge, UK: Cambridge University Press.

Ensor, R., & Hughes, C. (2008). Content or connectedness?: Mother–child talk and early social understanding. *Child Development, 79*, 201–216.

Garner, P. W., Jones, D. C., Gaddy, G., & Rennie, K. M. (1997). Low-income mothers' conversations about emotions and their children's emotional competence. *Social Development, 6*, 37–52.

Hadwin, J., & Perner, J. (1991). Pleased and surprised: Children's cognitive theory of emotion. *British Journal of Developmental Psychology, 9*, 215–234.

Harris, P. L. (1983). Children's understanding of the link between situation and emotion. *Journal of Experimental Child Psychology, 36*, 490–509.

Harris, P. L. (1989). *Children and emotion: The development of psychological understanding.* Oxford, UK: Blackwell.

Harris, P. L. (1991). The work of the imagination. In A. Whiten (Ed.), *Natural theories of mind* (pp. 283–304). Oxford, UK: Blackwell.

Harris, P. L., de Rosnay, M., & Pons, F. (2005). Language and children's understanding of mental states. *Current Directions in Psychological Science, 14*, 69–73.

Harris, P. L., de Rosnay, M., & Ronfard, S. (2013). The mysterious emotional life of Little Red Riding Hood. In K. H. Lagattuta (Ed.), *Contributions to human development.* Basel, Switzerland: Karger.

Harris, P. L., Guz, G. R., Lipian, M. S., & Man-Shu, Z. (1985). Insight into the time course of emotion among Western and Chinese children. *Child Development, 56*, 972–988.

Harris, P. L., Johnson, C. N., Hutton, D., Andrews, G., & Cooke, T. (1989). Young children's theory of mind and emotion. *Cognition and Emotion, 3*, 379–400.

Harris, P. L., Olhof, T., Meerum Terwogt, M., & Hardman, C. E. (1987). Children's knowledge of the situations that provoke emotion. *International Journal of Behavioral Development, 10*, 319–343.

Hughes, C. (2011). *Social understanding and social lives.* Hove, UK: Psychology Press.

Hughes, C., Jaffee, S. R., Happe, F., Taylor, A., Caspi, A., & Moffitt, T. E. (2005). Origins of individual differences in theory of mind: From nature to nurture? *Child Development, 76*, 356–370.

Keller, M., Lourenço, O., Malti, T., & Saalbach, H. (2003). The multifaceted phenomenon of "happy victimizers": A cross-cultural comparison of moral emotions. *British Journal of Developmental Psychology, 21*, 1–18.

Lagattuta, K. H. (2005). When you shouldn't do what you want to do: Young children's understanding of desires, rules and emotions. *Child Development, 76*, 713–733.

Lagattuta, K. H., & Wellman, H. M. (2001). Thinking about the past: Early knowledge about links between prior experience, thinking, and emotion. *Child Development, 72*, 82–102.

Lagattuta, K. H., & Wellman, H. M. (2002). Differences in early parent–child conversations about negative versus positive emotions: Implications for the development of psychological understanding. *Developmental Psychology, 38*, 564–580.

Laible, D. (2004). Mother–child discourse surrounding a child's past behavior at 30 months: Links to emotional understanding and early conscience development at 36 months. *Merrill–Palmer Quarterly, 50*(2), 159–189.

Lake, N., Lane, S., & Harris, P. L. (1995). The expectation of guilt and resistance to temptation. *Early Development and Parenting, 4*, 63–73.

Lutz, C. (1987). Goals, events, and understanding in Ifaluk emotion theory. In D. Holland & N. Quinn (Eds.), *Cultural models in language and thought* (pp. 290–312). Cambridge, UK: Cambridge University Press.

Maloney, E. A., & Beilock, S. L. (2012). Math anxiety: Who has it, why it develops, and how to guard against it. *Trends in Cognitive Sciences, 16*, 404–406.

Meins, E., Fernyhough, C., Wainright, R., Das Gupta, M., Fradley, E., & Tuckey, M. (2002). Maternal mind–mindedness and attachment security as predictors of theory of mind understanding. *Child Development, 73*, 1715–1726.

Nelson, K., & Gruendel, J. (1979). At morning it's lunchtime: A scriptal view of children's dialogues. *Discourse Processes, 2*, 73–94.

Nunner-Winkler, G. & Sodian, B. (1988). Children's understanding of moral emotions. *Child Development, 59*, 1323–1338.

Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1990). Are there emotion perception deficits in young autistic children? *Journal of Child Psychology and Psychiatry, 31*, 343–361.

Pennebaker, J. (1996). Cognitive, emotional, and language processes in disclosure. *Cognition and Emotion, 10*, 601–626.

Pennebaker, J. W., Barger, S. D., & Tiebout, J. (1989). Disclosures of traumas and health among Holocaust survivors. *Psychosomatic Medicine, 51*, 577–589.

Pons, F., & Harris, P. L. (2005). Longitudinal change and longitudinal stability of individual differences in children's emotion understanding. *Cognition and Emotion, 19*, 1158–1174.

Pons, F., Harris, P. L., & de Rosnay, M. (2004). Emotion comprehension between 3 and 11 years: Developmental periods and hierarchical organization. *European Journal of Developmental Psychology, 1*, 127–152.

Pons, F., Harris, P. L., & Doudin, P.-A. (2002). Teaching emotion understanding. *European Journal of Psychology of Education, 17*, 293–304.

Pons, F., Lawson, J., Harris, P. L., & de Rosnay, M. (2003). Individual differences in children's emotion understanding: Effects of age and language. *Scandinavian Journal of Psychology, 44*, 347–353.

Repacholi, B. M., & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month-olds. *Developmental Psychology, 33*, 12–21.

Ronfard, S., & Harris, P. L. (2014). When will Little Red Riding Hood become scared?: Children's attribution of mental states to a story character. *Developmental Psychology, 50*, 283–292.

Ruffman, T., Slade, L., & Crowe, E. (2002). The relation between children's and mother's mental state language and theory-of-mind understanding. *Child Development, 74*, 734–751.

Smetana, J. G. (1981). Preschool children's conception of moral and social rules. *Child Development, 52*, 1333–1336.

Smith, C. E., Blake, P. R., & Harris, P. L. (2013). I should but I won't: Why young children endorse norms of fair sharing but do not follow them. *PLoS ONE, 8*(3), e59510.

Smith, C. E., Chen, D., & Harris, P. L. (2010). When the happy victimizer says sorry: Children's understanding of apology and emotion. *British Journal of Developmental Psychology, 28*, 727–746.

Sutton, J., Smith, P. K., & Swettenham, J. (1999). Social cognition and bullying: Social inadequacy or skilled manipulation. *British Journal of Developmental Psychology, 17*, 435–450.

Tan, J., & Harris, P. L. (1991). Autistic children understand seeing and wanting. *Development and Psychopathology, 3*, 163–174.

Taumoepeau, M., & Ruffman, T. (2006). Mother and infant talk about mental states relates to desire language and emotion understanding. *Child Development, 77*, 465–481.

Taumoepeau, M., & Ruffman, T. (2008). Stepping stones to others' minds: Maternal talk relates to child mental state language and emotion understanding at 15, 24, and 33 months. *Child Development, 79*, 284–302.

Tenenbaum, H., Alfieri, L., Brooks, P., & Dunne, G. (2008). The effects of explanatory conversations on children's emotion understanding. *British Journal of Developmental Psychology, 26*, 249–263.

Trabasso, T., Stein, N. L., & Johnson, L. R. (1981). Children's knowledge of events: A causal analysis of story structure. In G. Bower (Ed.), *Learning and motivation* (Vol. 15, pp. 237–282). New York: Academic Press.

Vallotton, C. (2008). Signs of emotion: What can preverbal children "say" about internal states? *Infant Mental Health Journal, 29*, 234–258.

Wang, Q., & Fivush, R. (2005). Mother–child conversations of emotionally salient events: Exploring the functions of emotional reminiscing in European-American and Chinese families. *Social Development, 14*, 473–495.

Wellman, H. M., Harris, P. L., Banerjee, M., & Sinclair, A. (1995). Early understanding of emotion: Evidence from natural language. *Cognition and Emotion, 9*, 117–149.

Widen, S. C., & Russell, J. A. (2008). Young children's understanding of others' emotions. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 348–363). New York: Guilford Press.

Wittgenstein, L. (1953). *Philosophical investigations*. Oxford, UK: Blackwell.

Yuill, N. (1984). Young children's coordination of motive and outcome in judgments of satisfaction and morality. *British Journal of Developmental Psychology, 2*, 73–81.

CHAPTER 17

The Development of Children's Concepts of Emotion

Sherri C. Widen

Imagine a person who has just unexpectedly encountered a snake in the grass: Her eyes widen, she gasps, screams, and runs away. If a young child witnessed this encounter and said the person was *angry*, how should we interpret that response? Is the child wrong or does this response represent the child's current level of emotion concept development? The answer to these questions impact both developmental and emotion psychology. It is also important for parents, teachers, and others who work with children: Children's emotion concepts are related to their empathy and other aspects of emotional intelligence (see Emotional Intelligence, Chapter 30, this volume; Izard et al., 2001), cognitive and linguistic development (Blair, 2002), school readiness (Garner & Waajid, 2008), moral and prosocial understanding (Knafo, Steinberg, & Goldner, 2011), and intervention and therapy assessments (Southam-Gerow & Kendall, 2002). Saying that the child's response in the above example is wrong reflects a different approach to emotion from saying that the child's response represents his or her current level of concept development. This chapter compares these two approaches and the available evidence for each.

The Conceptual Approach: Broad-to-Differentiated Hypothesis

The field of research on emotion has been missing a theory that explains how children's concepts of emotion develop. Based on the basic emotions perspective, a common assumption is that children's concepts of emotion are built on an earlier understanding of facial expressions in terms of specific, discrete emotions (Denham, 1998; Harris, 1993; Izard, 1971, 1994). Indeed, researchers have proposed that, by 6 months of age, infants both produce and recognize facial expressions of basic-level emotions (Haviland & Lelwica, 1987; Walker-Andrews, 2005). In this view, facial expressions are assumed to signal specific emotions that are universally, easily, and perhaps innately recognized (Izard, 1994; Shariff & Tracy, 2011). Facial expressions provide the basis for children's acquisition of other aspects of emotion concepts (causes, consequences, and labels; Denham, 1998; Harris, 1993). Exactly how emotion concepts might be built on a prior understanding of facial expressions has never been described. No specific developmental account has been laid out.

In this chapter, I argue that the evidence is better described by what I call the broad-to-differentiated hypothesis (Widen, 2013). In this data-driven account, emotion concepts are acquired gradually and change over the course of childhood until they approximate the adult taxonomy.[1] Children's initial emotion concepts are broad and valence based (perhaps best described as *feels good* and *feels bad*). Children gradually differentiate within these broad initial concepts by linking the components (e.g., causes, consequences, facial expressions, vocalizations, behaviors) of each specific emotion. This process results in more discrete and complex concepts. Eventually, over the span of several years, the adult taxonomy is acquired. The central question is: What is the basis of this differentiation?

The development of children's emotion concepts is more complex than traditionally assumed. On the broad-to-differentiated view, children's (toddlers through middle childhood) initial valence-based concepts only gradually narrow and come to resemble adult concepts through a process of differentiation. This process of differentiation occurs as children begin to link the different components (e.g., cause, behavior, consequence) of an emotion concept together, which may take several years for some emotions. The basis of these concepts is not the same component for all emotion concepts; instead, it may be different components for different emotions (e.g., threatening behaviors for anger; causes, such as getting what you want, for happiness). Facial expressions are one of the components that are differentiated but are not primary in the process.

Children do not innately or easily understand facial expressions in terms of specific, discrete emotions. Instead, children more easily interpret facial expressions in terms of valence (feels good, feels bad), level of arousal, and other physical information (e.g., gaze direction, whether the person is pouting, gasping; Carroll & Russell, 1996). Attributing a specific emotion to a facial expression alone is possible, but this is a more difficult task. Other components of emotion concepts provide stronger cues to specific emotions. Thus, for most emotions, children more easily attribute a specific emotion to one of these other components than to a facial expression.

Children use all available information to determine how another feels. In a typical situation, "all available information" may include the facial movements, but also the cause, consequence, posture, vocalization, and so on. In laboratory studies, the information also includes the implicit instructions in the task (e.g., forced choice studies provide a short list that limit the emotions that may be attributed; see Widen & Russell, 2015) and so on. Thus, for the child, determining how another feels is a puzzle to solve using the available information. The puzzle's solution varies as the parts of the puzzle vary. As a result, the same facial expression may be interpreted as different emotions in different situations. Adults' interpretation of facial expressions are also influenced by the other parts of the puzzle (Aviezer et al., 2008; Hassin, Aviezer, & Bentin, 2013; Mondloch, 2012; Mondloch, Horner, & Mian, 2013).

Vocabulary and Cognitive Prerequisites

Around 13 months of age, infants begin using words; around 20 months, children begin using emotion words (Bretherton, Fritz, Zahn-Waxler, & Ridgeway, 1986). Children's use of emotion labels in spontaneous conversation follows a developmental progression (Smiley & Huttenlocher, 1989). Initially, children refer to their own emotions. Around 24 months, they also refer to the emotions of others (see Understanding Emotion, Chapter 16, this volume). By 3 years, children's spontaneous conversation suggests that they understand that emotions are internal feelings, distinct from their causes and consequences (Wellman, Harris, Banerjee, & Sinclair, 1995; see also Chapter 16, this volume).

In more structured research contexts, there is evidence of the development of young children's emotion concepts. By 3 years of age, children can both label and generate a cause for some emotions (Balconi & Carrera, 2007; Reichenbach & Masters, 1983; Russell & Widen, 2002a, 2002b; Widen & Russell, 2002, 2004, 2010a, 2010b). They can also give the expected label for happiness, sadness, and anger expressions (Camras & Allison, 1985; Denham & Couchoud, 1990; Harrigan, 1984; Widen & Russell, 2003, 2008c). Thus, by 3 years of age, the linguistic and cognitive prerequisites are in place for children to differentiate emotion concepts and to begin linking the components of a concept. (See Blankson et al., 2013; Porges, 2003; Posner & Rothbart, 2007, for perspectives on the connections between cognitive development and emotion understanding.)

Development of Emotion Concepts

Valence-Based Discrimination

Studies with infants and toddlers demonstrate that emotion concepts are initially valence based. Before the age of 10 months, infants make appropriate emotional and behavioral responses to positive and negative facial expressions (Caron, Caron, & Myers, 1985; Haviland & Lelwica, 1987) but do not respond differently to discrete negative emotions. In the social referencing paradigm, infants 10 months of age and older can use the valence of the caregiver's facial expressions to guide their own behavior (e.g., Klinnert, Emde, Butterfield, & Campos, 1986). When shown a positive expression, infants approach, and when shown a negative one, they withdraw. But, such studies rarely compare different negative expressions and thus do not provide evidence that infants can either discriminate or recognize specific emotions from facial expressions.

Two-year-olds have begun to use emotion labels such as "happy" and "mad," but their understanding of these labels is systematically different from adults'. For example, these children may label a number of different faces as "angry," but their label use is not random. Instead, responses that are incorrect by adult standards prove to be systematic: Children are more likely to use "angry" for expressions that have the same valence and similar levels of arousal (e.g., the disgust and sad expressions) than for expressions that are dissimilar on these dimensions (happiness expression). The unbiased hit rate (Wagner, 1992), which accounts for response biases, can be revealing of what label use may represent. The unbiased hit rate was applied to 2-year-olds' (aggregated from five studies, N = 94; Widen & Russell, 2003, 2008a, 2010a, 2010b) use of angry for each of six facial expressions. They used angry at above chance levels for the anger, sadness, and disgust expressions but did not do so for the fear, surprise, or happiness expressions.

Valence-based categories also emerge when children are not asked to produce any labels. For example, on a categorization task, the emotion category was presented as a box into which only people who felt a particular emotion could go (Russell & Widen, 2002a). Children decided whether each facial expression should go in the box or out. This task had low verbal demands—the child could respond by pointing—and children understood the task. Yet, children's responses revealed that they did not have a discrete concept of anger. Instead, when asked to include only the angry people, 2-year-olds were as likely to include the sadness, fear, and disgust expressions as the anger ones, but they excluded the happiness expressions. Two-year-olds show the same pattern when asked to select the angry faces in an array of facial expressions: They were equally likely to select all the negative expressions but unlikely to select the happy ones (Bullock & Russell, 1985). Thus, across tasks, 2-year-olds have broad, valence-based emotion concepts.

A question that has not yet been empirically addressed is how these young children differentiate facial expressions. On what basis do children who include all the negative facial expressions in the angry category decide which facial expressions to include (Bullock & Russell, 1985; Russell & Widen, 2002a)? Perhaps children attend to the full configuration of the facial expression or to a specific feature (such as the brow furrow, or lack of smile) common to these varied negative expressions.

Differentiation: From Broad to Differentiated Concepts

In this section, evidence related to children's understanding of facial expressions is explored to compare the basic emotions perspective and the broad-to-differentiated hypothesis. Then, the process of differentiation from children's initial valence-based concepts to more adult-like specific concepts is addressed.

"Correct" and "Incorrect" Responses

Gradually, older children's interpretation of faces becomes more discrete (e.g., Denham & Couchoud, 1990; Massarani, Gosselin, Montembeault, Gagnon, & Suurland, 2011; Vicari, Reilly, Pasqualetti, Vizzotto, & Caltagirone, 2000) as their concepts come to resemble adults'. To illustrate this gradual change, data from 11 studies in which children freely labeled facial expressions (Widen, Pochedly, & Russell, 2013; Widen & Russell, 2002, 2003, Study 2, Study 3, 2008a, 2008b, 2010a, 2010b, Study 1, Study 2, 2010c, 2013b) were aggregated. As shown in Figure 17.1, children used the expected label at an early age for happiness, sadness, and anger expressions; children's use of the expected label increased only gradually for surprise, fear, and disgust expressions. As illustrated in Table 17.1, other researchers find the same general pattern with the free-labeling task (Bisson, 2013; Harrigan, 1984; Markham & Adams, 1992; Markham & Wang, 1996; Michalson & Lewis, 1995; Nelson, Hudspeth, & Russell, 2013; Vicari et al., 2000).

Although young preschoolers label some facial expressions "correctly," just what that correctness represents is a big question. The basic emotions perspective assumes that young children recognize the angry face as *angry*, the scared face as *scared*, and so on. This recognition has also been extended to infants, who are assumed to recognize facial expressions within the first half year of life (e.g., D'Entremont & Muir, 1999; Haviland & Lelwica, 1987; Izard, 1971; Walker-Andrews, 2005). According to Izard (1994), "Infants discriminate between positive and negative expressions by about 3 months and among negative expressions by 6 or

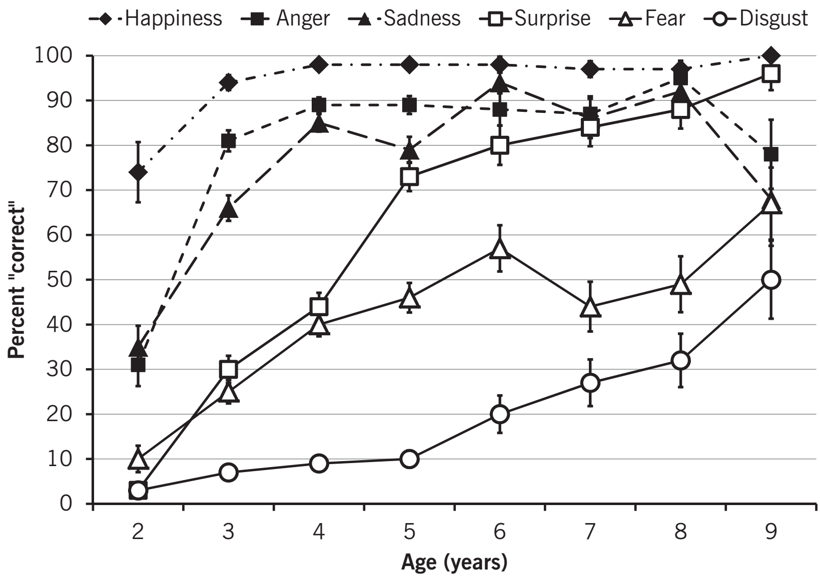

FIGURE 17.1. Children used the expected ("correct") labels (with standard errors) for the happiness, anger, and sadness expressions from an early age but for each of the other facial expressions use of the "correct" label increased gradually with age. Data from 11 studies were aggregated (Widen et al., 2013; Widen & Russell, 2002, 2003, Study 2, Study 3, 2008a, 2008b, 2010a, 2010b, Study 1, Study 2, 2010c, 2012b). The sample sizes for each age group were 2 years (n = 94), 3 years (*n* = 229), 4 years (*n* = 299), 5 years (*n* = 209), 6 years (*n* = 74), 7 years (*n* = 66), 8 years (*n* = 61), 9 years (*n* = 33).

7 months" (p. 292). And, it has also been proposed that "prior to the onset of language, the primary means by which infants can communicate with others in their environment, including caregivers, is by 'reading' faces" (Leppanen & Nelson, 2006, p. 38)—that is, by recognizing another's identity and emotions. The assumption that recognition is in place early is consistent with the assumption that facial expressions evolved to express specific, discrete emotions.

Alternatively, "correctness" in children 3 years and older may represent a different understanding of emotion than it does in adults, that is, young children's emotion concepts are systematically different from adults (Widen & Russell, 2003, 2008a, 2010a, 2010b). As children gradually begin to differentiate the negative concept into discrete negative emotions (e.g., Denham & Couchoud, 1990; Izard, 1971; Massarani et al., 2011; Roberson, Kikutani, Doge, Whitaker, & Majid, 2012; Vicari et al., 2000), one challenge is to determine how to analyze their responses.

Participants—both adults and children—tend to use some emotion terms more than others (Wagner, 1992). When children (2–10 years) were asked to freely label facial expressions or emotion stories, they used "happy," "sad," and "angry" most frequently, both "correctly" and "incorrectly" (Massarani et al., 2011; Widen & Russell, 2003, 2008a, 2010b, 2011). Thus, the high percentage of "correct" responses for the happiness, sadness, and anger expressions becomes suspect, especially for the younger children whose implicit definition of these labels is broadest and who are least likely to use other emotion labels. How many of these responses were genuinely correct, and how many were a happy accident of children's tendency to use these labels more frequently? Conversely, children used "scared," "surprised," and "disgusted" correctly less frequently but were unlikely to use these labels incorrectly. Use of the unbiased hit rate (Wagner, 1992) can ameliorate these response biases.

Focusing only on children's correct responses omits a large percentage of their responses, especially for fear, surprise, and disgust facial stimuli—and for other emotions such as embarrassment, shame, pride, and so on. Children are not silent when they do not give the expected response. For example, in one study, all of the children's (2–5 years) incorrect responses on a free-labeling task were coded as feeling versus nonfeeling words (Widen & Russell, 2008a): 75% were feeling words

TABLE 17.1. Percentages of Children Who "Correctly" Free Labeled Each of Six Basic-Level Facial Expressions in Nine Datasets

Study	Ages in years (*n*)	Facial expression					
		Happiness	Sadness	Anger	Fear	Surprise	Disgust
Harrigan (1984)	3–12 (96)	94	83	78	59	39	46
Markham and Adams (1992)	4–8 (72)	97	77	78	82	67	47
Michalson and Lewis (1985)	2 (10)	10	10	0	0	0	0
	3 (11)	36	45	18	0	9	0
	4 (9)	55	77	66	11	33	0
Markham and Wang (1996)[a]	4 (24)	85	50	58	58	46	47
	6 (24)	100	83	66	84	73	53
	8 (24)	100	80	77	90	93	66
Vicari et al. (2000)	5–6 (42)	100	81	75	58	42	27
	7–8 (39)	96	89	74	71	75	46
	9–10 (39)	100	88	84	86	89	75
Nelson et al. (2013)	3–5 (68)	94	81	91	28	59	10
Bisson (2013)	3–4 (54)	96	94	77	41	40	10
Massarani et al. (2011)[b]	5–6 (39)	87	79	91	53	32	3
	7–8 (36)	96	94	94	53	67	6
	9–10 (41)	98	98	96	63	88	6
Widen and Russell (2013b)[c]	2 (94)	46	36	32	9	5	3
	3 (229)	93	64	79	22	34	9
	4 (299)	97	83	89	37	52	12
	5 (209)	98	79	90	45	72	12
	6 (74)	99	95	87	57	78	16
	7 (66)	95	88	89	41	88	27
	8 (61)	96	89	96	48	90	33
	9 (33)	100	70	78	67	96	52
Weighted mean		92	78	81	44	56	21
Weighted mean omitting Widen and Russell (2013b)		92	82	78	58	57	32

Note. The task given the children was free labeling photographs of facial expressions.

[a]Australian sample.

[b]French Canadian sample, tested in French.

[c]Widen and Russell (2013b) is a database of 11 free labeling studies from our lab: Widen et al. (2013); Widen and Russell (2002, 2003, Study 2, Study 3, 2008a, 2008b, 2010a, 2010b, Study 1, Study 2, 2010c, 2012b).

that were incorrect for the target category. Ignoring incorrect responses also implicitly assumes the basic emotion perspective that facial expressions signal specific emotions and are easily, universally, and perhaps even innately, recognized. In dismissing children's "errors," the opportunity to explore and observe the development of their emotion concepts is missed.

There are other response formats that can be used to measure children's understanding of facial expressions. One of the most commonly used is choice from array (Bullock & Russell, 1984, 1985; Harrigan, 1984; Izard, 1971; Michalson & Lewis, 1995; Nelson & Russell, 2016; Widen & Naab, 2012; Widen & Russell, 2008b). In the choice-from-array task, children are given a label and asked to select the matching expression from an array of facial expressions. Thus, this task has no production demands and children are provided with both the label and the facial expressions. Indeed, studies that compared free labeling and choice from array have found that children are more likely to associate the emotion label with the target facial expression in choice from array than free labeling (Harrigan, 1984; Izard, 1971; Michalson & Lewis, 1995).

Unfortunately, choice from array suffers substantive problems. First, the choice-from-array task lacks face validity. Children are given a concept and asked to find a matching face. In their daily lives, it is unlikely that children seek out people who look sad or scared. Thus, tasks like free labeling ask the more important question of how children interpret an expression when they see it. Second, children can solve this task through a process of elimination. Asked to find the person who is scared, children who can reliably label the happiness, sadness, and anger faces can readily rule these faces out of the array, and they likely also associate the disgust face with anger (see Widen, 2013; Widen & Russell, 2015). Thus, children are left with only the fear and surprise faces to decide between—assuming all six faces are presented in the array. Indeed, children's performance increases as the size of the array decreases (Widen & Russell, 2013a), supporting the suggestion that they are using a process of elimination. Further evidence comes from a series of studies in which children (2–10 years) matched a nonsense emotion label to a nonsense facial expression in an array (Nelson & Russell, 2016). Children's performance for the nonsense label and face was as high as it was for the "real" emotions in the array. The nonsense match could only have been made through a process of elimination. This finding raises questions about children's performance on choice from array in general.

Differentiation of Emotion Concepts

Children's emotion concepts and their understanding of various emotion cues (facial expressions, emotion stories, labels, etc.) gradually undergo a differentiation process and their initial broad concepts become more discrete and adult-like. Only by examining all of children's responses—both correct and incorrect—did the systematic nature of this process become evident. This broad-to-differentiated pattern accounts for at least 80% of children in each sample, both for different cues to emotion and on different tasks (Widen & Russell, 2003, 2008a, 2010a, 2010b).

The differentiation pattern for how children label facial expressions was originally based on data from three studies (Widen & Russell, 2003). Here, the pattern is illustrated with the aggregated data from 10 studies and 1,050 children (2–9 years; Widen & Russell, 2002, 2003, 2008a, 2008b, 2010b, 2010c, 2015). On the free-labeling task, children at Labeling Level 0 (n = 32) use no emotion labels. Children at Labeling Level 1 (n = 15) use only one label ("happy"). Children at Labeling Level 2 (n = 58) use two labels, adding either "angry" or "sad." Children at Labeling Level 3 (n = 141) use all three labels ("happy," "sad," and "angry"). Children at Labeling Level 4 (n = 327) add "scared" or "surprised." Children at Labeling Level 5 (n = 191) use all five labels ("happy," "sad," "angry," "scared," and "surprised"). Children at Labeling Level 6 (n = 92) add "disgusted" and use all six target labels. Of the 1,050 children in this aggregated sample, 82% used one of these combinations. Age increased from a mean of 2 years, 6 months, at Labeling Level 0 to 6 years, 2 months, at Labeling Level 6. This pattern has also been supported in French Canadian children who were tested in French (Massarani et al., 2011).

Regardless of how few or how many emotion concepts/labels children have, they use them to account for the entire emotion domain. For example, at Labeling Level 2, children's only negative emotion label is "angry" (or "sad"), but children's implicit definition of the label is different from adults' and includes all negative emotions. Young preschoolers' (2–4 years, N = 148; Widen & Russell, 2010b) differentiation of this negative emotion concept beginning at Labeling Level 2 is shown in Figure 17.2. At this labeling level, children's modal label for all four negative facial expressions was "angry" (Figure 17.2A). For these children, the implicit definition of angry was broad and may be closer to feels bad. At Labeling Level 3, children are a little older, have more experience, and differentiate the broad negative concept into two. Now, angry is narrower and is used for the anger and disgust faces, and sad is used for the sadness and fear faces. Children's implicit definitions of angry and sad are still broader than adults'. At Labeling Level 4, sad becomes narrower and is used modally only for the sadness face, and scared is used for the fear face. (Surprise stimuli were not used in this study, so there was no Labeling Level 5.) At Labeling Level 6, disgusted is also added, though infrequently in this age range. As

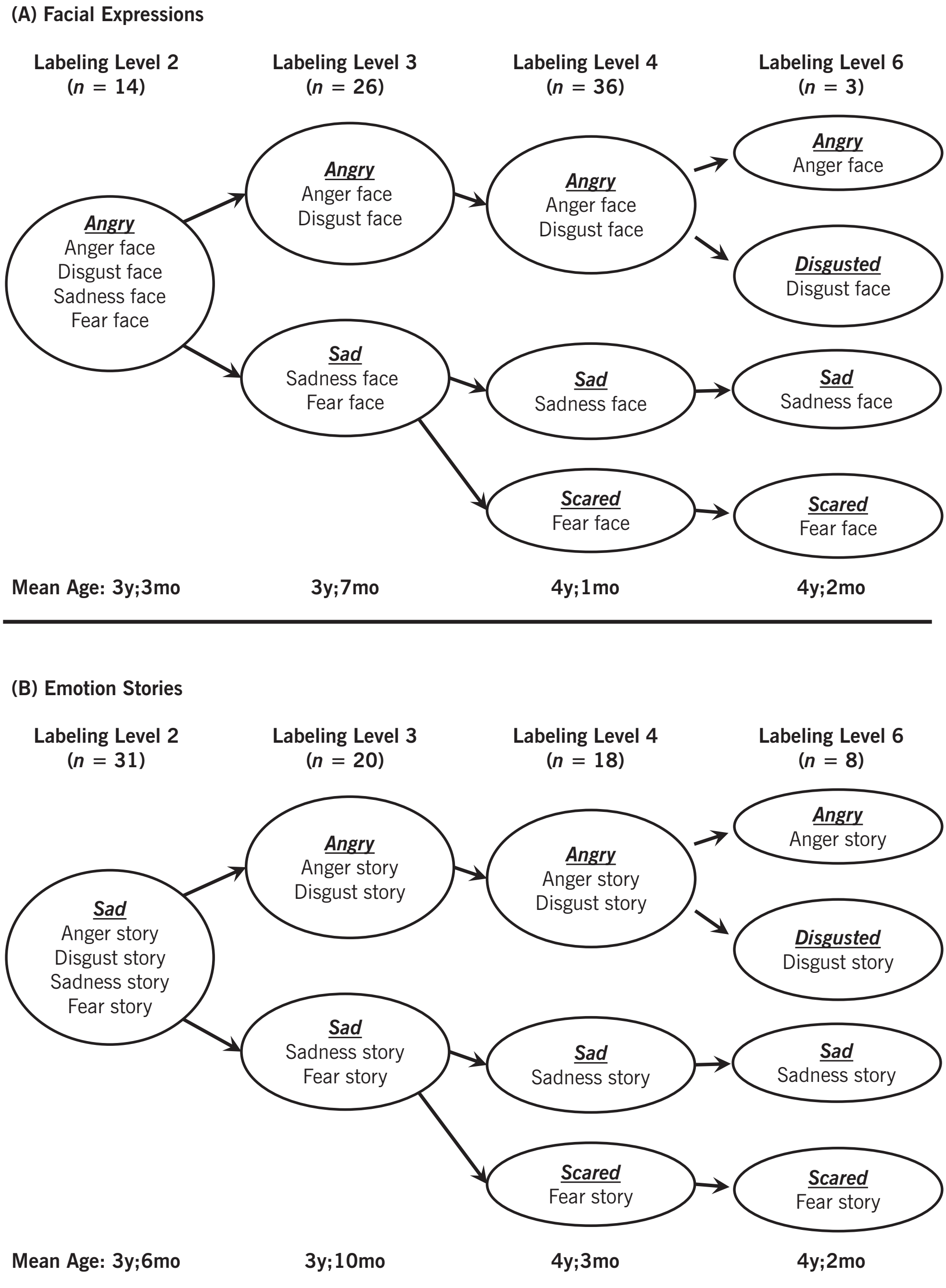

FIGURE 17.2. Differentiation of the broad negative emotion concept beginning at Labeling Level 2. The modal label that was used for each (A) face or (B) story at each labeling level. Data were aggregated from two studies (Widen & Russell, 2010b, Study 1, Study 2) that included 148 children between the ages of 2 and 4 years. There were no surprise facial expressions or stories in these studies so there was no Labeling Level 5.

additional concepts and labels are acquired, children's implicit definitions of angry and sad become narrower, gradually coming to resemble the adult definitions. Although children's use of "angry," "sad," and "scared"—and by corollary, their corresponding concepts—appear discrete around the age of 50 months in Figure 17.2A, this appearance is an artifact of the set of facial expressions that were tested. When a wider array of facial expressions were tested, older children (up to 10 years) used "angry" modally for contempt and disgust faces and "sad" modally for embarrassment and compassionate faces (Widen & Russell, 2010a). This pattern of differentiation also occurs in French Canadian children (5–10 years) who freely labeled basic-level facial expressions (Massarani et al., 2011). Palestinian children show the broad-to-differentiated pattern although their emotion concepts narrow at a later age than do American children's (Kayyal, Widen, & Russell, 2013).

The broad-to-differentiated pattern was first identified in children's free-labeling responses to facial expressions, but it also occurs with other stimuli. Children's differentiation of both facial expressions and brief emotion stories (each describing the cause and behavioral consequence of an emotion) shows the same pattern but also some differences (Russell & Widen, 2002b; Widen & Russell, 2010b). One difference was the modal label at Labeling Level 2: For negative facial expressions, it was "angry" (Figure 17.2A). As Figure 17.2B illustrates, for negative emotion stories, it was "sad." After Labeling Level 2, the differentiation pattern for this set of faces and stories was the same. A second difference was the average age at the lower labeling levels: On average, children were 2–3 months older for stories than for facial expressions at Labeling Levels 2, 3, and 4 (see Figure 17.2). However, when older children (4–10 years) were tested with a wider array of emotions (basic-level emotions and contempt, embarrassment, compassion, and shame), children differentiated stories earlier than facial expressions (Widen & Russell, 2010a). Taken together, the evidence supports the broad-to-differentiated hypothesis: Children's emotion concepts are initially broad and valence based and narrow only gradually as children acquire additional emotion concepts and an adult-like taxonomy.

The Basis of Differentiation

Of course, an emotion concept is complex and includes more than a label, facial expression, and even a cause and consequence. An emotion concept can be thought of as a script (Fehr & Russell, 1984; Chapter 16, this volume; Lewis, 1989). A mature emotion script is composed of a list of component events linked in a temporal and causal order, including prototypical causes, facial expressions, vocalizations, behaviors, consequences, a label(s), subjective experience, and so on. For example, sadness is caused by a personally relevant loss and the associated behavior is crying. Observation of these components can also serve to identify an emotion in another.

How do children move from a two-concept, valence-based system to full scripts for differentiated specific emotion concepts? On the broad-to-differentiated hypothesis, each emotion concept develops gradually, as components are added individually. A concept does not emerge fully formed. For example, to differentiate fear from the broad negative emotion concept, children might begin by adding causal components related to threat or consequence components related to flight. (See Lewis, 1989, for a discussion of cultural differences in emotion scripts.)

No one component is the basis for all scripts. Rather, any component (cause, consequence, behavior, etc.) may be the basis of each script. The cues that are initially tied to the two early concepts (positive and negative) are unknown but may be identified empirically. The cues could be behaviors (laughing and clapping vs. yelling and hitting), facial expressions (smiling vs. not smiling), or a primitive theory of mind (when people get what they want, they feel good; when they don't get what they want, they feel bad), or another component. For example, referential understanding studies test infants' (9–18 months) understanding of the connection between a person's emotional displays and his or her intentions and desires. Infants looked longer when a person's behavior did not match his or her emotional display (e.g., sadness, happiness; Barna & Legerstee, 2005; Phillips, Wellman, & Spelke, 2002). Another study showed that by 18 months, toddlers understood that someone's emotion (pleasure vs. disgust) indicated the food she preferred and wanted more of even when the toddlers themselves did not prefer that food (Repacholi & Gopnik, 1997). Theory-of-mind studies found that 2-year-olds could attribute emotions based on desire. They understood that "Bill who wants a bunny and finds one will be happy whereas Mary who wants a kitty and finds a bunny—the exact same bunny that Bill found—will be sad"; Wellman, 1995, p. 302).

They could not make parallel attributions based on beliefs. But each of these studies compared happiness and only one negative emotion. Thus, they do not speak to the question of if or when infants' and toddlers' specific, discrete emotion concepts begin to develop. They do provide some hints as to the components that may provide the bases of toddlers' positive and negative valence concepts.

One question is how children differentiate the broad negative emotion concept into multiple negative concepts (as illustrated in Figure 17.2). The basis of differentiation is unlikely to be the same component for all emotion concepts. By isolating the components of a script, those that children associate with specific emotions can be identified. Components children identify more strongly with a particular emotion are assumed to be those they acquired earlier.

The basic emotions perspective predicts that faces are the basis of children's emotion scripts. If so, children should associate the expected emotion with facial expressions earlier than with other components of emotion concepts. For example, on a storytelling task, 3- and 4-year-olds should be more likely to generate causes that adult judges recognize as the target emotion for facial expressions (e.g., fear face) than for labels (e.g., "scared") or consequences (e.g., "It made Danny scream. He ran away as fast as he could. Danny kept looking back to see if he was being followed. He just wanted to get home where he was safe"; Widen & Russell, 2004). Instead, an overall *face inferiority effect* was found: Children were least likely to generate recognizable causes for facial expressions. This effect was strongest for fear and disgust. The face inferiority effect is robust across a wide age range (3–10 years) and variety of tasks (generate causes, free labeling, categorization; Balconi & Carrera, 2007; Reichenbach & Masters, 1983; Russell & Widen, 2002a, 2002b; Widen & Russell, 2002, 2004, 2010a, 2010b).

One possible objection to findings of a face inferiority effect is that these studies used posed photographs. In daily experience, emotional expressions are dynamic. Thus, it has been proposed that children might be more likely to associate videos of dynamic expressions of emotion with expected labels than they do photographs (Caron et al., 1985; Eibl-Eibesfeldt, 1970; Flavell, 1985; Fogel, 1983; Vieillard & Guidetti, 2009). There are only four studies that have compared children's understanding of photographs and videos of emotion expressions (Leime, Neto, Alves, & Torro-Alves, 2013; Nelson et al., 2013; Nelson & Russell, 2011a, 2011b; Widen & Russell, 2015). None of these free-labeling studies found an overall advantage for videos over photographs. And two found that children were more likely to label the *photographs* of anger and disgust faces "correctly" than the corresponding videos (Nelson et al., 2013; Nelson & Russell, 2011b).

Tasks that compare children's understanding of emotion labels versus facial expressions have found a *label superiority effect*—children are more likely to give the expected response for the label than the facial expression (Bruce et al., 2000; Camras & Allison, 1985; Russell, 1990; Russell & Widen, 2002a, 2002b; Widen & Russell, 2004, 2010a). For example, children (4–10 years) freely labeled facial expressions and, separately, brief stories for anger, fear, surprise, disgust, compassion, embarrassment, shame, and contempt (Widen & Russell, 2010a). An overall label superiority effect was found, and this effect was also significant for five of the eight emotions (fear, disgust, compassion, embarrassment, and shame).

A strong label superiority effect has been found for disgust (Camras & Allison, 1985; Russell & Widen, 2002a, 2002b; Widen & Russell, 2004, 2010a; see Widen & Russell, 2013a, for a review of children's understanding disgust). Children are more likely to use "disgusted" (or a close synonym) for a disgust story than the corresponding facial expression. Indeed, the disgust face is one of the last components to be added to children's disgust concept; until then, they associate the disgust face with anger (Widen & Russell, 2013a). Once children have linked the facial expression to their disgust concept, as demonstrated in free labeling, they are also less likely to associate it with anger on other tasks (e.g., the box task; Widen & Russell, 2008a, 2008b). The label superiority effect supports research demonstrating the power of labels in children's acquisition of concepts more generally (Gelman, 2003; Gentner & Goldin-Meadow, 2003), the constitutive role of language in emotion perception (Lindquist, Barrett, Bliss-Moreau, & Russell, 2006; Lindquist & Gendron, 2013), and the differences in how languages and cultures divide the emotion domain (de Mendoza, Fernández-Dols, Parrott, & Carrera, 2010; Kayyal & Russell, 2013; Russell & Sato, 1995; Wierzbicka, 2009).

Conclusion

The central question of this chapter was how children's concepts of emotion develop. The evidence supports the broad-to-differentiated hypothesis: Children's emotion concepts undergo gradual development from broad, valence-based concepts to more specific, discrete concepts through a process of differentiation. Differentiation may begin when children notice that not all "feels bad" feelings are the same and is achieved by linking the components of an emotion concept together until children acquire the adult taxonomy—moving from feels bad to anger, fear, embarrassment, and so on, each with its own script. At all levels of development, children have a systematic way of interpreting the emotion domain, but acquiring adult-like emotion concepts is a years-long process.

At the outset, I observed the absence of a detailed theory of the development of children's concepts of emotion. Research that focuses only on children's "correct" responses in emotion tasks implicitly assumes that children's emotion concepts are the same as adults'. It also implicitly assumes that their "incorrect" responses are meaningless. I proposed an alternate approach—the broad-to-differentiated hypothesis—that describes the development of children's emotion concepts by analyzing both correct and incorrect responses and looked at how these responses change with age. Other alternatives are also possible and should be explored.

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Note

1. In their final adult form, emotion concepts vary as a function of language and culture (see Kayyal & Russell, 2013; de Mendoza, Fernández-Dols, Parrott, & Carrera, 2010; Mesquita & Frijda, 1992; Russell, 1991; Wierzbicka, 2009). However, this aspect of emotion concept development is not the focus of this chapter.

References

Aviezer, H., Hassin, R. R., Ryan, J., Grady, C., Susskind, J., Anderson, A., et al. (2008). Angry, disgusted, or afraid? Studies on the malleability of emotion perception. *Psychological Science, 19*(7), 724–732.

Balconi, M., & Carrera, A. (2007). Emotional representation in facial expression and script: A comparison between normal and autistic children. *Research in Developmental Disabilities, 28*, 409–422.

Barna, J., & Legerstee, M. (2005). Nine- and twelve-month-old infants relate emotions to people's actions. *Cognition and Emotion, 19*, 53–67.

Bisson, J. B. (2013). *The development of emotion understanding in preschoolers*. Unpublished doctoral dissertation, University of Connecticut, Storrs, CT.

Blair, C. (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist, 57*(2), 111–127.

Blankson, A. N., O'Brien, M., Leerkes, E. M., Marcovitch, S., Calkins, S. D., & Weaver, J. M. (2013). Developmental dynamics of emotion and cognition processes in preschoolers. *Child Development, 84*(1), 346–360.

Bretherton, I., Fritz, J., Zahn-Waxler, C., & Ridgeway, D. (1986). Learning to talk about emotions: A functionalist perspective. *Child Development, 57*, 529–548.

Bruce, V., Campbell, R. N., Doherty-Sneddon, G., Import, A., Langton, S., McAuley, S., et al. (2000). Testing face processing skills in children. *British Journal of Development Psychology, 18*, 319–333.

Bullock, M., & Russell, J. A. (1984). Preschool children's interpretation of facial expressions of emotion. *International Journal of Behavioral Development, 7*, 193–214.

Bullock, M., & Russell, J. A. (1985). Further evidence in preschoolers' interpretation of facial expressions. *International Journal of Behavioral Development, 8*(1), 15–38.

Camras, L. A., & Allison, K. (1985). Children's understanding of emotional facial expressions and verbal labels. *Journal of Nonverbal Behavior, 9*, 84–94.

Caron, R. F., Caron, A. J., & Myers, R. S. (1985). Do infants see emotional expressions in static faces? *Child Development, 56*(6), 1552–1560.

Carroll, J. M., & Russell, J. A. (1996). Do facial expressions signal specific emotions?: Judging emotion from the face in context. *Journal of Personality and Social Psychology, 70*(2), 205–218.

D'Entremont, B., & Muir, D. (1999). Infant responses to adult happy and sad vocal and facial expressions during face-to-face interactions. *Infant Behavior and Development, 22*(4), 527–539.

de Mendoza, A. H., Fernández-Dols, J. M., Parrott, W. G., & Carrera, P. (2010). Emotion terms, category structure, and the problem of translation: The case of shame and vergüenza. *Cognition and Emotion, 24*, 661–680.

Denham, S. A. (1998). *Emotional development in young children*. New York: Guilford Press.

Denham, S. A., & Couchoud, E. A. (1990). Young preschoolers' understanding of emotions. *Child Study Journal, 20*(3), 171–192.

Eibl-Eibesfeldt, I. (1970). *Ethology: The biology of behaviour.* New York: Holt, Rinehart & Winston.

Fehr, B., & Russell, J. A. (1984). Concept of emotion viewed from a prototype perspective. *Journal of Experimental Psychology: General, 113*, 464–486.

Flavell, J. H. (1985). *Cognitive development* (2nd ed.). New York: Prentice-Hall.

Fogel, A. (1983). Two principles of communication: Co-regulation and framing. In J. C. L. Nadel (Ed.), *New perspectives in early communicative development* (pp. 9–22). New York: Routledge.

Garner, P. W., & Waajid, B. (2008). The associations of emotion knowledge and teacher–child relationships to preschool children's school-related developmental competence. *Journal of Applied Developmental Psychology, 29*(2), 89–100.

Gelman, S. A. (2003). *The essential child: Origins of essentialism in everyday thought*. New York: Oxford University Press.

Gentner, D., & Goldin-Meadow, S. (Eds.). (2003). *Language in mind*. Cambridge, MA: MIT Press.

Harrigan, J. A. (1984). The effect of task order on children's identification of facial expressions. *Motivation and Emotion, 8*, 157–169.

Harris, P. L. (1993). Understanding emotion. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 237–246). New York: Guilford Press.

Hassin, R. R., Aviezer, H., & Bentin, S. (2013). Inherently ambiguous: Facial expressions of emotions, in context. *Emotion Review, 5*(4), 60–65.

Haviland, J. M., & Lelwica, M. (1987). The induced affect response: 10-week-old infants' responses to three emotion expressions. *Developmental Psychology, 21*(1), 97–104.

Izard, C. E. (1971). *Emotional development in young children*. New York: Appleton Century Crofts.

Izard, C. E. (1994). Innate and universal facial expressions: Evidence from developmental and cross-cultural research. *Psychological Bulletin, 115*(2), 288–299.

Izard, C. E., Fine, S., Schultz, D., Mostow, A., Ackerman, B., & Youngstrom, E. (2001). Emotion knowledge as a predictor of social behavior and academic competence in children at risk. *Psychological Science, 12*, 18–23.

Kayyal, M. H., & Russell, J. A. (2013). Language and emotion: Certain English–Arabic translations are not equivalent. *Journal of Language and Social Psychology, 32*, 261–271.

Kayyal, M. H., Widen, S. C., & Russell, J. A. (2013). *Palestinian and American children's understanding of facial expressions of emotion*. Manuscript in preparation.

Klinnert, M. D., Emde, R. N., Butterfield, P., & Campos, J. J. (1986). Social referencing: The infant's use of emotional signals from a friendly adult with mother present. *Developmental Psychology, 22*(4), 427–432.

Knafo, A., Steinberg, T., & Goldner, I. (2011). Children's low affective perspective-taking ability is associated with low self-initiated pro-sociality. *Emotion, 11*(1), 194–198.

Leime, J. L., Neto, J. R., Alves, S. M., & Torro-Alves, N. (2013). Recognition of facial expressions in children, young adults and elderly people. *Estudos de Psicologia (Campinas), 30*(2), 7.

Leppanen, J. M., & Nelson, C. A. (2006). The development and neural bases of facial emotion recognition. In R. V. Kail (Ed.), *Advances in child development and behavior* (Vol. 3434, pp. 207–246). San Diego, CA: Elsevier Academic Press.

Lewis, M. (1989). Cultural differences in children's knowledge of emotion scripts. In C. Saarni & P. L. Harris (Eds.), *Children's understanding of emoiton* (pp. 351–373). New York: Cambridge University Press.

Lindquist, K. A., Barrett, L. F., Bliss-Moreau, E., & Russell, J. A. (2006). Language and the perception of emotion. *Emotion Review, 6*, 125–138.

Lindquist, K. A., & Gendron, M. (2013). What's in a word?: Language constructs emotion perception. *Emotion Review, 5*, 66–71.

Markham, R., & Adams, K. (1992). The effect of type of task on children's identification of facial expressions. *Journal of Nonverbal Behavior, 16*, 21–39.

Markham, R., & Wang, L. (1996). Recognition of emotion by Chinese and Australian children. *Journal of Cross-Cultural Psychology, 27*, 616–643.

Massarani, R., Gosselin, P., Montembeault, P., Gagnon, M., & Suurland, A. (2011). *French-speaking children's freely produced labels for facial expressions*. Paper presented at the SRCD conference, Montreal, Quebec, Canada.

Mesquita, B., & Frijda, N. H. (1992). Cultural variations in emotions: A review. *Psychological Bulletin, 112*(2), 179.

Michalson, L., & Lewis, M. (1995). What do children know about emotion and when do they know it? In M. Lewis & C. Saarni (Eds.), *The soicalizaiton of emotions* (pp. 117–139). New York: Plenum Press.

Mondloch, C. J. (2012). Sad or fearful?: The influence of body posture on adults' and children's perception of facial displays of emotion. *Journal of Experimental Child Psychology, 111*, 180–196.

Mondloch, C. J., Horner, M., & Mian, J. (2013). Wide eyes and drooping arms: Adult-like congruency effects emerge early in the development of sensitivity to emotional faces and body postures. *Journal of Experimental Child Psychology, 114*(2), 203–216.

Nelson, N. L., Hudspeth, K., & Russell, J. A. (2013). A story superiority effect for disgust, fear, embarrassment, and pride. *British Journal of Developmental Psychology, 31*(Pt. 3), 334–348.

Nelson, N. L., & Russell, J. A. (2011a). Preschoolers' use of dynamic facial, bodily, and vocal cues to emotion. *Journal of Experimental Child Psychology, 110*, 52–61.

Nelson, N. L., & Russell, J. A. (2011b). Putting motion in emotion: Do dynamic presentations increase preschooler's recognition of emotion? *Cognitive Development, 26*, 248–259.

Nelson, N. L., & Russell, J. A. (2016). A facial expression of pax: Assessing children's "recognition" of emotion from faces. *Journal of Experimental Child Psychology, 141*, 49–64.

Phillips, A. T., Wellman, H. M., & Spelke, E. S. (2002). Infants' ability to connect gaze and emotional expression to intentional action. *Cognition and Emotion, 85*, 53–78.

Porges, S. W. (2003). The polyvagal theory: Phylogenetic contributions to social behavior. *Physiology and Behavior, 79*(3), 503–513.

Posner, M. I., & Rothbart, M. K. (2007). Research on attention networks as a model for the integration of psychological science. *Annual Review of Psychology, 58*, 1–23.

Reichenbach, L., & Masters, J. C. (1983). Children's use of expressive and contextual cues in judgements of emotion. *Child Development, 53*, 993–1004.

Repacholi, B. M., & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month-olds. *Developmental Psychology, 33*, 12–21.

Roberson, D., Kikutani, M., Doge, P., Whitaker, L., & Majid, A. (2012). Shades of emotion: What the addition of sunglasses or masks to faces reveals about the development of facial expression processing. *Cognition, 125*(2), 195–206.

Russell, J. A. (1990). The preschooler's understanding of the causes and consequences of emotion. *Child Development, 61*, 1872–1881.

Russell, J. A. (1991). Culture and the categorization of emotions. *Psychological Bulletin, 110*(3), 426.

Russell, J. A., & Sato, K. (1995). Comparing emotion words between languages. *Journal of Cross-Cultural Psychology, 26*, 384–391.

Russell, J. A., & Widen, S. C. (2002a). A label superiority effect in children's categorization of facial expressions. *Social Development, 11*(1), 30–52.

Russell, J. A., & Widen, S. C. (2002b). Words versus faces in evoking preschool children's knowledge of the causes of emotions. *International Journal of Behavioral Development, 26*(2), 97–103.

Shariff, A. F., & Tracy, J. L. (2011). What are emotion expressions for? *Current Directions in Psychological Science, 20*, 5.

Smiley, P., & Huttenlocher, J. (1989). Young children's acquisition of emotion concepts. In C. Saarni & P. L. Harris (Eds.), *Children's understanding of emotions* (pp. 27–49). Cambridge, UK: Cambridge University Press.

Southam-Gerow, M. A., & Kendall, P. C. (2002). Emotion regulation and understanding: Implications for child psychopathology and therapy. *Clinical Psychology Review, 22*(2), 189–222.

Vicari, S., Reilly, J. S., Pasqualetti, P., Vizzotto, A., & Caltagirone, C. (2000). Recognition of facial expression of emotions in school-age children: The intersection of perceptual and semantic categories. *Acta Pædtr, 89*, 836–845.

Vieillard, S., & Guidetti, M. (2009). Children's perception and understanding of (dis)similarities among dynamic bodily/facial expressions of happiness, pleasure, anger, and irritation. *Journal of Experimental Child Psychology, 102*(1), 78–95.

Wagner, H. L. (1992). On measuring performance in category judgment studies of nonverbal behavior. *Journal of Nonverbal Behavior, 17*, 3–28.

Walker-Andrews, A. (2005). Perceiving social affordances: The development of emotional understanding. In B. D. Homer & C. S. Tamis-LeMonda (Eds.), *The development of social cognition and communication* (pp. 93–116). Mahwah, NJ: Erlbaum.

Wellman, H. M. (1995). Young children's conception of mind and emotion: Evidence from English Speakers. In J. A. Russell & J.-M. Fernández-Dols (Eds.), *Everyday conceptions of emotion* (pp. 289–313). Amsterdam: Kluwer Academic.

Wellman, H. M., Harris, P. L., Banerjee, M., & Sinclair, A. (1995). Early understanding of emotion: Evidence from natural language. *Cognition and Emotion, 9*, 117–149.

Widen, S. C. (2013). Children's interpretation of facial expressions: The long path from valence-based to specific discrete categories. *Emotion Review, 5*(1), 72–77.

Widen, S. C., & Naab, P. (2012). Can an anger face also be scared? Malleability of facial expressions. *Emotion, 12*(5), 919–925.

Widen, S. C., Pochedly, J. T., & Russell, J. A. (2013). *A story superiority effect in adolescents*. Manuscript in preparation.

Widen, S. C., & Russell, J. A. (2002). Gender and preschoolers' perception of emotion. *Merrill–Palmer Quarterly, 48*(3), 248–262.

Widen, S. C., & Russell, J. A. (2003). A closer look at preschoolers' freely produced labels for facial expressions. *Developmental Psychology, 39*(1), 114–128.

Widen, S. C., & Russell, J. A. (2004). The relative power of an emotion's facial expression, label, and behavioral consequence to evoke preschoolers' knowledge of its cause. *Cognitive Development, 19*(1), 111–125.

Widen, S. C., & Russell, J. A. (2008a). Children acquire emotion categories gradually. *Cognitive Development, 23*(2), 291–312.

Widen, S. C., & Russell, J. A. (2008b). Children's and adults' understanding of the "disgust face." *Cognition and Emotion, 22*(8), 1513–1541.

Widen, S. C., & Russell, J. A. (2008c). Young children's understanding of others' emotions. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 348–363). New York: Guilford Press.

Widen, S. C., & Russell, J. A. (2010a). Children's scripts for social emotions: Causes and consequences are more central than are facial expressions. *British Journal of Developmental Psychology, 28*(3), 565–581.

Widen, S. C., & Russell, J. A. (2010b). Differentiation in preschooler's categories of emotion. *Emotion, 10*(5), 651–661.

Widen, S. C., & Russell, J. A. (2010c). The "disgust face" conveys anger to children. *Emotion, 10*(4), 455–466.

Widen, S. C., & Russell, J. A. (2011). In building a script for an emotion, do preschoolers add its cause before its behavior consequence? *Social Development, 20*(3), 471–485.

Widen, S. C., & Russell, J. A. (2013a). Children's recognition of disgust in others. *Psychological Bulletin, 139*(2), 271–299.

Widen, S. C., & Russell, J. A. (2013b). *Free labelling database*. Unpublished data.

Widen, S. C., & Russell, J. A. (2015). Do dynamic facial expressions convey emotions to children better than do static ones? *Journal of Cognition and Development.*

Wierzbicka, A. (2009). Language and metalanguage: Key issues in emotion research. *Emotion Review, 1*, 3–14.

CHAPTER 18

Emotion and Aging

Mara Mather and Allison Ponzio

Emotions depend on a complex circuitry of brain regions interacting with neurotransmitter systems and stress and sex hormones. They are shaped by experience and current circumstances. Feedback loops and self-directed control mechanisms regulate emotions and help curtail how long they last and how intense they get. All of these basic mechanisms and contextual factors change in normal aging and so it is not surprising that emotional experience and processes change with age as well. The changes are not what one might initially predict, however. With aging come health challenges, physical declines, and the loss of friends and family because of illness and death. Furthermore, prefrontal control processes that help regulate behavior, attention, and memory deteriorate, which should make it more difficult to regulate negative emotion. Despite these constraints and challenges, emotional well-being does not tend to decline in normal aging. Why do older adults not revert back to the emotional intelligence of teenagers, a time when their frontal lobes were not yet functioning at full capacity? The surprising lack of decline in emotional function makes aging a fascinating test case for understanding the mechanisms of emotional well-being. In this chapter, we review some key issues regarding emotion and aging: How emotional well-being is maintained across the lifespan, how aging affects specific emotions, how emotions predict longevity, the age-related positivity effect in attention and memory, which aspects of emotion regulation processes are influenced by aging, changes in arousal and stress response processes during aging, interoceptive declines in aging, changes in recognizing the emotions of others, shifts in the causes of depression and anxiety, how dementia affects emotion, and potential cultural differences in emotion and aging.

Emotional Well-Being

As we review below, emotional functioning holds up remarkably well in normal aging. Given the limitations and biases of memory (e.g., Kennedy, Mather, & Carstensen, 2004; Levine & Safer, 2002; Redelmeier, Katz, & Kahneman, 2003), emotional well-being should ideally be assessed in the moment, with enough moments sampled over time to estimate an average. One landmark study used experience sampling methods to assess frequency and intensity of 19 emotions across a 1-week period in a representative sample of healthy adults, and repeated the assessment across three waves of data collection each 5 years apart (Carstensen et al., 2011). Emotional well-being was defined by subtracting the average frequency of negative emotions experienced from the average frequency of positive emotions experienced. At each wave, the balance of positive to negative emotional experience increased into the late 60s and then stopped increasing. The same pattern was seen within individuals who were assessed at multiple waves. In contrast, the intensity of experienced emotions did not vary based on age.

A similar age-related increase in ratios of positive to negative affect was found in a survey of over 300,000 people in the United States (Stone, Schwartz, Broderick, & Deaton, 2010). Respondents were asked, "Did you experience the following feelings during a lot of the day yesterday?" about enjoyment, happiness, stress, worry, anger, and sadness. From ages 50 to 70, positive emotions increased and negative emotions decreased with age. Before and after those ages, patterns differed across specific emotions, but the older cohorts overall had a higher positive-relative-to-negative emotional experience than the younger ones. Other studies in the United States show similar increases in emotional well-being with age (Charles, Reynolds, & Gatz, 2001; Gross et al., 1997; Mroczek & Kolarz, 1998). Such increases in emotional well-being across adulthood are intriguing. Even with aging-related hardships, older adults generally are satisfied with old age and experience relatively high levels of emotional well-being and decreases in negative affect (Grühn, Smith, & Baltes, 2005).

Specific Emotions

In the following sections, we move from general well-being to focus on the trajectories of some specific emotions—namely, happiness, anger, sadness, and regret.

Happiness

When he drafted the U.S. Declaration of Independence, Thomas Jefferson wrote that all men have the right to life, liberty, and the pursuit of happiness (Boyd, 1950). After mostly neglecting the topic, in recent years both economists and psychologists developed a stronger appreciation of the importance of happiness (e.g., Frey & Stutzer, 2010; Seligman, 2012). Happiness predicts success in many domains (Lyubomirsky, King, & Diener, 2005) and can help people develop resilience to challenging and shifting circumstances (Cohn, Fredrickson, Brown, Mikels, & Conway, 2009).

A widespread belief is that people become less happy as they get older—but this belief conflicts with happiness self-reports. For instance, in one study, both younger and older adults estimated significant decline in happiness with age, although in fact the younger group was less happy than the older group (Figure 18.1; Lacey, Smith, & Ubel, 2006). In cross-sectional studies, happiness increases with age among cohorts in their mid-50s to mid-70s, then stabilizes or declines slightly in late life (Mroczek & Kolarz, 1998; Stone et al., 2010).

One question is how much happiness declines in very late life (after age 85). One perspective is that although things look good for the "young old" (in Western cultures, this often refers to those in their 60s and 70s), things are so bleak among the oldest old that "living longer seems to be a major

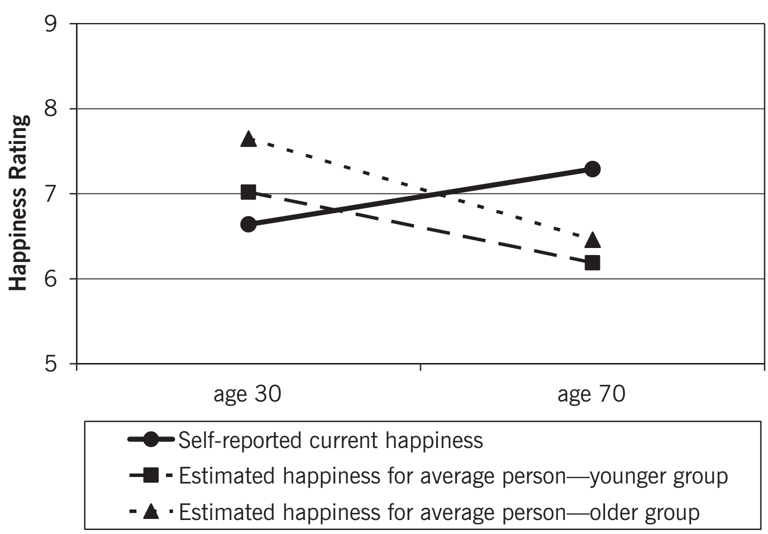

FIGURE 18.1. Current happiness self-reports versus happiness estimates for the average person, for ages 30 and 70. From Lacey, Smith, and Ubel (2006). Copyright 2006 by. Reprinted by permission.

risk factor for human dignity" (Baltes & Smith, 2003, p. 128). Baltes and Smith argue that aspects of emotion and well-being that show no decline in the young old show prominent decline among the oldest old. Part of their pessimism about this phase in life is that Alzheimer's disease is common among the oldest old. They state, "It may be a sad commentary, but dying before reaching the oldest ages is currently the only way to avoid succumbing to Alzheimer-type dementia!" (p. 129).

Indeed, in the face of physical dysfunction (e.g., dementia or other age-related chronic disease), it is natural to expect dramatic increases in depression. Yet, counter to this expectation, a population-based sample of German centenarians indicated as much happiness as representative middle-age and older Germans (Jopp & Rott, 2006). This counters the notion that happiness declines precipitously in the oldest old and is a striking finding given that 80% of the centenarians surveyed needed nursing care.

Anger

In contrast with happiness, anger can be hazardous to one's health (Suinn, 2001; Williams, 2012). Anger is especially likely to trigger and exacerbate cardiovascular disease, the leading cause of death in the United States (Heidenreich et al., 2011). People who generally have poor anger control are more likely to develop cardiovascular disease in the next 10–15 years (Haukkala, Konttinen, Laatikainen, Kawachi, & Uutela, 2010) and outbursts of anger increase the likelihood of an acute cardiovascular event in the next 2 hours (Mostofsky, Penner, & Mittleman, 2014).

The frequency of self-reported anger increases during young adulthood but then decreases steadily until old age (Kunzmann, Richter, & Schmukle, 2013; Kunzmann & Thomas, 2014; Stone et al., 2010). When specifically asked about interpersonal tensions, older adults report experiencing less anger and using more loyalty strategies such as doing nothing and fewer anger exit strategies, such as yelling, than younger adults (Birditt & Fingerman, 2003, 2005; Birditt, Fingerman, & Almeida, 2005; Blanchard-Fields & Coats, 2008). More generally, in representative samples in both the United States and Japan, there was stability in positive interactions and decreases in negative interactions in close relationships (Akiyama, Antonucci, Takahashi, & Langfahl, 2003).

Older adults also respond to triggers with less anger than younger adults in laboratory studies. When confronted with a recorded conversation of two people ostensibly talking about them, older adults reported less anger but equal levels of sadness compared with younger adults, and their comments seemed less negative to raters (Charles & Carstensen, 2008). Compared with younger adults, older adults showed decreased visual cortex-evoked potentials in response to angry but not to sad or happy faces (Mienaltowski, Corballis, Blanchard-Fields, Parks, & Hilimire, 2011), a finding that may relate to older adults interpreting a protagonist in a videotape as less angry than younger adults do (Charles, Carstensen, & McFall, 2001). These decreases in anger as people age may be critical for survival, given that anger increases the risk of cardiovascular events and that rates of cardiovascular disease are so high among older adults (among people free of cardiovascular disease at age 50, the lifetime risk to develop it was 52% for men and 39% for women; Lloyd-Jones et al., 2010).

Sadness

Losses trigger sadness (Bowlby, 1998). Losing a loved one is the most obvious example, but loss of social roles, places, or things can all lead to sadness. Older adults tend to have older peer groups and spouses, making them susceptible to loss of close loved ones. They also have a lifetime of accumulated roles, familiar places, and things that are all at risk of loss, while they suffer age-related declines in some physical and mental abilities. And they are closer to the end of their own lives. Thus, among the biggest emotional challenges older adults face is how to cope with loss, both past and future, and these challenges seem likely to lead to increases in sadness.

Although some studies show increases in older age, others show no change in sadness. Self-reported everyday sadness shows an almost flat profile across age groups, with studies showing either no age differences (Kunzmann & Thomas, 2014), a midlife small bump that decreases in later life (Stone et al., 2010), or a flat profile across most of adulthood with an increase among those in their late 70s and 80s (Kunzmann et al., 2013). When reporting on emotional reactions to interpersonal conflict, participants show no significant age differences in reported sadness (Birditt & Fingerman, 2003). In the lab, there are no age differences in sadness elicited by conversations involving disparaging comments about the participant (Charles & Carstensen, 2008), or by a film clip about a boy mourning his father's death (Tsai, Levenson, & Carstensen, 2000), but older adults felt more sadness than younger adults after watching other film clips involving themes of death or Alzheimer's disease (Kunzmann & Gruhn, 2005; Seider, Shiota, Whalen, & Levenson, 2011).

Thus, while some (but not all) studies suggest that sadness is a more accessible emotion for older adults, there is less of an increase in sadness than might be expected given the losses associated with aging. This discrepancy between circumstances and reactions is particularly striking in a longitudinal study in which German participants ages 58–81 estimated perceived deficits in performance and losses in abilities and also rated how contented they were with themselves and their present functional state in the respective domains (Rothermund & Brandstädter, 2003). Perceived losses and deficits increased significantly with age, but contentment with performance did not decline.

Regret

Regret involves sadness or remorse over past acts. Having a longer life to look back on means that there are more things to regret and also potentially fewer opportunities to address the regrets via new behaviors. Surprisingly, given their longer lives and increased opportunities for regrets, older adults are less likely than younger adults to report regrets. For instance, nearly 4,000 Dutch and German adults 40–85 years old were asked to complete the sentence, "When looking back on my past life, I regret . . ." (Timmer, Westerhof, & Dittmann-Kohli, 2005); the likelihood of reporting nothing to regret increased with age. In addition, among 825 Swedish adults between 18 and 85 years old, self-reported frequency of regret decreased with age, along with the intensity and duration of everyday regrets (Västfjäll, Peters, & Bjälkebring, 2011; see also Bjälkebring, Västfjäll, & Johansson, 2013).

Even when regrets are induced in the laboratory as part of risky gamble choices and so younger and older adults have the same temporal distance from their choices, there are age differences in how much people focus on potential or past regrets. For instance, when asked why they made the choices they did in a risky gamble situation, older adults were more focused on receiving some positive reward and cared less about avoiding potential regret than younger adults (Mather, Mazar, Gorlick, Lighthall, & Ariely, 2012). In another study, feedback about missed chances on one risky-choice trial predicted risk-taking behavior on the next trial in healthy younger and depressed older adults (suggesting their choices were modulated by regret), but not in healthy older adults (Brassen, Gamer, Peters, Gluth, & Büchel, 2012). In addition, the healthy younger and depressed older adults showed decreased brain activity in reward-processing regions when shown their missed opportunities, whereas healthy older adults did not. In contrast, only the healthy older adults showed more anterior cingulate activation during presentation of missed opportunities relative to trials without a missed chance, potentially reflecting cognitive control efforts to disengage from regret.

An increased likelihood of resolving regrets among older adults was also seen in a study of 455 caregivers of terminally ill patients, when interviewed 6 months after their loved ones died (Torges, Stewart, & Nolen-Hoeksema, 2008). The likelihood the caregivers had resolved their regrets increased linearly with age, and regret resolution predicted lower depressive symptoms and higher well-being 18 months after their loved one's death.

The most effective strategies for defusing regrets may shift with age. In one study, older adults experienced less regret when they felt little control over the event, whereas younger adults felt less regret when they felt high levels of control (Wrosch & Heckhausen, 2002). The authors argued that low attributions of control could be an adaptive strategy when feeling that there is little time left for active attempts to change regrettable behavior. In another study, older adults' lower levels of regret were mediated both by postdecision reappraisal ("I try to reevaluate the decision") and by predecision avoidance ("Delay the decision"; Bjälkebring et al., 2013). Other studies also suggest older adults are more likely to avoid decisions to postpone negative affect and regret (Mather, 2006). Thus, research suggests that older adults use various strategies including decision avoidance as well as more cognitively engaging strategies to defuse regret and that, with decreasing time left in life to change regrettable things, older adults may be better off if they attribute less self-control to themselves about the things they regret.

Emotions Predict Longevity

People who experience relatively more positive than negative emotions in their everyday lives live longer (Carstensen et al., 2011; Diener & Chan, 2011). Subjective well-being consistently predicts longevity among those who are healthy, albeit with a weaker relationship with longevity among those suffering from a disease (Diener & Chan, 2011). For instance, positive emotional content in nuns' early life autobiographies predicted longevity six decades later (Danner, Snowdon, & Friesen, 2001). Likewise, baseball players who smiled authentically (moving muscles both around the mouth and eyes) in their photos in the 1952 *Baseball Register* were half as likely to die in any subsequent year compared with nonsmilers (Figure 18.2; Abel & Kruger, 2010).

In addition to predicting mortality, negative emotions are associated with physical health in late life. For instance, among older adults, higher levels of intense life regrets are associated with more cortisol secretion and health problems (Wrosch, Bauer, Miller, & Lupien, 2007).

One question the survival effects raise is how much the decrease in negative affect among older cohorts results from the happiest people surviving the longest. So far, no studies have tackled the question of how much of the variance in cohort comparison studies is related to survival effects. Longitudinal studies, however, show emotional well-being increases within individuals across adulthood (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Carstensen et al., 2011; Charles, Reynolds, et al., 2001) indicating that it is not just a matter of all the people who are chronically unhappy dying off; instead, across the adult lifespan emotional experience tends to improve.

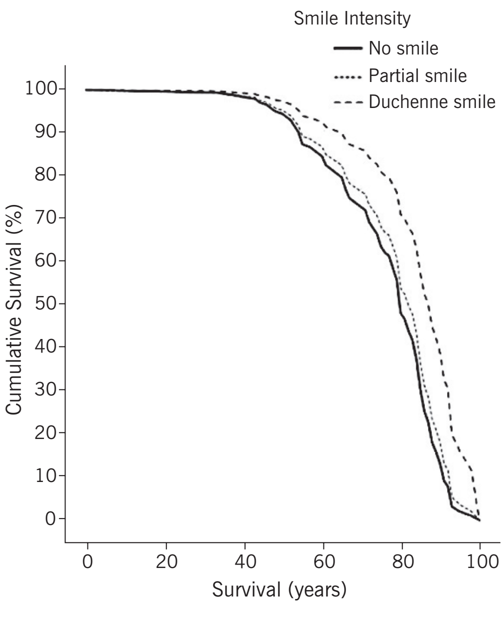

FIGURE 18.2. Percentage of Major League Baseball player's cumulative survival based on photographed smile intensity. The curves represent the probability of survival as predicted by a history of no smile in pictures, partial smile in pictures, or full (otherwise known as Duchenne) smile in pictures. From Abel and Kruger (2010). Copyright 2010 by. Reprinted by permission.

Another question these findings raise is: If negative emotions are associated with shorter and less healthy lives, why do we even have them? According to functionalist theories of emotion, all emotions have some adaptive benefits (Farb, Chapman, & Anderson, 2013; Keltner & Haidt, 1999; Levenson, 1999). For instance, sadness and depression can focus and enhance analysis of social problems and signal to partners the need to help or make concessions (Watson & Andrews, 2002). Depression also facilitates disengagement from unattainable goals (Wrosch & Miller, 2009). Anger, in contrast, promotes readiness to take action and persistence (Frijda, Kuipers, & ter Schure, 1989; Lench & Levine, 2008).

The adaptations of specific emotions may change with age. For instance, goal disengagement may play a more important role for older adults as they perceive diminishing opportunities to undo the consequences of their regrets (Wrosch, Bauer, & Scheier, 2005). Consistent with the idea that certain negative emotions may promote well-being most at certain life phases, the relationship between participants' negative emotions in response to a thematically ambiguous film and their subjective well-being depended on age, with anger responses associated with higher well-being for middle age but not younger or older adults, and sadness responses associated with higher well-being for older but not the other groups (Haase, Seider, Shiota, & Levenson, 2012).

Age-Related Positivity Effect

In the research reviewed thus far, a picture emerges of late life as a time of surprising emotional resilience, with well-maintained positive emotions and somewhat decreased negative emotions. It turns out that there is also an age-related positivity effect in attention and memory (Mather & Carstensen, 2005). For example, in one study where younger, middle-age, and older adults completed a recall test of positive negative and neutral pictures, the ratio of positive to negative images recalled increased with the age of the participant (Figure 18.3; Charles, Mather, & Carstensen, 2003).

Similar age-by-valence interactions have emerged in other studies as well. A meta-analysis of over 100 studies using both positive and negative stimuli and testing both younger and older participants found that, compared with younger adults, older adults were significantly more likely to favor positive over negative information in attention and memory (Reed, Chan, & Mikels, 2014).

What are the mechanisms underlying this striking pattern? One obvious possibility is that it is just a side effect of older adults being in a better mood and showing mood-congruent memory and attention. Current mood and negative emotion levels fail to account for the positivity effect, however (Charles et al., 2003; Kennedy et al., 2004; Mather & Carstensen, 2003; Mather & Knight, 2005). Given everything we know about the neural, cognitive, and physical declines associated with aging, another obvious explanation is that older adults' positivity effect is a serendipitous side effect of some sort of decline. For instance, perhaps the amygdala, a brain region attuned to negative potentially threatening information, declines more than other brain regions and so leads to this pattern (Cacioppo, Berntson, Bechara, Tranel, & Hawkley, 2011).

Contrary to this aging-brain model, however, older adults show intact threat detection advantages in visual search (Leclerc & Kensinger, 2008; Mather & Knight, 2006) and less structural decline in the amygdala than in most of the rest of the brain (Mather, in press; Nashiro, Sakaki, & Mather, 2012). And although older adults show less amygdala activity in response to negative stimuli than do younger adults, this does not seem to be due to decline but instead to what they are most attuned to, as they show more amygdala response to positive than to negative stimuli (Leclerc & Kensinger, 2011; Mather et al., 2004; Waldinger, Kensinger, & Schulz, 2011). Another problem for the decline story is that the positivity effect is stronger in older adults who do well on tests of cognitive control than in those who do poorly (Mather & Knight, 2005; Petrican, Moscovitch, & Schimmack, 2008) and emerges in visual search tasks that require controlled attentional processes, but not in those that require only automatic processes (Hahn, Carlson, Singer, & Gronlund, 2006). When presented with stimuli while engaged in a task that taps cognitive control resources, older adults no longer show a positivity effect (Knight et al., 2007; Mather & Knight, 2005). Thus, cognitive control mechanisms seem to promote older adults' positivity in attention and memory. Indeed, the effect size of the positivity effect is larger when participants are free to process stimuli as they choose

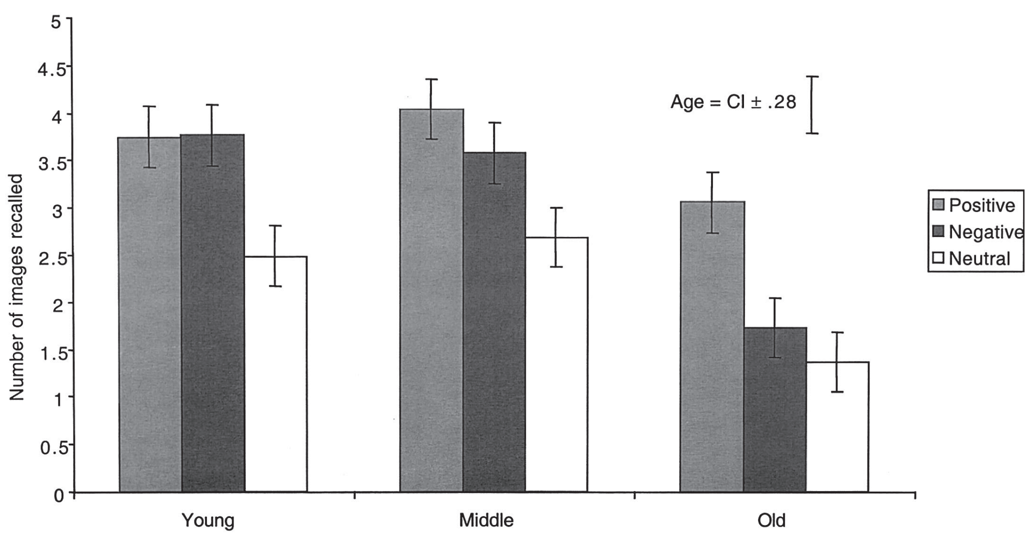

FIGURE 18.3. Number of positive, negative, and neutral images recalled for younger adults, middle-age adults, and older adults. From Charles, Mather, and Carstensen (2003). Copyright 2003 by. Reprinted by permission.

rather than being constrained by specific task instructions (Reed et al., 2014).

Furthermore, in functional magnetic resonance imaging studies older adults show more prefrontal activity while processing emotional than neutral stimuli, compared with younger adults (Mather, 2012), suggesting they are engaging prefrontal control processes to help guide the way they process emotional information. In particular, for older adults with strong positivity biases in attention, prefrontal control processes appear to downregulate amygdala responses to negative stimuli (Sakaki, Nga, & Mather, 2013). Likewise, anterior cingulate activation is related to a positivity bias and emotional stability in successful aging (Brassen, Gamer, & Buchel, 2011).

In summary, these findings reveal a surprising answer to the question of the mechanisms leading to older adults' positivity effect. Instead of being associated with age-related decline in brain regions that detect and respond to negative information, older adults' positivity effect is associated with prefrontal control mechanisms that help people direct their own attention and memory processes. This is not yet a complete answer, however. Cognitive control processes decline more than almost all other cognitive processes in normal aging, so why would older adults use these resources more than younger adults to guide their processing of emotional stimuli?

One potential answer is offered by a lifespan theory of how time perspective can influence motivation (Carstensen, Isaacowitz, & Charles, 1999). According to socioemotional selectivity theory, time horizons shape the ways in which people prioritize and set goals. When people view their time as expansive, they spend more time investing in their future, acquiring new knowledge, looking for novelty, and expanding their time horizons. Alternatively, when people view their time as being limited, they often direct their attention to more emotionally meaningful endeavors, including the desire to have emotionally fulfilling relationships and feeling socially connected (Carstensen, 2006). This more limited time perspective among older adults may account for their greater focus on regulating emotions, a better emotional well-being profile, and their positivity effect (Barber, Opitz, Martins, Sakaki, & Mather, in press; Carstensen, Mikels, & Mather, 2006; Reed & Carstensen, 2012). In addition, in terms of the question about how older adults could rely more than younger adults on cognitive control resources to direct attention and memory when processing emotional stimuli, insofar as older adults chronically focus more on emotion regulation goals than younger adults do, older adults should also recruit cognitive control processes more in the service of emotional goals than do younger adults, even if they have diminished cognitive control resources overall (Kryla-Lighthall & Mather, 2009).

Emotion Regulation

Given the findings covered so far about how the balance of positive to negative affect improves with age, an obvious assumption is that older adults get better at regulating their emotions. Consistent with this possibility, older adults give themselves higher ratings than younger adults in response to the question, "Overall, how much control would you say you have over your emotions?" (Gross et al., 1997). In addition, older adults are less likely to ruminate on negative emotions (McConatha & Huba, 1999). Life experience might also help people become expert emotion regulators (e.g., Blanchard-Fields, 2007), just as it seems to increase their social expertise (Hess & Kotter-Grühn, 2011). Yet laboratory studies that compare younger and older adults' performance when they are instructed to regulate in response to emotional stimuli reveal no consistent age advantages for either younger or older adults (see Mather, 2012, for a review). Instead, where age differences are more likely to emerge is in which regulation strategies people tend to use. Older people are more likely to report using suppression and less likely to report using reappraisal, rumination, and active coping than younger adults (Nolen-Hoeksema & Aldao, 2011; Marquez-Gonzalez, de Troconiz, Cerrato, & Baltar, 2008; but see John & Gross, 2004). Older adults also report prioritizing avoiding emotional situations more than do younger adults (Lawton, Kleban, Rajagopal, & Dean, 1992). This pattern of age differences is more challenging to investigate using laboratory methods, as what needs to be measured are people's habitual modes of processing rather than their skill at any one type of processing.

A recent framework explains why younger and older adults spontaneously select different strategies to regulate their emotions. The framework—selection, optimization, and compensation with emotion regulation (Urry & Gross, 2010)—follows previous theoretical thinking (Baltes & Baltes, 1990) that by sticking to three core tenets (selection, optimization, and compensation), successful living can be achieved at any stage of life. Selection requires an individual to assess his or her own realistic capabilities and make realistic goals. Optimization requires time, practice, and effort to achieve the set goals. And finally, compensation involves increasing effort or acquiring help to overcome losses. Applying these principles to emotion regulation strategies (Opitz, Gross, & Urry, 2012), available cognitive resources may influence strategy selection. Younger people may be more likely to use regulation strategies that require heavy cognitive control involvement, such as reappraisal. In contrast, older adults may rely more heavily on social support and situation selection (Sims & Carstensen, 2014).

Emotion and Physiology

Arousal

Common aging ailments like peripheral neuropathy and cataracts can impact arousal responses, including skin conductance and pupil dilation. As people age, their arteries become less plastic and cardiac muscles become weaker, resulting in greater peripheral resistance and poorer blood circulation efficiency (Lakatta, 1990). These changes in the cardiovascular system influence some psychophysiological measures of arousal, like blood pressure and heartbeat. Aging also causes changes in the electrodermal system, resulting in a decrease in the quantity of sweat glands, the amount of sweat produced (Porges & Fox, 1986), and the accuracy with which we may be able to measure skin conductance. Thus, not surprisingly, age-related decreases on measures such as heartbeat interval, skin conductance, respiration period, ear pulse transmission, and systolic blood pressure have been found in people's responses to emotional cues (Kunzmann, Kupperbusch, & Levenson, 2005; Levenson, Friesen, Ekman, & Carstensen, 1991; Tsai et al., 2000; but see Denburg, Buchanan, Tranel, & Adolphs, 2003; Neiss, Leigland, Carlson, & Janowsky, 2009, for studies finding no significant age differences for skin conductance).

In a longitudinal clinical–pathological cohort study, researchers found that a higher density of noradrenergic neurons in the locus coeruleus, a structure in the pons important for physiological responses to arousal, was predictive of a slower rate of cognitive decline (Wilson et al., 2013). This suggests that there is a relationship between the integrity of emotional arousal processes and cognitive performance during late life (Watson et al., 2006). One intriguing possibility is that, via noradrenaline's neuroprotective effects, experiencing novel, arousing events throughout life by having an engaging career and social life maintains brain function (and builds "cognitive reserve") even as neuropathology increases (Robertson, 2013).

Stress

Cortisol, a hormone responsible for stress regulation, on average shows a different diurnal rhythm in younger and older people. Although both younger and older people experience a peak (and subsequent slow decline) in the hormone after waking, older adults never reach the same lowest level as younger adults (Van Cauter, Leproult, & Kupfer, 1996). Since older adults never reach the same low cortisol levels achieved by younger adults, mean daily cortisol levels increase 20–50% from age 20 to 80 (Van Cauter et al., 1996; see also Nicolson, Storms, Ponds, & Sulon, 1997). In another study that examined subgroups, 50% of older adults in the sample maintained typical cycles, while most of the rest of the sample had daily cycles that varied substantially from day to day (Ice, Katz-Stein, Himes, & Kane, 2004). This indicates that, while day-to-day variation may increase, normal diurnal rhythms of cortisol can be maintained in late life.

Younger and older adults show similar cortisol responses to acute physical stressors such as holding a hand in ice water (Mather, Gorlick, & Lighthall, 2009; Lighthall, Gorlick, Schoeke, Frank, & Mather, 2013) and to the Trier Social Stress Test, an acute social stressors test (Kudielka, Buske-Kirschbaum, Hellhammer, & Kirschbaum, 2004; Rohleder, Kudielka, Hellhammer, Wolf, & Kirschbaum, 2002). One study, looking at adrenaline and noradrenaline (hormones responsible for the fight-or-flight response) effects on psychophysiological responses in older men, found that, after experiencing a psychosocial stressor, blood pressure and adrenaline levels increased steadily in both middle-age and older men, but were slower to return to normal levels in the older men (Faucheux, Bourliere, Baulon, & Dupuis, 1981). A meta-analysis that included studies using pharmacological challenges found that, on average, older adults (and especially women) showed greater cortisol responses to challenge (Otte et al., 2005). So, in general, older adults' cortisol response to acute stress is as strong or stronger than that of younger adults.

According to strength and vulnerability integration (SAVI) theory, in order to understand how age, stress, and affective experience interact, the context of daily life needs to be understood (Charles & Piazza, 2009; Charles, 2010). When older adults avoid or reduce exposure to emotional distress, they often respond better than younger adults. But when older adults experience high levels of sustained emotional arousal, age-related advantages in emotional well-being are diminished, and older adults have greater difficulties returning to homeostasis (see Charles & Luong, 2013, for a review). The theory claims that there are three instances that make people unable to avoid stressors or reduce exposure to caustic events: social isolation (see Ong, Rothstein, & Uchino, 2012), neurological dysregulation (see Kryla-Lighthall & Mather, 2009, for review), and exposure to chronic and unpredictable stressors and inevitable stressor overload (see Piazza, Charles, Stawski, & Almeida, 2013).

Interoception

Since the work of William James and Carl Lange (Lange & James, 1922), research in the field of emotion has recognized the key role of body sensations in emotion. Signals from brain regions that track body sensations such as heartbeats, breath, digestion processes, and skin flushing help shape our emotional experience (Barrett, Quigley, Bliss-Moreau, & Aronson, 2004; Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004; Damasio, 1999). With age, people are less able to detect visceral sensations such as gastric distension, rectal distension, esophageal pain, and their own heartbeat (Khalsa, Rudrauf, & Tranel, 2009; Lagier et al., 1999; Lasch, Castell, & Castell, 1997; Rayner, MacIntosh, Chapman, & Horowitz, 2000). The as-yet-unanswered question in the field is how these changes influence emotional experience and general well-being. Even just the simple question of whether these interoceptive sensation declines correlate with emotional experience has not been addressed and is an important question for future research.

Recognizing Others' Emotional Facial Expressions

Other people are the most likely trigger as well as object of emotions for almost all humans (Oatley, 2004). What would life be like if we could not detect the emotions of others? Without this skill, it would be much more challenging to fulfill social goals such as cooperating, forming a new relationship, showing affection, seeking help, deferring to others, and fighting. Emotions are conveyed in many ways, but faces are often the most specific and clear signal of emotions.

Recognition of some emotions is more impaired by aging than others (see Isaacowitz & Stanley, 2011; Ruffman, Henry, Livingstone, & Phillips, 2008, for reviews). Older adults are typically worse than younger adults at recognizing fear and sadness. They also sometimes are worse at recognizing angry expressions. They typically are as good as or better than younger adults, however, at recognizing disgusted expressions. Older adults also show age equivalence, smaller deficits, or even advantages in recognizing happy and surprised facial expressions.

Older adults' maintained ability to identify facial expressions of disgust is particularly striking because disgust is one of the emotions younger adults find most difficult to identify (Ruffman et al., 2008). Disgust recognition seems to depend in particular on the insula (Adolphs, Tranel, & Damasio, 2003; Calder, Keane, Manes, Antoun, & Young, 2000). Thus, one possibility is that the insula maintains its influence over face-processing networks more effectively with age than other brain regions that are more important for other types of facial emotions, such as the ventral striatum or amygdala (Adolphs et al., 2005; Calder, Keane, Lawrence, & Manes, 2004). For instance, while encoding fearful faces, younger adults showed more amygdala and hippocampal activation than older adults, while older adults showed more insular cortex and right superior frontal gyrus activity (Fischer, Nyberg, & Backman, 2010). Neither age difference was apparent during encoding of neutral faces. Likewise, another study found that older adults showed greater insula activity than younger adults during rating emotional expressions (Keightley, Chiew, Winocur, & Grady, 2007). Thus, shifts in the brain regions most likely to contribute to face processing may contribute to which types of facial expressions are most likely to be recognized.

Another possibility is that age-related shifts in which emotions are easiest to identify result from changes in which facial features are noticed most. When viewing faces, older adults fixate less on the eyes than younger adults do, and more on the mouth and nose (Firestone, Turk-Browne, & Ryan, 2007; Murphy & Isaacowitz, 2010; Sullivan, Ruffman, & Hutton, 2007; Wong, Cronin-Golomb, & Neargarder, 2005), especially when the faces have already been seen recently (Heisz & Ryan, 2011). In addition, older adults are less likely than younger adults to follow the eye gaze cues of younger adults (Slessor, Phillips, & Bull, 2008).

Clinical Issues

Depression

Contrary to common perception, rates of depression in older adults are lower than in younger adults (Blazer, 2003; Hasin, Goodwin, Stinson, & Grant, 2005). But older adults' symptoms of depression may be more harmful than younger adults' symptoms (Fiske, Wetherell, & Gatz, 2009). Depression at older ages is associated with decreased cognitive, physical, and social functioning; increased risk of morbidity; increased risk of suicide; increased self-neglect; and increased mortality (Blazer, 2003). Clinical presentation at old age is the sum of a lifetime of social, environmental, and physiological risk and protective factors (Fiske et al., 2009). Depression is also associated with increased frailty (Mezuk, Edwards, Lohman, Choi, & Lapane, 2012). Stressful life events have been associated with an increased risk of depression at all ages (Nolen-Hoeksema & Ahrens, 2002), though the types of events would likely differ for younger and older people. Precipitating events in later life include financial difficulties, a new illness or disability, a family member with a new illness or disability, retirement, or change in living situation (Fiske et al., 2009). Older adults who experience socioeconomic disadvantage are more likely to have higher rates of depression (Mojtabai & Olfson, 2004). Several age-related diseases lead to an increased risk for depression, including cardiovascular disease (Carney & Freedland, 2003) and diabetes (Li, Ford, Strine, & Mokdad, 2008). Depression in older people can present as either a lifetime illness with repeated depressive symptoms across the lifespan, or solely as a late-life condition. Differences in depression in late life as compared with early in life exist in etiology, prognosis, and lived experiences (Fiske et al., 2009). There are some important differences between early and late onset. Those with early onset of depression are more likely to have a family history of depression, suggesting a possible genetic influence (Heun, Papassotiropoulos, Jessen, Maier, & Breitner, 2001). Older adults with late-onset depression are more likely to have vascular risk factors, experience disruption in cognitive functioning, and are more likely to develop dementia (Hickie et al., 2005; Schweitzer, Tuckwell, O'Brien, & Ames, 2002).

Depressed older adults often present with more physical than emotional symptoms (Büchtemann, Luppa, Bramesfeld, & Riedel-Heller, 2012). Older adults with depression are less likely to endorse dysphoria (a state of unease or general dissatisfaction with life) and feelings of worthlessness or guilt. Older adults with late-onset depression display sleep disturbances, fatigue, psychomotor retardation, loss of interest in living, and hopelessness about the future, more so than younger adults or older adults who had early-onset depression (Fiske et al., 2009). Depressed older adults are also more likely to complain about poor memory and concentration (Christensen, Jorm, MacKinnon, Korten, Jacomb, et al., 1999).

Anxiety

Anxiety symptoms are likely twice as prevalent as depression symptoms in older people (Singleton, Bumpstead, O'Brien, Lee, & Meltzer, 2003) and a mix of anxiety and depression is common (Wetherell, Maser, & Balkom, 2005). Depression and anxiety often present together and have similar risk profiles (Vink, Aartsen, & Schoevers, 2008). Though anxiety is a common psychological symptom at any age, it has several older-age specific facets (Wolitzky-Taylor, Castriotta, Lenze, Stanley, & Craske, 2010). Anxiety related to fear of falling and anxiety comorbid to other illnesses are most common in older ages. Fear of falling has a strong relationship with limiting physical and social activity, and therefore has an impact on independence and mobility. Anxiety also predicts limited activity independent of depression (Norton et al., 2012). Poor balance and reduced activity levels make individuals fear falling and its serious health outcomes, such as hip fractures (Cumming, Salkeld, Thomas, & Szonyi, 2000). Sometimes referred to as "postfall syndrome," this disorder has been cited as the most common anxiety reported in older people (Howland et al., 1993). Anxiety can often be comorbid to other diseases. In a community dwelling group of older adults with cardiovascular diseases, subthreshold anxiety was found to be highly prevalent, suggesting that anxiety could be comorbid with high blood pressure and depression (Grenier et al., 2012). A review indicated that there was a relationship between anxiety and menopause. Specifically, menopause was linked to both vasomotor symptoms and panic disorder (Bryant, Judd, & Hickey, 2012).

Dementia and Alzheimer's Disease

Alzheimer's disease and other dementias impair thinking and reasoning and increase in prevalence with age (Corrada, Brookmeyer, Paganini-Hill, Berlau, & Kawas, 2010). Population-based studies that surveyed centenarians estimated 51% in Denmark had dementia (Andersen-Ranberg, Vasegaard, & Jeune, 2001) and 70% in Japan (Asada et al., 1996). While normal aging has the biggest impact on fronto-striatal brain systems, Alzheimer's disease targets medial temporal lobes and cortical networks involving the posterior cingulate and retrosplenial cortex (Buckner, 2004). These different trajectories are also apparent for emotions, which fare worse in Alzheimer's disease than in normal aging. A community-based sample study of dementia found that apathy was the most common emotional symptom, followed by depression and agitation or aggression (Lyketsos et al., 2000). Both depression and Alzheimer's disease involve chronic inflammation and hyperactivation of the hypothalamic–pituitary–adrenal axis (Caraci, Copani, Nicoletti, & Drago, 2010). The aggression and other psychiatric symptoms sometimes seen with Alzheimer's disease have been linked to damage to the serotonergic and dopaminergic systems in the brain (Katz et al., 1999; Assal & Cummings, 2002).

Cultural Caveats in How Age Relates to Emotion

One limitation of this review is that the majority of age-related comparisons in emotion and associated processes have been conducted in English-speaking countries. It is unclear if there are similar age associations elsewhere or if there are cultural differences. One study suggests that culture can have a significant impact on how emotional well-being differs across age cohorts (Steptoe, Deaton, & Stone, 2015). While English-speaking wealthy countries showed the general pattern of increasing emotional well-being with age, regions such as the former Soviet Union and Eastern European satellites showed a decreasing ratio of positive-to-negative emotional ratings, and other regions such as Africa and Latin American regions showed few age differences or mixed patterns. Differences in these cross-sectional trends across countries may be the result of societal upheavals in some regions of the world that deprive older adults of security and economic resources. Further research is needed to better understand cultural factors influencing well-being, ideally, longitudinal studies that involve experience sampling.

Only a few studies examining how valence influences emotional attention or memory have been run in non-Western samples (Reed et al., 2014), however, among those there were significant positive effect age × valence interactions among Koreans (Ko, Lee, Yoon, Kwon, & Mather, 2011; Kwon, Scheibe, Samanez-Larkin, & Tsai, 2009) and Hong Kong Chinese (Fung, Isaacowitz, Lu, & Li, 2010; but see Fung et al., 2008), suggesting that the shift toward remembering positive relatively better than negative information occurs in Asian as well as Western cultures.

Do individuals within a culture take on more of their culture's values over time? If so, this would predict that cultural differences would be most pronounced among older cohorts. Indeed, there are some initial findings suggesting that social values and personality traits such as optimism differ most across cultures among older cohorts (Fung, 2013). But cultural differences are sometimes most pronounced among the younger cohorts (Fung & You, 2011; Ko et al., 2011). Whereas younger Koreans versus Americans show the expected cultural difference in which Asians integrate the emotional context more when rating the emotion of a foreground face, older Koreans versus Americans do not show any differences in context integration (Ko et al., 2011). Thus, emotional differences across cultures are likely influenced by factors other than a deepening identification with one's culture over time.

Conclusion

Whether addressing the topics of discrete emotions, psychophysiological arousal, or emotion regulation, it is clear that in terms of aging, the results are not always what people initially assume. Even though people believe that they will get less happy with age, older adults tend to self-report being more happy and less angry then their younger adult counterparts. As they age, people are more likely to lose those they care about, yet they do not necessarily become sadder with time. After a lifetime of learning from emotion regulation successes and failures, older adults report feeling more in control of their own emotions. Older adults may experience declines in systems important for *feeling* emotion (i.e., electrodermal and cardiovascular systems) but some measures of psychophysiological arousal show similar results between younger and older people. Depression is less frequent in later than earlier adulthood and depression that starts at older ages is associated with a lifetime of stressful experiences, a decrease in social networks, and an increase in comorbidities, and differs from depression at younger ages. Older people are often anxious about falling and comorbidities—things younger people worry little about. In general, emotion is a domain in which older adults fare surprisingly well especially considering declines in cognitive and physical domains. Current theoretical models have helped explain some of the age differences in emotional processes, but more research is needed to see which (if any) of the theoretical frameworks outlined above can be ruled out or further supported.

References

Abel, E. L., & Kruger, M. L. (2010). Smile intensity in photographs predicts longevity. *Psychological Science, 21*(4), 542–544.

Adolphs, R., Gosselin, F., Buchanan, T. W., Tranel, D., Schyns, P., & Damasio, A. R. (2005). A mechanism for impaired fear recognition after amygdala damage. *Nature, 433*(7021), 68–72.

Adolphs, R., Tranel, D., & Damasio, A. R. (2003). Dissociable neural systems for recognizing emotions. *Brain and Cognition, 52*(1), 61–69.

Akiyama, H., Antonucci, T., Takahashi, K., & Langfahl, E. S. (2003). Negative interactions in close relationships across the life span. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 58*(2), P70–P79.

Andersen-Ranberg, K., Vasegaard, L., & Jeune, B. (2001). Dementia is not inevitable: A population-based tudy of Danish centenarians. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 56*(3), P152–P159.

Asada, T., Yamagata, Z., Kinoshita, T., Kinoshita, A., Kariya, T., Asaka, A., et al. (1996). Prevalence of dementia and distribution of ApoE alleles in Japanese centenarians: An almost-complete survey in Yamanashi Prefecture, Japan. *Journal of the American Geriatrics Society, 44*(2), 151–155.

Assal, F., & Cummings, J. L. (2002). Neuropsychiatric symptoms in the dementias. *Current Opinion in Neurology, 15*(4), 445–450.

Baltes, P. B., & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. *Successful Aging: Perspectives from the Behavioral Sciences, 1*, 1–34.

Baltes, P. B., & Smith, J. (2003). New frontiers in the future of aging: From successful aging of the young old to the dilemmas of the fourth age. *Gerontology, 49*(2), 123–135.

Barber, S. J., Opitz, P. C., Martins, B., Sakaki, M., & Mather, M. (in press). Thinking about a limited future enhances the positivity of younger and older adults' recall: Support for socioemotional selectivity theory. *Memory and Cognition.*

Barrett, L. F., Quigley, K. S., Bliss-Moreau, E., & Aronson, K. R. (2004). Interoceptive sensitivity and self-reports of emotional experience. *Journal of Personality and Social Psychology, 87*(5), 684.

Birditt, K. S., & Fingerman, K. L. (2003). Age and gender differences in adults' descriptions of emotional reactions to interpersonal problems. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 58*(4), P237–P245.

Birditt, K. S., & Fingerman, K. L. (2005). Do we get better at picking our battles?: Age group differences in descriptions of behavioral reactions to interpersonal tensions. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 60B*(3), P121–P128.

Birditt, K. S., Fingerman, K. L., & Almeida, D. M. (2005). Age differences in exposure and reactions to interpersonal tensions: A daily diary study. *Psychology and Aging, 20*(2), 330–340.

Bjälkebring, P., Västfjäll, D., & Johansson, B. (2013). Regulation of experienced and anticipated regret for daily decisions in younger and older adults in a Swedish one-week diary study. *GeroPsych: Journal of Gerontopsychology and Geriatric Psychiatry, 26*(4), 233.

Blanchard-Fields, F. (2007). Everyday problem solving and emotion: An adult developmental perspective. *Current Directions in Psychological Science, 16*(1), 26–31.

Blanchard-Fields, F., & Coats, A. H. (2008). The experience of anger and sadness in everyday problems impacts age differences in emotion regulation. *Developmental Psychology, 44*(6), 1547.

Blazer, D. G. (2003). Depression in late life: Review and commentary. *Journals of Gerontology. Series B: Psychological Sciences and Social Sciences, 58A*, 249–265.

Bowlby, J. (1998). *Loss: Sadness and depression.* New York: Random House.

Boyd, J. P. E. (1950). *The papers of Thomas Jefferson (Vol. 1: 1760–1776).* Princeton, NJ: Princeton University Press.

Brassen, S., Gamer, M., & Buchel, C. (2011). Anterior cingulate activation is related to a positivity bias and emotional stability in successful aging. *Biological Psychiatry, 70*(2), 131–137.

Brassen, S., Gamer, M., Peters, J., Gluth, S., & Büchel, C. (2012). Don't look back in anger!: Responsiveness to missed chances in successful and nonsuccessful aging. *Science, 336*(6081), 612–614.

Bryant, C., Judd, F. K., & Hickey, M. (2012). Anxiety during the menopausal transition: A systematic review. *Journal of Affective Disorders, 139*(2), 141–148.

Büchtemann, D., Luppa, M., Bramesfeld, A., & Riedel-Heller, S. (2012). Incidence of late-life depression: A systematic review. *Journal of Affective Disorders, 142*(1), 172–179.

Buckner, R. L. (2004). Memory and executive function in aging and AD: Multiple factors that cause decline and reserve factors that compensate. *Neuron, 44*(1), 195–208.

Cacioppo, J. T., Berntson, C. G., Bechara, A., Tranel, D., & Hawkley, L. C. (2011). Could an aging brain contribute to subjective well-being?: The value added by a social neuroscience perspective. In A. Todorov, S. T. Fiske, & D. Prentice (Eds.), *Social neuroscience: Toward understanding the underpinnings of the social mind* (pp. 249–262). New York: Oxford University Press.

Calder, A. J., Keane, J., Lawrence, A. D., & Manes, F. (2004). Impaired recognition of anger following damage to the ventral striatum. *Brain, 127*, 1958–1969.

Calder, A. J., Keane, J., Manes, F., Antoun, N., & Young, A. W. (2000). Impaired recognition and experience of disgust following brain injury. *Nature Neuroscience, 3*(11), 1077–1078.

Caraci, F., Copani, A., Nicoletti, F., & Drago, F. (2010). Depression and Alzheimer's disease: Neurobiological links and common pharmacological targets. *European Journal of Pharmacology, 626*(1), 64–71.

Carney, R. M., & Freedland, K. E. (2003). Depression, mortality, and medical morbidity in patients with coronary heart disease. *Biological Psychiatry, 54*(3), 241–247.

Carstensen, L. L. (2006). The influence of a sense of time on human development. *Science, 312*, 1913–1915.

Carstensen, L. L., Isaacowitz, D. M., & Charles, S. T. (1999). Taking time seriously: A theory of socioemotional selectivity. *American Psychologist, 54*, 165–181.

Carstensen, L. L., Mikels, J. A., & Mather, M. (2006). Aging and the intersection of cognition, motivation and emotion. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (6th ed., pp. 343–362). San Diego, CA: Academic Press.

Carstensen, L. L., Pasupathi, M., Mayr, U., & Nesselroade, J. R. (2000). Emotional experience in everyday life across the adult life span. *Journal of Personality and Social Psychology, 79*, 644–655.

Carstensen, L. L., Turan, B., Scheibe, S., Ram, N., Ersner-Hershfield, H., Samanez-Larkin, G., et al. (2011). Emotional experience improves with age: Evidence based on over 10 years of experience sampling. *Psychology and Aging, 26*(1), 21.

Charles, S. T. (2010). Strength and vulnerability integration: A model of emotional well-being across adulthood. *Psychological Bulletin, 136*(6), 1068–1091.

Charles, S. T., & Carstensen, L. L. (2008). Unpleasant situations elicit different emotional responses in younger and older adults. *Psychology and Aging, 23*(3), 495–504.

Charles, S. T., Carstensen, L. L., & McFall, R. M. (2001). Problem-solving in the nursing home environment: Age and experience differences in emotional reactions and responses. *Journal of Clinical Geropsychology, 7*(4), 319–330.

Charles, S. T., & Luong, G. (2013). Emotional experience across adulthood: The theoretical model of strength and vulnerability integration. *Current Directions in Psychological Science, 22*(6), 443–448.

Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Aging and emotional memory: The forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General, 132*, 310–324.

Charles, S. T., & Piazza, J. R. (2009). Age differences in affective well-being: Context matters. *Social and Personality Psychology Compass, 3*, 1–14.

Charles, S. T., Reynolds, C. A., & Gatz, M. (2001). Age-related differences and change in positive and negative affect over 23 years. *Journal of Personality and Social Psychology, 80*, 136–151.

Christensen, H., Jorm, A. F., MacKinnon, A. J., Korten, A. E., Jacomb, P. A., Henderson, A. S., & Rodgers, B. (1999). Age differences in depression and anxiety symptoms: A structural equation modelling analysis of data from a general population sample. *Psychological Medicine, 29*(2), 325–339.

Cohn, M. A., Fredrickson, B. L., Brown, S. L., Mikels, J. A., & Conway, A. M. (2009). Happiness unpacked: Positive emotions increase life satisfaction by building resilience. *Emotion, 9*(3), 361.

Corrada, M. M., Brookmeyer, R., Paganini-Hill, A., Berlau, D., & Kawas, C. H. (2010). Dementia incidence continues to increase with age in the oldest old: The 90+ study. *Annals of Neurology, 67*(1), 114–121.

Critchley, H. D., Wiens, S., Rotshtein, P., Ohman, A., & Dolan, R. J. (2004). Neural systems supporting interoceptive awareness. *Nature Neuroscience, 7*(2), 189–195.

Cumming, R. G., Salkeld, G., Thomas, M., & Szonyi, G. (2000). Prospective study of the impact of fear of falling on activities of daily living, SF-36 scores, and nursing home admission. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 55*(5), M299–M305.

Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness*. New York: Harcourt Brace.

Danner, D. D., Snowdon, D. A., & Friesen, W. V. (2001). Positive emotions in early life and longevity: Findings from the nun study. *Journal of Personality and Social Psychology, 80*(5), 804.

Denburg, N. L., Buchanan, D., Tranel, D., & Adolphs, R. (2003). Evidence for preserved emotional memory in normal elderly persons. *Emotion, 3*, 239–253.

Diener, E., & Chan, M. Y. (2011). Happy people live longer: Subjective well-being contributes to health and longevity. *Applied Psychology: Health and Well-Being, 3*(1), 1–43.

Farb, N. A., Chapman, H. A., & Anderson, A. K. (2013). Emotions: Form follows function. *Current Opinion in Neurobiology, 23*(3), 393–398.

Faucheux, B., Bourliere, F., Baulon, A., & Dupuis, C. (1981). The effects of psychosocial stress on urinary excretion of adrenaline and noradrenaline in 51- to 55- and, 71- to 74-year-old men. *Gerontology, 27*(6), 313–325.

Firestone, A., Turk-Browne, N. B., & Ryan, J. D. (2007). Age-related deficits in face recognition are related to underlying changes in scanning behavior. *Aging Neuropsychology and Cognition, 14*(6), 594–607.

Fischer, H., Nyberg, L., & Backman, L. (2010). Age-related differences in brain regions supporting successful encoding of emotional faces. *Cortex, 46*(4), 490–497.

Fiske, A., Wetherell, J. L., & Gatz, M. (2009). Depression in older adults. *Annual Review of Clinical Psychology, 5*, 363.

Frey, B. S., & Stutzer, A. (2010). *Happiness and economics: How the economy and institutions affect human well-being*. Princeton, NJ: Princeton University Press.

Frijda, N. H., Kuipers, P., & ter Schure, E. (1989). Relations among emotion, appraisal, and emotional action readiness. *Journal of Personality and Social Psychology, 57*(2), 212–228.

Fung, H. H. (2013). Aging in culture. *The Gerontologist, 53*(3), 369–377.

Fung, H. H., Isaacowitz, D. M., Lu, A. Y., & Li, T. Y. (2010). Interdependent self-construal moderates the age-related negativity reduction effect in memory and visual attention. *Psychology and Aging, 25*(2), 321–329.

Fung, H. H., Isaacowitz, D. M., Lu, A. Y., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2008). Age-related positivity enhancement is not universal: Older Chinese look away from positive stimuli. *Psychology and Aging, 23*, 440–446.

Fung, H. H., & You, J. (2011). Age differences in the likelihood of destructive anger responses under different relationship contexts: A comparison of mainland and Hong Kong Chinese. *Psychology and Aging, 26*(3), 605.

Grenier, S., Potvin, O., Hudon, C., Boyer, R., Préville, M., Desjardins, L., et al. (2012). Twelve-month prevalence and correlates of subthreshold and threshold anxiety in community-dwelling older adults with cardiovascular diseases. *Journal of Affective Disorders, 136*(3), 724–732.

Gross, J. J., Carstensen, L. L., Pasupathi, M., Tsai, J., Skorpen, C. G., & Hsu, A. Y. C. (1997). Emotion and aging: Experience, expression, and control. *Psychology and Aging, 12*, 590–599.

Grühn, D., Smith, J., & Baltes, P. B. (2005). No aging bias favoring memory for positive material: Evidence from a heterogeneity–homogeneity list paradigm using emotionally toned words. *Psychology and Aging, 20*(4), 579–588.

Haase, C. M., Seider, B. H., Shiota, M. N., & Levenson, R. W. (2012). Anger and sadness in response to an emotionally neutral film: Evidence for age-specific associations with well-being. *Psychology and Aging, 27*(2), 305.

Hahn, S., Carlson, C., Singer, S., & Gronlund, S. D. (2006). Aging and visual search: Automatic and controlled attentional bias to threat faces. *Acta Psychologica, 123*(3), 312–336.

Hasin, D. S., Goodwin, R. D., Stinson, F. S., & Grant, B. F. (2005). Epidemiology of major depressive disorder: Results from the National Epidemiologic Survey on Alcoholism and Related Conditions. *Archives of General Psychiatry, 62*(10), 1097–1106.

Haukkala, A., Konttinen, H., Laatikainen, T., Kawachi, I., & Uutela, A. (2010). Hostility, anger control, and anger expression as predictors of cardiovascular disease. *Psychosomatic Medicine, 72*(6), 556–562.

Heidenreich, P. A., Trogdon, J. G., Khavjou, O. A., Butler, J., Dracup, K., Ezekowitz, M. D., et al. (2011). Forecasting the future of cardiovascular disease in the United States: A policy statement from the American Heart Association. *Circulation, 123*(8), 933–944.

Heisz, J. J., & Ryan, J. D. (2011). The effects of prior exposure on face processing in younger and older adults. *Frontiers in Aging Neuroscience, 3.*

Hess, T. M., & Kotter-Grühn, D. (2011). Social knowledge and goal-based influences on social information processing in adulthood. *Psychology and Aging, 26*(4), 792.

Heun, R., Papassotiropoulos, A., Jessen, F., Maier, W., & Breitner, J. C. (2001). A family study of Alzheimer disease and early- and late-onset depression in elderly patients. *Archives of General Psychiatry, 58*(2), 190–196.

Hickie, I., Naismith, S., Ward, P. B., Turner, K., Scott, E., Mitchell, P., et al. (2005). Reduced hippocampal volumes and memory loss in patients with early- and late-onset depression. *British Journal of Psychiatry, 186*(3), 197–202.

Howland, J., Peterson, E. W., Levin, W. C., Fried, L., Pordon, D., & Bak, S. (1993). Fear of falling among the community-dwelling elderly. *Journal of Aging and Health, 5*(2), 229–243.

Isaacowitz, D. M., & Stanley, J. T. (2011). Bringing an ecological perspective to the study of aging and recognition of emotional facial expressions: Past, current, and future methods. *Journal of Nonverbal Behavior, 35*(4), 261–278.

Ice, G. H., Katz-Stein, A., Himes, J., & Kane, R. L. (2004). Diurnal cycles of salivary cortisol in older adults. *Psychoneuroendocrinology, 29*(3), 355–370.

John, O. P., & Gross, J. J. (2004). Healthy and unhealthy emotion regulation: Personality processes, individual differences, and life span development. *Journal of Personality, 72*(6), 1301–1334.

Jopp, D., & Rott, C. (2006). Adaptation in very old age: Exploring the role of resources, beliefs, and attitudes for centenarians' happiness. *Psychology and Aging, 21*(2), 266.

Katz, I. R., Jeste, D. V., Mintzer, J. E., Clyde, C., Napolitano, J., & Brecher, M. (1999). Comparison of Risperidone and placebo for psychosis and behavioral disturbances associated with dementia: A randomized, double-blind trial. *Journal of Clinical Psychiatry, 60*, 107–115.

Keightley, M. L., Chiew, K. S., Winocur, G., & Grady, C. L. (2007). Age-related differences in brain activity underlying identification of emotional expressions in faces. *Social Cognitive and Affective Neuroscience, 2*(4), 292–302.

Keltner, D., & Haidt, J. (1999). Social functions of emotions at four levels of analysis. *Cognition and Emotion, 13*(5), 505–521.

Kennedy, Q., Mather, M., & Carstensen, L. L. (2004). The role of motivation in the age-related positivity effect in autobiographical memory. *Psychological Science, 15*, 208–214.

Khalsa, S. S., Rudrauf, D., & Tranel, D. (2009). Interoceptive awareness declines with age. *Psychophysiology, 46*, 1–7.

Knight, M., Seymour, T. L., Gaunt, J. T., Baker, C., Nesmith, K., & Mather, M. (2007). Aging and goal-directed emotional attention: Distraction reverses emotional biases. *Emotion, 7*(4), 705–714.

Ko, S. G., Lee, T. H., Yoon, H. Y., Kwon, J. H., & Mather, M. (2011). How does context affect assessments of facial

emotion?: The role of culture and age. *Psychology and Aging, 26*(1), 48–59.
Kryla-Lighthall, N., & Mather, M. (2009). The role of cognitive control in older adults' emotional well-being. In V. Berngtson, D. Gans, N. Putney, & M. Silverstein (Eds.), *Handbook of theories of aging* (2nd ed., pp. 323–344). New York: Springer.
Kudielka, B. M., Buske-Kirschbaum, A., Hellhammer, D. H., & Kirschbaum, C. (2004). HPA axis responses to laboratory psychosocial stress in healthy elderly adults, younger adults, and children: Impact of age and gender. *Psychoneuroendocrinology, 29*(1), 83–98.
Kunzmann, U., & Gruhn, D. (2005). Age differences in emotional reactivity: The sample case of sadness. *Psychology and Aging, 20*(1), 47–59.
Kunzmann, U., Kupperbusch, C. S., & Levenson, R. W. (2005). Behavioral inhibition and amplification during emotional arousal: A comparison of two age groups. *Psychology and Aging, 20*(1), 144–158.
Kunzmann, U., Richter, D., & Schmukle, S. C. (2013). Stability and change in affective experience across the adult life span: Analyses with a national sample from Germany. *Emotion, 13*(6), 1086–1095.
Kunzmann, U., & Thomas, S. (2014). Multidirectional age differences in anger and sadness. *Psychology and Aging, 29*(1), 16.
Kwon, Y., Scheibe, S., Samanez-Larkin, G. R., & Tsai, J. L. (2009). Replicating the positivity effect in picture memory in Koreans: Evidence for cross-cultural generalizability. *Psychology and Aging, 24*, 748–754.
Lacey, H. P., Smith, D. M., & Ubel, P. A. (2006). Hope I die before I get old: Mispredicting happiness across the adult lifespan. *Journal of Happiness Studies, 7*(2), 167–182.
Lagier, E., Delvaux, M., Vellas, B., Fioramonti, J., Bueno, L., Albarede, J. L., et al. (1999). Influence of age on rectal tone and sensitivity to distension in healthy subjects. *Neurogastroenterology and Motility, 11*(2), 101–107.
Lakatta, E. G. (1990). Heart and circulation. In E. Schneider (Ed.), *Handbook of biology of aging* (pp. 181–216). San Diego, CA: Academic Press.
Lange, C. G., & James, W. (1922). *The emotions* (Vol. 1). Baltimore, MD: Williams and Wilkins.
Lasch, H., Castell, D. O., & Castell, J. A. (1997). Evidence for diminished visceral pain with aging: Studies using graded intraesophageal balloon distension. *American Journal of Physiology–Gastrointestinal and Liver Physiology, 272*(1), G1–G3.
Lawton, M. P., Kleban, M. H., Rajagopal, D., & Dean, J. (1992). Dimensions of affective experience in three age groups. *Psychology and Aging, 7*, 171–184.
Leclerc, C. M., & Kensinger, E. A. (2008). Effects of age on detection of emotional information. *Psychology and Aging, 23*(1), 209–215.
Leclerc, C. M., & Kensinger, E. A. (2011). Neural processing of emotional pictures and words: A comparison of young and older adults. *Developmental Neuropsychology, 36*(4), 519–538.
Lench, H. C., & Levine, L. J. (2008). Goals and responses to failure: Knowing when to hold them and when to fold them. *Motivation and Emotion, 32*(2), 127–140.
Levenson, R. W. (1999). The intrapersonal functions of emotion. *Cognition and Emotion, 13*(5), 481–504.
Levenson, R. W., Friesen, W. V., Ekman, P., & Carstensen, L. L. (1991). Emotion, physiology, and expression in old age. *Psychology and Aging, 6*(1), 28–35.
Levine, L. J., & Safer, M. A. (2002). Sources of bias in memory for emotions. *Current Directions in Psychological Science, 11*, 169–173.
Li, C., Ford, E. S., Strine, T. W., & Mokdad, A. H. (2008). Prevalence of depression among US adults with diabetes findings from the 2006 Behavioral Risk Factor Surveillance System. *Diabetes Care, 31*(1), 105–107.
Lighthall, N. R., Gorlick, M. A., Schoeke, A., Frank, M. J., & Mather, M. (2013). Stress modulates reinforcement learning in younger and older adults. *Psychology and Aging, 28*, 35–46.
Lloyd-Jones, D., Adams, R. J., Brown, T. M., Carnethon, M., Dai, S., De Simone, G., et al. (2010). Heart disease and stroke statistics—2010 update: A report from the American Heart Association. *Circulation, 121*(7), e46–e215.
Lyketsos, C. G., Steinberg, M., Tschanz, J. T., Norton, M. C., Steffens, D. C., & Breitner, J. C. (2000). Mental and behavioral disturbances in dementia: Findings from the Cache County Study on Memory in Aging. *American Journal of Psychiatry, 157*(5), 708–714.
Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: Does happiness lead to success? *Psychological Bulletin, 131*(6), 803.
Marquez-Gonzalez, M., de Troconiz, M. I. F., Cerrato, I. M., & Baltar, A. L. (2008). Emotional experience and regulation across the adult lifespan: Comparative analysis in three age groups. *Psicothema, 20*(4), 616–622.
Mather, M. (2006). A review of decision-making processes: Weighing the risks and benefits of aging. In L. L. Carstensen & C. R. Hartel (Eds.), *When I'm 64* (pp. 145–173). Washington, DC: National Academies Press.
Mather, M. (2012). The emotion paradox in the aging brain. *Annals of the New York Academy of Sciences, 1251*, 33–49.
Mather, M. (in press). The affective neuroscience of aging. *Annual Review of Psychology, 67*.
Mather, M., Canli, T., English, T., Whitfield, S. L., Wais, P., Ochsner, K. N., et al. (2004). Amygdala responses to emotionally valenced stimuli in older and younger adults. *Psychological Science, 15*, 259–263.
Mather, M., & Carstensen, L. L. (2003). Aging and attentional biases for emotional faces. *Psychological Science, 14*, 409–415.
Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences, 9*(10), 496–502.
Mather, M., Gorlick, M. A., & Lighthall, N. R. (2009). To brake or accelerate when the light turns yellow?: Stress reduces older adults' risk taking in a driving game. *Psychological Science, 20*, 174–176.
Mather, M., & Knight, M. (2005). Goal-directed memory: The role of cognitive control in older adults' emotional memory. *Psychology and Aging, 20*, 554–570.
Mather, M., & Knight, M. R. (2006). Angry faces get no-

ticed quickly: Threat detection is not impaired among older adults. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 61*, P54–P57.

Mather, M., Mazar, N., Gorlick, M., Lighthall, N. R., & Ariely, D. (2012). Risk preferences and aging: The "certainty effect" in older adults' decision making. *Psychology and Aging, 27*, 801–816.

McConatha, J. T., & Huba, H. M. (1999). Primary, secondary, and emotional control across adulthood. *Current Psychology, 18*, 164–170.

Mezuk, B., Edwards, L., Lohman, M., Choi, M., & Lapane, K. (2012). Depression and frailty in later life: A synthetic review. *International Journal of Geriatric Psychiatry, 27*(9), 879–892.

Mienaltowski, A., Corballis, P. M., Blanchard-Fields, F., Parks, N. A., & Hilimire, M. R. (2011). Anger management: Age differences in emotional modulation of visual processing. *Psychology and Aging, 26*(1), 224–231.

Mojtabai, R., & Olfson, M. (2004). Major depression in community-dwelling middle-aged and older adults: Prevalence and 2- and 4-year follow-up symptoms. *Psychological Medicine, 34*(4), 623–634.

Mostofsky, E., Penner, E. A., & Mittleman, M. A. (2014). Outbursts of anger as a trigger of acute cardiovascular events: A systematic review and meta-analysis. *European Heart Journal*, ehu033.

Mroczek, D. K., & Kolarz, C. M. (1998). The effect of age on positive and negative affect: A developmental perspective on happiness. *Journal of Personality and Social Psychology, 75*, 1333–1349.

Murphy, N. A., & Isaacowitz, D. M. (2010). Age effects and gaze patterns in recognising emotional expressions: An in-depth look at gaze measures and covariates. *Cognition and Emotion, 24*(3), 436–452.

Nashiro, K., Sakaki, M., & Mather, M. (2012). Age differences in brain activity during emotion processing: Reflections of age-related decline or increased emotion regulation? *Gerontology, 58*, 156–163.

Neiss, M. B., Leigland, L. A., Carlson, N. E., & Janowsky, J. S. (2009). Age differences in perception and awareness of emotion. *Neurobiology of Aging, 30*(8), 1305–1313.

Nicolson, N., Storms, C., Ponds, R., & Sulon, J. (1997). Salivary cortisol levels and stress reactivity in human aging. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 52*(2), M68–M75.

Nolen-Hoeksema, S., & Ahrens, C. (2002). Age differences and similarities in the correlates of depressive symptoms. *Psychology and Aging, 17*(1), 116.

Nolen-Hoeksema, S., & Aldao, A. (2011). Gender and age differences in emotion regulation strategies and their relationship to depressive symptoms. *Personality and Individual Differences, 51*(6), 704–708.

Norton, J., Ancelin, M. L., Stewart, R., Berr, C., Ritchie, K., & Carrière, I. (2012). Anxiety symptoms and disorder predict activity limitations in the elderly. *Journal of Affective Disorders, 141*(2), 276–285.

Oatley, K. (2004). *Emotions: A brief history*. Malden, MA: Blackwell.

Ong, A. D., Rothstein, J. D., & Uchino, B. N. (2012). Loneliness accentuates age differences in cardiovascular responses to social evaluative threat. *Psychology and Aging, 27*(1), 190.

Opitz, P. C., Gross, J. J., & Urry, H. L. (2012). Selection, optimization, and compensation in the domain of emotion regulation: Applications to adolescence, older age, and major depressive disorder. *Social and Personality Psychology Compass, 6*(2), 142–155.

Otte, C., Hart, S., Neylan, T. C., Marmar, C. R., Yaffe, K., & Mohr, D. C. (2005). A meta-analysis of cortisol response to challenge in human aging: Importance of gender. *Psychoneuroendocrinology, 30*(1), 80–91.

Petrican, R., Moscovitch, M., & Schimmack, U. (2008). Cognitive resources, valence, and memory retrieval of emotional events in older adults. *Psychology and Aging, 23*(3), 585–594.

Piazza, J. R., Charles, S. T., Stawski, R. S., & Almeida, D. M. (2013). Age and the association between negative affective states and diurnal cortisol. *Psychology and Aging, 28*(1), 47.

Porges, S., & Fox, N. (1986). Developmental psychophysiology. In M. G. H. Coles, E. Donchin, & S. W. Porges (Eds.), *Psychophysiology: Systems, processes, and applications* (pp. 611–625). New York: Guilford Press.

Rayner, C. K., MacIntosh, C. G., Chapman, I. M., & Horowitz, M. (2000). Effects of age on proximal gastric motor and sensory function. *Scandinavian Journal of Gastroenterology, 35*(10), 1041–1047.

Redelmeier, D. A., Katz, J., & Kahneman, D. (2003). Memories of colonoscopy: A randomized trial. *Pain, 104*, 187–194.

Reed, A. E., & Carstensen, L. L. (2012). The theory behind the age-related positivity effect. *Frontiers in Psychology, 3*.

Reed, A. E., Chan, L., & Mikels, J. A. (2014). Meta-analysis of the age-related positivity effect: Age differences in preferences for positive over negative information. *Psychology and Aging, 29*(1), 1.

Robertson, I. H. (2013). A noradrenergic theory of cognitive reserve: Implications for Alzheimer's disease. *Neurobiology of Aging, 34*(1), 298–308.

Rohleder, N., Kudielka, B. M., Hellhammer, D. H., Wolf, J. M., & Kirschbaum, C. (2002). Age and sex steroid-related changes in glucocorticoid sensitivity of pro-inflammatory cytokine production after psychosocial stress. *Journal of Neuroimmunology, 126*(1), 69–77.

Rothermund, K., & Brandstädter, J. (2003). Coping with deficits and losses in later life: From compensatory action to accommodation. *Psychology and Aging, 18*(4), 896.

Ruffman, T., Henry, J. D., Livingstone, V., & Phillips, L. H. (2008). A meta-analytic review of emotion recognition and aging: Implications for neuropsychological models of aging. *Neuroscience and Biobehavioral Reviews, 32*(4), 863–881.

Sakaki, M., Nga, L., & Mather, M. (2013). Amygdala functional connectivity with medial prefrontal cortex at rest predicts the positivity effect in older adults' memory. *Journal of Cognitive Neuroscience, 25*(8), 1206–1224.

Schweitzer, I., Tuckwell, V., O'Brien, J., & Ames, D. (2002). Is late onset depression a prodrome to dementia? *International Journal of Geriatric Psychiatry, 17*(11), 997–1005.

Seider, B. H., Shiota, M. N., Whalen, P., & Levenson, R. W. (2011). Greater sadness reactivity in late life. *Social Cognitive and Affective Neuroscience,* 6(2), 186–194.

Seligman, M. E. (2012). *Flourish: A visionary new understanding of happiness and well-being.* New York: Free Press.

Sims, T. L., & Carstensen, L. L. (2014). The elusiveness of a life-span model of emotion regulation. *International Society for the Study of Behavioral Development, 38,* 30–32.

Singleton, N., Bumpstead, R., O'Brien, M., Lee, A., & Meltzer, H. (2003). Psychiatric morbidity among adults living in private households, 2000. *International Review of Psychiatry, 15*(1–2), 65–73.

Slessor, G., Phillips, L. H., & Bull, R. (2008). Age-related declines in basic social perception: Evidence from tasks assessing eye-gaze processing. *Psychology and Aging, 23*(4), 812–822.

Steptoe, A., Deaton, A., & Stone, A. A. (2015). Subjective wellbeing, health, and ageing. *The Lancet, 385*(9968), 640–648.

Stone, A. A., Schwartz, J. E., Broderick, J. E., & Deaton, A. (2010). A snapshot of the age distribution of psychological well-being in the United States. *Proceedings of the National Academy of Sciences, 107*(22), 9985–9990.

Suinn, R. M. (2001). The terrible twos—anger and anxiety: Hazardous to your health. *American Psychologist, 56*(1), 27.

Sullivan, S., Ruffman, T., & Hutton, S. B. (2007). Age differences in emotion recognition skills and the visual scanning of emotion faces. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 62*(1), P53–P60.

Timmer, E., Westerhof, G. J., & Dittmann-Kohli, F. (2005). "When looking back on my past life I regret . . .": Retrospective regret in the second half of life. *Death Studies, 29*(7), 625–644.

Torges, C. M., Stewart, A. J., & Nolen-Hoeksema, S. (2008). Regret resolution, aging, and adapting to loss. *Psychology and Aging, 23*(1), 169.

Tsai, J. L., Levenson, R. W., & Carstensen, L. L. (2000). Autonomic, subjective, and expressive responses to emotional films in older and younger Chinese Americans and European Americans. *Psychology and Aging, 15*(4), 684–693.

Urry, H. L., & Gross, J. J. (2010). Emotion regulation in older age. *Current Directions in Psychological Science, 19*(6), 352–357.

Van Cauter, E., Leproult, R., & Kupfer, D. J. (1996). Effects of gender and age on the levels and circadian rhythmicity of plasma cortisol. *Journal of Clinical Endocrinology and Metabolism, 81*(7), 2468–2473.

Västfjäll, D., Peters, E., & Bjälkebring, P. (2011). The experience and regulation of regret across the adult life span. In I. Nyklíček, A. J. J. M. Vingerhoets, & M. Zeelenberg (Eds.), *Emotion regulation and well-being* (pp. 165–180). New York: Springer.

Vink, D., Aartsen, M. J., & Schoevers, R. A. (2008). Risk factors for anxiety and depression in the elderly: A review. *Journal of Affective Disorders, 106*(1), 29–44.

Waldinger, R. J., Kensinger, E. A., & Schulz, M. S. (2011). Neural activity, neural connectivity, and the processing of emotionally valenced information in older adults: Links with life satisfaction. *Cognitive Affective and Behavioral Neuroscience, 11*(3), 426–436.

Watson, G. S., Bernhardt, T., Reger, M. A., Cholerton, B. A., Baker, L. D., Peskind, E. R., et al. (2006). Insulin effects on CSF norepinephrine and cognition in Alzheimer's disease. *Neurobiology of Aging, 27*(1), 38–41.

Watson, P. J., & Andrews, P. W. (2002). Toward a revised evolutionary adaptationist analysis of depression: The social navigation hypothesis. *Journal of Affective Disorders, 72*(1), 1–14.

Wetherell, J. L., Maser, J. D., & Balkom, A. V. (2005). Anxiety disorders in the elderly: Outdated beliefs and a research agenda. *Acta Psychiatrica Scandinavica, 111*(6), 401–402.

Williams, R. (2012). *Anger kills: Seventeen strategies for controlling hostility that can harm your health.* New York: Random House.

Wilson, R. S., Nag, S., Boyle, P. A., Hizel, L. P., Yu, L., Buchman, A. S., et al. (2013). Neural reserve, neuronal density in the locus ceruleus, and cognitive decline. *Neurology, 80*(13), 1202–1208.

Wolitzky-Taylor, K. B., Castriotta, N., Lenze, E. J., Stanley, M. A., & Craske, M. G. (2010). Anxiety disorders in older adults: A comprehensive review. *Depression and Anxiety, 27*(2), 190–211.

Wong, B., Cronin-Golomb, A., & Neargarder, S. (2005). Patterns of visual scanning as predictors of emotion identification in normal aging. *Neuropsychology, 19*(6), 739–749.

Wrosch, C., Bauer, I., Miller, G. E., & Lupien, S. (2007). Regret intensity, diurnal cortisol secretion, and physical health in older individuals: Evidence for directional effects and protective factors. *Psychology and Aging, 22*(2), 319.

Wrosch, C., Bauer, I., & Scheier, M. F. (2005). Regret and quality of life across the adult life span: The influence of disengagement and available future goals. *Psychology and Aging, 20*(4), 657.

Wrosch, C., & Heckhausen, J. (2002). Peceived control of life regrets: Good for young and bad for old adults. *Psychology and Aging, 17*(2), 340.

Wrosch, C., & Miller, G. E. (2009). Depressive symptoms can be useful: Self-regulatory and emotional benefits of dysphoric mood in adolescence. *Journal of Personality and Social Psychology, 96*(6), 1181.

CHAPTER 19

The Interplay of Motivation and Emotion

View from Adulthood and Old Age

Molly Sands, Nhi Ngo, and Derek M. Isaacowitz

In this chapter, we consider the relationship between emotion and motivation, with a particular focus on how this relationship changes across the lifespan. Emotion and motivation have generally been considered by psychologists to be distinct constructs, although they have much in common (Lazarus, 1991). For instance, both emotion and motivation are thought to play an important role in directing thoughts and behaviors (Bradley & Lang, 2000; Pessoa, 2009). Emotion can facilitate motivation and help define desired goals, while failure or success in motivated goal pursuit can also cause emotional responses. Below, we focus specifically on how various motivational processes may influence emotion by examining key research findings, and the theoretical frameworks used to interpret them, in the context of lifespan development.

Over the past several decades, cross-sectional and longitudinal research has revealed age-related differences in various types of emotional processes, including affective experience, emotion regulation, and emotion perception (Charles, Reynolds, & Gatz, 2001; Stanley & Isaacowitz, 2014). Since chronological age alone does not adequately explain changes in emotional processes across the lifespan (Wohlwill, 1970) there has been a strong interest in understanding and explaining the underlying mechanisms that drive these age differences in emotional processes. Prominent theories of socioemotional development have proposed that changes in motivation result in changes in these emotional processes, so it is important to examine how these motivational theories can explain, or fail to explain, age differences in emotion. In this chapter, we assess empirical evidence of age differences in emotional processes through the lenses of two motivational models of lifespan development: (1) the selection, optimization, and compensation (SOC) metatheory; and (2) socioemotional selectivity theory (SST). Conceptually, these theories are consistent in offering motivational accounts for age differences in emotion. However, each theory ascribes these changes to different mechanisms that may help us understand emotions in the context of aging. This is not meant to be an exhaustive list of lifespan motivational theories. Instead, we have selected the models that are most frequently linked to findings in the extant literature on emotion.

These two prominent theoretical orientations have guided research questions and provided a framework for interpreting empirical results in the emotion regulation and emotion perception literature. In the remainder of this chapter, we first present key empirical findings and review the primary motivational accounts used to explain them. We then evaluate how effectively they explain the current state of findings in the areas of emotion regulation and emotion perception, two of the most studied emotional processes in aging.

Empirical Evidence for Age Differences in Emotional Processes

Age Differences in Affective Experience

Aging has been associated with stability, and in some cases improvements, in affective well-being (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000). Initially, this may seem counterintuitive considering age-related losses in cognitive function, physical performance, and control over the environment (Salthouse, Atkinson, & Berish, 2003; Perera, Mody, Woodman, & Studenski, 2006). However, in general, older adults have been found to maintain higher levels of positive affect and subjective well-being and have lower levels of negative affect (Charles et al., 2001; Kunzmann, Little, & Smith, 2000). Since positive and negative affect appear to be separate dimensions rather than opposite ends of a bipolar scale (Bradburn, 1969), we gain the best understanding of age-related changes in well-being by examining positive and negative affect separately.

Older adults report less frequent and less intense experiences of negative emotions than their younger counterparts (Diener, Sandvik, & Larsen, 1985). Cross-sectional data also suggest that negative affect consistently declines from adolescence until about 60 years of age, but then plateaus or slightly increases (Carstensen et al., 2000; Diener & Suh, 1998). Analyses of the Berlin Aging Study data revealed that when factors such as personality and cognitive function were controlled for, advanced age did not account for changes in negative affect, suggesting that contextual changes also explain age differences in affective experience in very old age (Isaacowitz & Smith, 2003). Cumulatively, these findings suggest that individuals exhibit relatively stable levels of negative affect, with a slow decline throughout the lifespan until very late life, in which negative affect typically increases (Charles et al., 2001).

Positive affect, however, exhibits a less clear pattern of age differences, with some studies finding slight decreases and others indicating stability or even increases throughout the lifespan. In two longitudinal studies of lifespan samples, positive affect slightly decreased, especially for people in late life (Charles et al., 2001; Stacey & Gatz, 1991). Mroczek and Kolarz (1998) found increases in positive affect in a lifespan sample that were best modeled by a quadratic curve. These findings suggested that the trajectory of change in positive affect differs by gender but consistently increased with age and only decreased in very late life. A longitudinal experience sampling study revealed that age is associated with more frequent experiences of positive affect, greater emotional stability, and increases in the co-occurrence of positive and negative emotions (Carstensen et al., 2011). In contrast, another experience sampling study found no age differences in the frequency or intensity of positive emotions in a sample ranging from 18 to 94 years of age (Carstensen et al., 2000). Overall, it seems affective well-being improves throughout the lifespan, with declines in negative affect and relative stability of positive affect, until very old age.

Age Differences in Emotion Regulation

Findings of age differences in affective experience raise questions about the effects of aging on emotion regulation—the processes by which people impact or alter their emotional experiences. There are a number of ways in which individuals can regulate their emotions throughout the lifespan, but much of the research in this area has been guided by the process model of emotion regulation (Gross & Thompson, 2007) and thus focuses on the strategies proposed by this framework. In this framework, antecedent strategies occur early in the emotion generative process, and include situation selection, situation modification, attentional deployment, and cognitive change. Later, response modification strategies, such as expressive suppression, are available.

Older adults have been found to effectively utilize antecedent emotion regulation strategies, especially those that minimize engagement with negative stimuli. In a laboratory study of choices of affective materials, older adults with high emotional self-efficacy choose to spend less time interacting with negative stimuli than younger adults with the same beliefs (Rovenpor, Skogsberg, & Isaacowitz, 2013), though no main effect of age was found in that study or a series of follow-up studies (Isaacowitz, Livingstone, Harris, & Marcotte, 2015). Additionally, older adults exhibit a preference for close, emotionally rewarding social partners. As people age, there is a reduction in the total number of social partners they engage with (Carstensen, 1992; Fung, Carstensen, & Lang, 2001). Early interpretations of this finding posited that older adults experienced a decrease in social partners due to physical challenges or declining resources; however, the reductions in social networks begin long before these age-related losses (Carstensen, 1992). As the number of social partners people engage with declines, they actually report closer, more satisfying emotional relationships with this relatively smaller number of individuals (Fung et al., 2001). The selection of social partners is not a direct measure of situation selection as a regulatory strategy, but suggests that older adults may shape their environment in ways that promote positive emotions.

Numerous studies have also shown that older adults remember and attend to a higher ratio of positive compared with negative information, a phenomenon termed the "age-related positivity effect," which has often been interpreted as information processing in the service of emotion regulatory goals (Isaacowitz & Blanchard-Fields, 2012; Mather & Carstensen, 2005). In memory recall tasks, older adults show a reduction in memory for negative stimuli (Charles, Mather, & Carstensen, 2003). Additionally, in a recognition task younger adults were better able to identify negative images while older adults did not differ in recognition of positive and negative stimuli (Charles et al., 2003). However, when participants of all ages were primed to focus on their current emotional state, instead of memory accuracy, they were more likely to display positivity effects, suggesting that positive biases in memory are motivated by emotion regulatory goals (Kennedy, Mather, & Carstensen, 2004).

Studies of visual attention to emotional stimuli have also found evidence of positivity effects, which have primarily been interpreted as support for motivational accounts. In order to determine if positivity effects in memory are also related to age differences in attentional patterns, we examined visual attention to emotional faces using eye tracking in older and younger adults and in fact, the results of these studies were consistent with positivity effects in memory (Isaacowitz, 2006). In a subsequent eye-tracking study, we examined older and younger adults' gaze patterns while viewing emotional faces and again found that older adults fixated significantly less on angry and fearful faces and significantly more on happy facial expressions (Isaacowitz, Wadlinger, Goren, & Wilson, 2006). To determine if these findings were related to motivation for older adults to feel good, and not simply mood-congruent gaze patterns, we conducted another study that accounted for baseline mood. If younger adults started the task in a negative mood, they exhibited mood-congruent looking patterns by attending more to negative stimuli, but if older adults started the task in a negative mood, they attended most to happy faces; they did not display valence preferences when in a positive or neutral mood (Isaacowitz, Toner, Goren, & Wilson, 2008). However, positive looking patterns only seem to help older adults with good attentional abilities regulate their moods (Isaacowitz, Toner, & Neupert, 2009; Noh, Lohani, & Isaacowitz, 2011). In sum, these findings suggest that as people age they use and benefit more from attentional strategies, which allow them to engage less with negative emotional content, and potentially improve negative moods.

Age differences in the use of cognitive change as an emotion regulation strategy indicate, however, that younger adults may rely more on cognitive regulatory strategies. Shiota and Levenson (2009) found that detached reappraisal (adopting an unemotional, objective attitude) was most effective for younger adults, whereas positive reappraisal (focusing on the positive aspects) led to the best emotional outcomes and lower levels of physiological reactivity for older adults in response to negative film clips. In another laboratory study, younger and older adults were asked to perform a cognitive load task while down-regulating from a negative emotional state; mood recovery was assessed over time. Younger adults under cognitive load had more difficulty regulating their emotions than older adults under cognitive load, suggesting that they may inherently rely more on cognitive forms of regulation (Scheibe & Blanchard-Fields, 2009). Cumulatively, the results of these studies suggest that older adults may be using different mechanisms to regulate their emotions than younger adults, which in turn may impact the use and effectiveness of various emotion regulation strategies.

Age Differences in Emotion Perception

Although affective experience and some forms of emotion regulation appear to improve with age, the trajectory is the opposite for the perception of emotion in others. A meta-analytic review (Ruffman, Henry, Livingston, & Phillips, 2008), a theoretical review (Isaacowitz & Stanley, 2011), and a detailed, tabulated summary of past findings (Isaacowitz et al., 2007) all concluded that older adults have more difficulty than younger adults in identifying facial expressions, especially those of negative emotions. Ruffman and colleagues (2008) analyzed 28 datasets from 15 published studies and found that older adults have more difficulty than younger adults in identifying at least some of the basic emotions across a number of modalities (faces, voices, bodies/contexts, and face–voice matching). Older adults perform worse than younger adults in identifying most negative facial expressions, specifically of fear, sadness, and anger (Calder et al., 2003; Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006; Orgeta & Phillips, 2008; Phillips, MacLean, & Allen, 2002; Ruffman et al., 2008; Sullivan & Ruffman, 2004a; Wong, Cronin-Golomb, & Neargarder, 2005). The exception of this pattern is the disgusted face, which older adults identify as consistently (Orgeta & Phillips, 2008; Phillips et al., 2002) or better than younger adults (Calder et al., 2003; Suzuki, Hoshino, Shigemasu, & Kawamura, 2007; Wong et al., 2005). The age-associated deficit also does not extend to happy and surprised faces (Murphy & Isaacowitz, 2010; Orgeta & Phillips, 2008; Phillips et al., 2002; Sullivan & Ruffman, 2004a).

There are a few possible nonmotivational accounts of the age-associated deficit in emotion perception that have been tested in the literature. First, older adults' response biases for certain emotions can lead to decreased accuracy in other emotions. Older adults were found to have a response bias for disgust, fear (Isaacowitz et al., 2007; Sasson et al., 2010), neutral, sadness, and anger labels for facial expressions (Sasson et al., 2010) and happiness, sadness, and surprise labels for words (Isaacowitz et al., 2007). While not directly calculating response biases, Ebner, He, and Johnson (2011) found that older adults mistake angry faces for disgusted, while younger adults did not show this pattern. It remains to be seen why older adults prefer certain labels over others, although their response biases might not necessarily be related to their emotion perception difficulty. Age differences in accuracy remain even after controlling for emotion-specific response biases (Isaacowitz et al., 2007; Sasson et al., 2010), indicating that older adults' decreased accuracy has roots beyond their tendency to choose particular emotion labels.

As aging comes with various declines in cognitive functioning, emotion perception deficits in older adults can be a consequence or a specific manifestation of general cognitive and perceptual decline. Age differences were reduced when cognitive measures were statistically controlled for (Orgeta & Phillips, 2008), and low-functioning older adults were more impaired at anger perception than high-functioning older adults (Krendl & Ambady, 2010), suggesting there is at least some overlap between general cognitive ability and emotion perception. However, in several studies, cognitive functioning accounted for the age differences in perception of only some facial expressions (Sullivan & Ruffman, 2004b; Suzuki & Akiyama, 2013; Murphy & Isaacowitz, 2010). Besides standard cognitive measures used in those studies, other measures of cognitive ability such as face processing and processing speed (Orgeta & Phillips, 2008; Sullivan & Ruffman, 2004b) also did not explain age differences in emotion perception. Age differences in emotion perception ability might be related to decline in general cognitive functioning, but is not entirely caused by cognitive decline in old age.

Aging also comes with changes in the structural and functional properties of the brain (e.g., Raz et al., 2005), which poses the question of whether these changes can lead to changes in emotion perception abilities. Most of the studies that look at age differences in neural activity related to facial expressions had participants passively view the stimuli without making explicit categorization. It is therefore still unknown how patterns of neural activity are associated with deficits in older adults' ability to label emotional facial expressions (see Isaacowitz & Stanley, 2011). The few studies that explored age differences in neural activity while participants identified facial expressions have yielded mixed results (Ebner, Johnson, Fischer, 2012; Williams et al., 2006). Another possible cause for the emotion perception deficit is older adults' attentional patterns. Older adults focus more on the lower half of the face when identifying facial expressions, a gaze pattern associated with lower accuracy in emotion identification (Sullivan, Ruffman, & Hutton, 2007; Wong et al., 2005). However, when different measures of fixation were controlled for, age differences were still significant for some facial expressions (Murphy & Isaacowitz, 2010).

In summary, older adults are consistently less accurate than younger adults in emotion identification tasks partly due to their response biases to a select few emotion labels, decline in general cognitive ability, and preference to look at the lower half of the face. However, none of these factors have fully explained the age-associated deficit in emotion perception, as age differences in accuracy still remain after controlling for these factors.

Motivational Models of Lifespan Development

Selection, Optimization, and Compensation

The SOC metatheory posits that successful human development is characterized by the maximization of gains and minimization of losses (Baltes & Baltes, 1990; Freund & Baltes, 2000). In this framework, developmental regulation of gains and losses consists of three processes: selection, optimization, and compensation. SOC aims to capture changes in the dynamics of these three processes across the lifespan and their consequences for successful development across different domains of functioning. In the domain of personal goals, SOC has proved to be particularly useful for understanding motivational changes across the lifespan.

The first assumption of the SOC model is that developmental trajectories contain both growth (gains) and decline (losses), and that these trajectories are present at all stages of development. For example, children gain new knowledge but lose the ability to speak a foreign language at native level after the age of 12; older adults may learn new things even as their health is in decline. Individuals are also thought to have constrained resources at any point in their lifespan, although they are especially more limited in old age than earlier in life (Baltes, 1997). The ratio of gains to losses thus becomes less positive with age, which motivates older individuals to utilize resources to avoid losses in order to maintain a desired level of functioning, as opposed to allocating these resources toward growth. Freedom from age-related social expectations allows older adults to be less constrained in their goal selection and pursuit, yet they are more limited in terms of resources to shape their environment according to their goals. Selection of goals and goal domains, optimization of remaining resources, and compensation for losses of resources for goal attainment are thus crucial in old age.

Selection involves reducing the numerous domains of functioning to those with available or attainable resources, as resources become more limited with increasing age. Focusing on a few select domains can increase the likelihood of successful goal achievement for older adults whose resources become more constrained (Freund & Baltes, 1998). Selection is only the first step in achieving goals. Individuals must engage in goal-relevant actions and invest resources to improve performance in the selected domains and attain goals. This process is called *optimization*. Optimization to achieve growth-related goals is especially important in old age, when the focus is primarily on losses (Freund & Baltes, 2000). When faced with losses in means to attain goals, individuals *compensate* in order to maintain a given level of functioning. Optimization means are used to successfully attain goals, whereas compensation is used to prevent losses, which has greater value than gains (Freund, 2006). Compensation is therefore important in old age due to declines in cognitive and physical functioning. To compensate for a loss in goal-related means, individuals can substitute by drawing on unused but functioning and equivalent means, or by acquiring new means.

Evidence for SOC comes most prominently from studies in aging, where changes in SOC correspond to the expected human development trajectory. Younger adults, who have more opportunities for growth, focus on optimization, whereas older adults, due to their increasing losses, focus on compensation. This pattern has been found in several self-report studies when participants were asked to rate the focus of their goals (e.g., Ebner, Freund, & Baltes, 2006; Heckhausen, 1997), although the results are not consistent across all studies (Freund & Baltes, 1998, 2002; Ogilvie, Rose, & Heppen, 2001). Results are clearer with behavioral studies. In an experiment where participants, after being trained, engaged in a dual-task paradigm that required both sensorimotor skills (walking) and cognitive resources (memory), older adults suffered from greater dual-task cost in the memory domain, but not the walking component. When both tasks increased in difficulty, older adults chose to employ external aids for walking but not for memory. This result indicates that older adults engaged in loss-based selection and compensation for the domain that they deemed both more important and prone to less loss (Li, Lindenberger, Freund, & Baltes, 2001).

Another study using behavioral measures found similar results (Freund, 2006). In two experiments, older adults spent more time on a task in which they were instructed to compensate for a loss, whereas younger adults persisted more on another task in which they were instructed to strive to do better (optimize). This pattern held even when controlling for differences in performance levels, and when the instructions changed into descriptions of difficulty, as opposed to the original ones focusing on gains and losses. The SOC metatheory provides a useful account of how the selection of developmentally relevant goals and an individual's ability to optimize resources and compensate for losses contributes to goal attainment and successful aging.

Applications to Emotion Regulation

Urry and Gross (2010) applied the SOC metatheory specifically to age differences in emotion regulation (selection, optimization, and compensation—emotion regulation [SOC-ER]). In this model, they propose that changes in resources may be important determinants of the emotion regulation strategies people use. SOC-ER posits that older adults compensate for losses in resources by selecting and optimizing strategies that rely on resources that improve or remain stable as they age in order to continue to effectively regulate their emotions. Older adults do not appear to experience deficits in their abilities to regulate their emotions, in fact, findings about affective experience suggest they may even have improved regulatory abilities (Charles et al., 2001. Older adults often report higher levels of affective well-being and it is likely that they are optimizing their emotion regulation efforts to attain these positive emotional outcomes.

Specifically, the SOC-ER model proposes that older adults rely on antecedent emotion regulation strategies, such as attentional deployment and situation selection, which draw primarily on experience with emotions and less on cognitive resources that decline with age. For instance, older adults have better emotional outcomes when they use regulatory strategies that rely on social support, a resource known to improve with age, rather than working memory capacity, a resource known to decline as people age (Opitz, Gross, & Urry, 2012). The positivity effect, which seems to be influenced by motivated differences in attention, also provides support for this framework. Older adults benefit from attentional deployment but only when they have good attentional abilities, suggesting that selecting strategies that rely on available resources, and perhaps compensate for losses, is particularly important for successful emotion regulation as people age (Isaacowitz et al., 2009; Noh et al., 2011). However, it is also important to consider to what extent individuals' preferences for these strategies have been differentiated from their effectiveness at regulating mood in empirical research to truly understand how these resource-based changes influence emotion regulation outcomes (Isaacowitz & Blanchard-Fields, 2012).

Applications to Emotion Perception

The applications of the SOC framework to findings about age deficits in emotion perception have been more limited than in emotion regulation. Explanations have primarily focused on abilities, with the assumption that older adults' decreased accuracy is related to a decline in some aspect of functioning, such as cognitive functioning, gaze patterns, or neural activity. Few studies have examined the possibility that it is not ability that changes across the lifespan, but motivation related to emotion perception that does.

It is possible that age differences in emotion perception are not motivated only by emotional goals, but also social cognitive goals. In this domain, older adults have demonstrated selective engagement, such that they select to engage only when stimuli are meaningful or relevant in some way, a phenomenon termed the "selective engagement hypothesis" (Hess, 2006, 2014). This hypothesis posits that older adults utilize SOC-type strategies to achieve their desired level of social cognitive functioning, by being selective in which goals they pursue. In addition, older adults optimize and compensate using their social expertise, which is accumulated knowledge over the lifespan about social situations (Hess, 2006). Selectivity in social cognition is demonstrated through enhanced performance for stimuli that have higher personal relevance or meaningfulness in older adults (e.g., Hess, Rosenberg, & Waters, 2001).

The selective engagement hypothesis can be helpful in explaining the age-associated emotion deficit, especially in light of studies that found no age differences in emotion perception using dynamic stimuli and stimuli embedded in information-rich context (Richter, Dietzel, & Kunzmann, 2011; Murphy, Lerhreld, & Isaacowitz, 2010; Noh & Isaacowitz, 2013). From the perspective of the selective engagement hypothesis, if older adults are motivated to preserve their cognitive resources and engage only in relevant, meaningful tasks, they may not perform well in emotion perception tasks in which stimuli are less relevant, unrealistic, and challenging. In real life, people, particularly older adults, do not often have to decode emotions through static and isolated images. The experience of doing so in a laboratory setting might thus appear highly contrived and consequently less motivating to older adults.

Stimuli and tasks that are low in ecological validity also put older adults at a disadvantage. In real-life social interactions, older adults might be using other cues from the environment as well as their social expertise to decode emotions. Social expertise—or social knowledge developed from experience over time—improves with age and can be used as a source of optimization and compensation in social cognitive functioning. Depriving older adults of these sources of environmental and personal resources can impede older adults from performing well.

In addition to being unrealistic, targets used in emotion perception tasks may be less relevant to older adults because they are faces of strangers. In real life, older adults interact with their small and tight social network, and rarely with strangers. Perceived closeness can therefore motivate older adults in emotion perception. In fact, increasing perceived closeness by telling participants that the targets had similar interests to theirs significantly enhanced emotion identification accuracy for older adults, and only marginally so for younger adults (Zhang, Fung, Stanley, Isaacowitz, & Ho, 2013). Additionally, the age differences in emotion perception were reduced for close social partners (Stanley & Isaacowitz, 2014).

Thus far, we have seen that while SOC-based motivational explanations of lifespan emotion perception findings present promising alternatives to cognitive-based accounts, very few studies have looked into SOC strategies as part of the mechanism behind the age-associated emotion perception deficit. It is worthwhile for future research to incorporate SOC into their investigation of lifespan emotion perception, as changes in motivation in late adulthood can impact emotion perception performance beyond the consequences of decline in ability or cognitive functioning.

Socioemotional Selectivity Theory

SST posits that as people age, they are motivated to prioritize emotional goals, due to a limited future time perspective (Carstensen, Isaacowitz, & Charles, 1999). There are two primary categories of social goals that individuals are motivated to pursue: knowledge acquisition and emotionally relevant goals. At any point in development, resources for goal pursuit are limited, and therefore, people can pursue only a limited number of goals simultaneously (Baltes, 1997). Because age and time left in life are inextricably linked, most of the research on SST has focused on age-related changes in emotional goals. Younger adults, for whom time seems expansive, tend to prioritize future-oriented goals such as knowledge acquisition. In these earlier phases of development, social behavior such as interacting with novel social partners and attending to negative emotional information provides important information that may play a crucial role in human functioning. As people age, however, their sense of time left in life becomes more limited, making emotionally meaningful goals more salient and motivating them to select socially relevant prohedonic goals.

Although shifts in goals are age related, SST posits that it is time perspective, and not age itself, that motivates individuals to prioritize positive emotions. Laboratory studies in which time perspective is not associated with age, or is experimentally manipulated, have found similar effects of limited time perspective on social partner selection. In one study, same-age participants who differed in their HIV status were asked to select from a series of social partners who would provide either a novel experience that might lead to knowledge acquisition, or an experience likely to be more emotionally meaningful. HIV-positive, symptomatic participants whose time perspective was the most limited, showed the same preference for close, emotionally rewarding social partners as older adults did in the same task, supporting the idea that it is time perspective, not chronological age, that motivates individuals to preferentially pursue prohedonic goals (Carstensen & Fredrickson, 1998). Similar effects of time perspective have been found in groups that are experiencing the "end of an era." For instance, college seniors also display preferences for close emotional partners while students with more time left in their current social environment show more interest in novel social interactions (Fredrickson, 1995). By examining the motivational role of time perspective in groups other than older adults, researchers have identified time perspective as an underlying mechanism that motivates changes in socially relevant goals. Individuals' social goals motivate their behavior and in turn influence emotional processes, such as emotion regulation and emotion perception.

Applications to Emotion Regulation

In the domain of emotion regulation, SST posits that prohedonic goals motivate older adults to regulate their emotions in ways that allow them to avoid experiencing negative emotions and ultimately maintain high levels of positive affect. SST is consistent with SOC in that the model considers selection of certain goals to be adaptive, especially in the social domain. These age differences in emotional goals have been evident in multiple domains, including preferences for social partners and cognitive processing of emotional stimuli.

One of the key ways SST has been applied is to explain age differences in affective experience as the result of preferences for emotion regulation strategies that are motivated by older adults' desire to feel good. The strength and vulnerability integration (SAVI) model (Charles, 2010) builds upon the SST framework by outlining the strengths and challenges associated with aging, and discussing their implications for emotion regulation. SAVI suggests that older adults attain their positive emotional goals by relying on emotion regulation strategies that become more effective, or at least maintain their effectiveness, with age. On the one hand, increased knowledge and experience with emotions is a major strength of aging. Older adults may be better able to interpret emotional cues and utilize prior experience to achieve their affective goals. On the other hand, older adults experience declines in cognitive and physiological flexibility, which may make it more difficult to down-regulate from high arousal, negative emotional states.

Emotion regulation strategies in which older adults are able to avoid or limit engagement with negative emotional content, are likely increasingly effective with age, since older adults seem to be better able to predict the emotional outcomes of situations but less equipped to down-regulate after experiencing a full-blown emotional response. Older adults selectively invest resources in emotionally rewarding relationships, which may also aid in emotion regulation and help them to compensate for losses in physical and cognitive resources that could negatively impact emotional outcomes (Fung et al., 2001). For instance, familiar partners can enhance memory by providing contextual clues and can utilize knowledge about physical ailments to help older adults compensate, thus enhancing emotional well-being (Baltes & Carstensen, 1996).

The SST framework has also guided much of the research about age differences in the cognitive processing of emotional information. According to SST, positivity effects (i.e., more positive patterns of memory and attention) are self-regulatory processes that align with older adults' emotional goals. Though cognitive resources decline with age, cognitive processing of emotional materials may remain somewhat stable, yet older adults display a preference for positive emotional information (Carstensen & Mikels, 2005). Positivity effects, particularly in attention, have also been associated with better moods in older adults, suggesting they serve regulatory functions, especially for older adults with good attentional abilities (Isaacowitz, 2012; Isaacowitz & Blanchard-Fields, 2012).

Generally, SST explains age differences in affective experience and regulation as motivated by changes in goals, which influence these emotional processes. This framework has been a major contributor to the literature and has driven much of the research in the area of aging and emotion. It aligns with the SOC framework by considering social goal selection as a key facet of motivation and proposing that some of the ways older adults attain prohedonic goals rely on optimization of emotion regulation and compensatory strategies. However, SST assumes that these chronically activated emotional goals guide most facets of older adults' behavior and research is limited about circumstances in which contrahedonic goals might be beneficial to older adults.

Applications to Emotion Perception

Age-associated deficits in emotion perception have been found mostly in facial expressions of negative emotions, whereas perception of expressions of positive or neutral emotions appears intact with age (Ruffman et al., 2008). It is possible that this deficit is caused by older adults' prioritization of prohedonic goals, and consequently preferential processing of positive stimuli and avoidance of negative ones (Cartensen & Mikels, 2005). Older adults are less likely to report anger in an angry–happy face blend (Bucks, Garner, Tarrant, Bradley, & Mogg, 2008), and demonstrate automatic response biases for happy over neutral, and neutral over fearful responses to low-intensity facial expressions (Johnson & Whiting, 2013). Reduced activity in the medial frontal cortex in response to fearful faces, and increased activity for happy faces in older adults indicates a discrepancy in controlled processing for positive and negative facial expressions (Williams et al., 2006), with negative facial expressions requiring more regulation efforts to avoid negative emotions. These findings could be interpreted as supporting motivated positivity effects in older adults' emotion perception.

Alternatively, this difference in processing efforts may stem from the levels of difficulty of identifying different facial expressions (Isaacowitz & Stanley, 2011). In the majority of experiments on age differences in emotion perception, happiness is the only positive emotion presented to the participants, or the only positive response option. In contrast, there is a range of negative emotions in stimuli and response options that might be more challenging to distinguish. Older and younger adults' equivalent performance on positive emotions therefore can be a result of a ceiling effect, as older adults still perform worse than younger adults in identifying positive facial expressions when the task becomes more difficult (Isaacowitz et al., 2007; Orgeta, 2010). Furthermore, age differences in perception of negative emotions are not uniform across studies, with older adults exhibiting difficulty for some emotions, but not others. Older adults' motivation to avoid negative emotions, therefore, cannot fully explain why the deficit varies across negative facial expressions, but are more pronounced for only some.

Contributions of Motivational Accounts

The models reviewed above overlap in a few critical ways. First, these frameworks propose that motivation is central to understanding age differences in emotional processes. They also both conceptualize successful aging as the ability to effectively pursue goals that enhance well-being, not as the absence of age-related decline in some domains. In addition, they both acknowledge shifting resources throughout the lifespan as people pursue social goals.

In the domains of emotional experience and emotion regulation, although each of these motivational accounts of development can provide interpretations of the empirical findings, some have been applied to specific findings more than others. For instance, the majority of the research on positivity effects has been from the conceptual perspective of SST, whereas emotion regulation is frequently linked to SOC through the SOC-ER model. An open question is whether these models simply have more explanatory power for findings they are applied to, or if research in these areas has thus far not adequately interpreted findings using alternative accounts. It is important for motivational models to be tested against one another, as well as against alternative nonmotivational accounts of lifespan development to determine which aspects of these findings can be explained by various predictors.

In the emotion perception literature, findings of an age-associated deficit in identification of isolated and contextualized facial expressions suggest that there is a change in the emotion perception process in older age. However, instead of conceptualizing this change as a decline in the ability to identify facial expression, it is more appropriate to think of this change as a shift in the utilization of alternate resources, which may be partly involuntary due to loss of primary cognitive or perceptual resources, and partly voluntary due to motivation to optimize and compensate to maintain a normal level of functioning. In other words, older adults are both obliged and motivated to rely more on external cues from the target of perception and the environment that both they (the perceiver) and the target are in to identify facial expressions. Older adults thus are at a disadvantage in the traditional lab-based emotion perception tasks. Motivational accounts can facilitate holistic considerations of the internal cues from the perceiver (how motivated the perceiver is to decode the target's emotion) as well as the external cues from the target (how relevant, familiar, or contextualized the target is) and the environment (what other cues besides the target are available). Therefore, the differences between emotion perception deficits due to ability, and those due to motivation, need to be further explored.

Avenues for Future Research

In reviewing the key empirical findings about lifespan emotional development and applying the most prominent lifespan motivational theories to them, we found that age-related changes in motivation may plausibly influence both emotion regulation and perception, and could lead to age differences in these emotional processes. At the same time, the individual studies that the larger body of research comprises have typically followed from, and thus only tested, one of the several possible motivational models (e.g., studies that investigate SST only as a possible explanation). In addition to SOC, there are other models that try to delineate motivation in aging across different domains. One such model is the motivational theory of lifespan development, which specifically focuses on the role of primary and secondary control in goal pursuit, and provides a compelling framework for interpreting findings about age differences in the affective consequences of goal selection, engagement, and disengagement. However, there has been a lack of empirical research about emotion regulation and perception conducted in the context of this theory, and so it has been less informative about age differences in these emotional processes (Heckhausen, Wrosch, & Schulz, 2010).

In order to fully understand these emotional processes and the potential role of motivation underlying them, it is critical that researchers focus on empirically testing motivational models in comparison to one another, in paradigms that do not simply aim to affirm or reject one model. It is also possible that these models could be integrated into an overarching framework to more adequately explain the role of motivation in emotion regulation and perception throughout the lifespan. In the domain of emotion regulation, motivational models provide compelling accounts for many of the empirical findings. However, the extent to which these various models uniquely contribute to our understanding of emotional processing throughout development remains unclear. The SOC-ER framework provides a comprehensive model for understanding age-related changes in emotion regulation. Nevertheless, the model is contingent on cognitive decline and other shifting resources, accounting for age-related variability in emotion regulation. In order to empirically test its validity, it will be critical to isolate changes in resources (such as cognitive function) and determine if these are sufficient to produce patterns consistent with age differences in emotion regulation. SST has successfully identified time perspective as a variable that accounts for differences in emotional goals. The theory is particularly effective at explaining positivity effects and changes in social environments throughout the lifespan. Though SST has been supported by substantial descriptive evidence of age-related positivity effects, Isaacowitz and Blanchard-Fields (2012) address the distinction between studying age differences in how emotional information is processed and understanding the downstream consequences of these differences. In order to understand how processing of emotional information influences emotional experience, we must assess positivity effects' real-time outcomes for mood (e.g., Isaacowitz et al., 2008).

There are still many open questions about affective experience and emotion regulation, and how these processes dynamically change throughout the lifespan. For instance, findings about the lifespan trajectory of affective experience have been somewhat contradictory. Therefore, it may be important to consider alternative explanations, or more nuanced versions of motivational models as potential explanations. There is also a need to better identify in which contexts older and younger adults rely on differential emotion regulation strategies to obtain a more nuanced understanding of factors that motivate these age differences.

Alternative theories, such as nonmotivational models, may also explain key age differences in emotion. The aging brain model proposes that structural changes in key emotion-generative brain areas, such as decreased volume of the amygdala, lead to fewer experiences of negative affect. Structural and functional changes in the brain are important to consider especially when interpreting age differences in emotional experience and emotion regulation (Cacioppo, Berntson, Bechara, Tranel, & Hawkley, 2011). However, age-related changes in positive affect seem to vary and are not entirely consistent with the idea that diminished brain activity leads to diminished affective experiences (Urry & Gross, 2010). Alternatively, some empirical results suggest that older adults experience greater sensitivity in amygdala responses. For instance, younger adults experience greater increases in amygdala activity than older adults in response to negative, but not positive images (Mather et al., 2004). In response to negative images, older adults also experience less activity in a parietal brain region, suggesting that positivity effects may also exist in low-level processing of emotional stimuli. We should also consider that differences in neural response during affective experiences could be the result of emotion regulation to pursue prohedonic goals (Samanez-Larkin & Carstensen, 2011). Additionally, in the domain of emotion perception, differences in task engagement and stimuli salience may also be evident in brain activity. In response to facial stimuli, older adults exhibit lower levels of amygdala activity, which is often interpreted as dysfunction in this brain region. However, behavioral studies provide support for the idea that processing of emotional stimuli remains intact and thus decreased amygdala activity may instead be related to decreased salience of the stimuli (Samanez-Larkin & Carstensen, 2011).

Another nonmotivational framework, dynamic integration theory (DIT) attempts to resolve the discrepancy between improvements in well-being, which are often attributed to enhanced regulatory ability, and emotion regulation challenges associated with age-related cognitive decline (Labouvie-Vief, 2003). To integrate these findings, DIT proposes a dynamic relationship between emotion and cognition that allows individuals to coordinate optimization, which relies on preconscious experience and is somewhat automatic, and differentiation, which requires more elaborative cognitive processing. As people age, they maintain higher levels of well-being if they are able to successfully integrate and balance these processes of optimization and differentiation. Older adults may sacrifice differentiation for optimization, suggesting that age-related differences in affective experience (and perhaps regulation) may be compensatory strategies.

Blanchard-Fields (2007) offers another nonmotivational account of aging that centers on expertise. In a series of everyday problem-solving tasks, older adults displayed a wider range of problem-solving strategies and used them effectively to regulate emotion and strategically solve problems (Blanchard-Fields, 2007). In this account, experience and the flexible use of context-appropriate strategies lead to successful emotion regulation and positive affective outcomes. Future studies will need to ascertain methods for testing among these approaches that may sometimes make only subtly different predictions, at least about observable outcomes.

Though motivational accounts have been employed to test predictions and interpret results regarding emotion regulation, only a few studies have attempted to directly investigate the role of motivation, specifically SST (e.g., Williams et al., 2006) and SOC (selective engagement; Zhang et al., 2013), in emotion perception. As discussed above, the potential of motivational theories in emotion perception and aging has not been fully explored. For example, while SST is compelling in explaining why older adults' deficit in emotion categorization applies to only negative faces, one critique of this account is that positive emotion in most emotion perception studies has an unfair advantage: The only positive facial expression being tested or the only positive response option is happy. Only one study so far with younger and older adults has used alluring faces along with happy faces to examine emotion perception abilities, and found a linear decrease in emotion perception ability with age for both positive and negative emotions (Lambrecht, Kreifelts, & Wildgruber, 2012).

Similarly, despite the focus on goals of motivation models, most studies have yet to explicitly investigate older adults' specific goals in emotion perception, making it difficult to apply the principles of SOC to evaluate the effect of motivational processes on emotion perception outcomes. Selective engagement is thought to play a role in task engagement and subsequent performance in emotion perception, but this effect has not yet been adequately applied to the study of age differences in emotion perception. In daily life, we interact more with dynamic facial expressions than static ones, and it is possible that static images of strangers' posed facial expressions are neither familiar nor relevant to older adults.

Motivation to process context is another approach that merits further consideration. Older adults' use of context in cognitive tasks stems from both a motivation to compensate for loss in cognitive abilities, and an involuntary yield to external control of cognitive functioning due to a decline in internal control (Lindenberger & Mayr, 2014), although little is known about the extent to which this hypothesis applies to emotion perception. Only one study so far has addressed this question (Ngo & Isaacowitz, 2015) but future research can investigate whether context processing in emotion perception is a result of changes in cognitive functioning or motivation, or a combination of both.

In addition to considering effects of motivation on context processing, there are a few other models that have not yet been evaluated in emotion perception but may suggest new venues for research that should be further explored. For instance, despite being similar to younger adults in avoidance goals (Nikitin & Freund, 2011), older adults' approach and avoidance goals might affect their performance on negative facial expressions, especially when not all negative emotions promote avoidance (Hutcherson & Gross, 2011). Additionally, the regulatory fit framework posits that individuals engage more with tasks that align with their goals, which then influences judgments and task performance (Higgins, 2005). This theory echoes the predictions of SOC and selective engagement as discussed above. It is possible that within the laboratory environment the means for older adults to succeed in emotion perception are not adequately available. If this is the case, older adults may not be able to reach their goals, leading to decreased task engagement (Higgins, 2000, 2005). Motivational models, and alternative theories, should be considered when interpreting empirical findings in the emotion perception literature.

Conclusion

Motivational models are prominent in the study of emotion and aging, and these models have generated important findings across the research areas of emotional experience, emotion regulation, and emotion perception. At the same time, there is much work to be done in order to align motivational theories with descriptive data about similarities and differences in emotion-relevant processes across adulthood and old age. In particular, studies that test motivational theories against each other rather than only affirming one particular model, and studies that test motivational against nonmotivational theories, will be critical in advancing the field. Only by clearly understanding the limits of motivational influences on emotion across adulthood can we fully appreciate the important role motivational processes can and do play in emotion from younger adulthood into old age.

References

Baltes, M. M., & Carstensen, L. L. (1996). The process of successful ageing. *Ageing and Society, 16*(4), 397–422.

Baltes, P. B. (1997). On the incomplete architecture of human ontogeny. *American Psychologist, 52*(4), 366–380.

Baltes, P. B., & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. *Successful Aging: Perspectives from the Behavioral Sciences, 1*, 1–34.

Blanchard-Fields, F. (2007). Everyday problem solving and emotion. *Current Directions in Psychological Science, 16*(1), 26–32.

Bradburn, N. M. (1969). *The structure of psychological well-being.* Oxford, UK: Aldine.

Bradley, M. M., & Lang, P. J. (2000). Emotion and motivation. In J. Cacioppo, L. Tassinary, & G. Berntson (Eds.), *Handbook of psychophysiology* (pp. 602–642). New York: Cambridge University Press.

Bucks, R. S., Garner, M., Tarrant, L., Bradley, B. P., & Mogg, K. (2008). Interpretation of emotionally ambiguous faces in older adults. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 63*(6), 337–343.

Cacioppo, J. T., Berntson, G. G., Bechara, A., Tranel, D., & Hawkley, L. C. (2011). Could an aging brain contribute to subjective well-being?: The value added by a social neuroscience perspective. In A. Todorov & S. Fiske (Eds.), *Social neuroscience: Toward understanding the underpinnings of the social mind* (pp. 249–262). New York: Oxford University Press.

Calder, A. J., Keane, J., Manly, T., Sprengelmeyer, R., Scott, S., Nimmo-Smith, I., et al. (2003). Facial expression recognition across the adult life span. *Neuropsychologia, 41*(2), 195–202.

Carstensen, L. L. (1992). Social and emotional patterns in adulthood: Support for socioemotional selectivity theory. *Psychology and Aging, 7*(3), 331–338.

Carstensen, L. L., & Fredrickson, B. L. (1998). Influence of HIV status and age on cognitive representations of others. *Health Psychology, 17*(6), 494–503.

Carstensen, L. L., Isaacowitz, D. M., & Charles, S. T. (1999). Taking time seriously: A theory of socioemotional selectivity. *American Psychologist, 54*(3), 165–181.

Carstensen, L. L., & Mikels, J. A. (2005). At the intersection of emotion and cognition aging and the positivity effect. *Current Directions in Psychological Science, 14*(3), 117–121.

Carstensen, L. L., Pasupathi, M., Mayr, U., & Nesselroade, J. R. (2000). Emotional experience in everyday life across the adult life span. *Journal of Personality and Social Psychology, 79*(4), 644–655.

Carstensen, L. L., Turan, B., Scheibe, S., Ram, N., Ersner-Hershfield, H., Samanez-Larkin, G. R., et al. (2011). Emotional experience improves with age: Evidence based on over 10 years of experience sampling. *Psychology and Aging, 26*(1), 21–33.

Charles, S. T. (2010). Strength and vulnerability integration: A model of emotional well-being across adulthood. *Psychological Bulletin, 136*(6), 1068–1091.

Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Aging and emotional memory: The forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General, 132*(2), 310–324.

Charles, S. T., Reynolds, C. A., & Gatz, M. (2001). Age-related differences and change in positive and negative affect over 23 years. *Journal of Personality and Social Psychology, 80*(1), 136–151.

Diener, E., Sandvik, E., & Larsen, R. J. (1985). Age and sex effects for emotional intensity. *Developmental Psychology, 21*(3), 542–546.

Diener, E., & Suh, M. E. (1998). *Subjective well-being and age: An international analysis.* New York: Springer.

Ebner, N. C., Freund, A. M., & Baltes, P. B. (2006). Developmental changes in personal goal orientation from young to late adulthood: From striving for gains to maintenance and prevention of losses. *Psychology and Aging, 21*(4), 664–678.

Ebner, N. C., He, Y., & Johnson, M. K. (2011). Age and emotion affect how we look at a face: Visual scan patterns differ for own-age versus other-age emotional faces. *Cognition and Emotion, 25*(6), 983–997.

Ebner, N. C., Johnson, M. K., & Fischer, H. (2012). Neural mechanisms of reading facial emotions in young and older adults. *Frontiers in Psychology, 3*, 223–242.

Fredrickson, B. L. (1995). Socioemotional behavior at the end of college life. *Journal of Social and Personal Relationships, 12*(2), 261–276.

Freund, A. M. (2006). Age-differential motivational consequences of optimization versus compensation focus in younger and older adults. *Psychology and Aging, 21*(2), 240–252.

Freund, A. M., & Baltes, P. B. (1998). Selection, optimization, and compensation as strategies of life management: Correlations with subjective indicators of successful aging. *Psychology and Aging, 13*(4), 531–543.

Freund, A. M., & Baltes, P. B. (2000). *The orchestration of selection, optimization and compensation: An action–theoretical conceptualization of a theory of developmental regulation.* Mahwah, NJ: Erlbaum.

Freund, A. M., & Baltes, P. B. (2002). Life-management strategies of selection, optimization and compensation: Measurement by self-report and construct validity. *Journal of Personality and Social Psychology, 82*(4), 642–662.

Fung, H. H., Carstensen, L. L., & Lang, F. R. (2001). Age-related patterns in social networks among European Americans and African Americans: Implications for socioemotional selectivity across the life span. *International Journal of Aging and Human Development, 52*(3), 185–206.

Gross, J. J., & Thompson, R. A. (2007). Emotion regulation: Conceptual foundations. In J. Gross (Ed.), *Handbook of emotion regulation* (pp. 3–24). New York: Guilford Press.

Heckhausen, J. (1997). Developmental regulation across adulthood: Primary and secondary control of age-related challenges. *Developmental Psychology, 33*(1), 176–187.

Heckhausen, J., Wrosch, C., & Schulz, R. (2010). A motivational theory of life-span development. *Psychological Review, 117*(1), 32–60.

Hess, T. M. (2006). Adaptive aspects of social cognitive functioning in adulthood: Age-related goal and knowledge influences. *Social Cognition, 24*(3), 279–309.

Hess, T. M. (2014). Selective engagement of cognitive resources: Motivational influences on older adults' cognitive functioning. *Perspectives on Psychological Science,* 9(4), 388–407.

Hess, T. M., Rosenberg, D. C., & Waters, S. J. (2001). Motivation and representational processes in adulthood: The effects of social accountability and information relevance. *Psychology and Aging, 16*(4), 629–642.

Higgins, E. T. (2000). Making a good decision: Value from fit. *American Psychologist, 55*(11), 1217–1230.

Higgins, E. T. (2005). Value from regulatory fit. *Current Directions in Psychological Science, 14*(4), 209–213.

Hutcherson, C. A., & Gross, J. J. (2011). The moral emotions: A social–functionalist account of anger, disgust, and contempt. *Journal of Personality and Social Psychology, 100*(4), 719–737.

Isaacowitz, D. M. (2006). Motivated gaze: The view from the gazer. *Current Directions in Psychological Science, 15*(2), 68–72.

Isaacowitz, D. M. (2012). Mood regulation in real time: Age differences in the role of looking. *Current Directions in Psychological Science, 21*, 237–242.

Isaacowitz, D. M., & Blanchard-Fields, F. (2012). Linking process and outcome in the study of emotion and aging. *Perspectives on Psychological Science, 7*(1), 3–17.

Isaacowitz, D. M., Livingstone, K. M., Harris, J. A., & Marcotte, S. L. (2015). Mobile eye tracking reveals little evidence for age differences in attentional selection for mood regulation. *Emotion, 15*(2), 151–161.

Isaacowitz, D. M., Löckenhoff, C., Wright, R., Sechrest, L., Riedel, R., Lane, R. A., et al. (2007). Age differences in recognition of emotion in lexical stimuli and facial expressions. *Psychology and Aging, 22*(1), 147–159.

Isaacowitz, D. M., & Smith, J. (2003). Positive and negative affect in very old age. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 58*(3), 143–152.

Isaacowitz, D. M., & Stanley, J. T. (2011). Bringing an ecological perspective to the study of aging and recognition of emotional facial expressions: Past, current, and future methods. *Journal of Nonverbal Behavior, 35*(4), 261–278.

Isaacowitz, D. M., Toner, K., Goren, D., & Wilson, H. R. (2008). Looking while unhappy: Mood-congruent gaze in young adults, positive gaze in older adults. *Psychological Science, 19*(9), 848–853.

Isaacowitz, D. M., Toner, K., & Neupert, S. D. (2009). Use of gaze for real-time mood regulation: Effects of age and attentional functioning. *Psychology and Aging, 24*(4), 989–994.

Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006). Selective preference in visual fixation away from negative images in old age?: An eye-tracking study. *Psychology and Aging, 21*(1), 40.

Johnson, D. R., & Whiting, W. L. (2013). Detecting subtle expressions: Older adults demonstrate automatic and controlled positive response bias in emotional perception. *Psychology and Aging, 28*(1), 172–178.

Keightley, M. L., Winocur, G., Burianova, H., Hongwanishkul, D., & Grady, C. L. (2006). Age effects on social cognition: Faces tell a different story. *Psychology and Aging, 21*(3), 558–572.

Kennedy, Q., Mather, M., & Carstensen, L. L. (2004). The role of motivation in the age-related positivity effect in autobiographical memory. *Psychological Science, 15*(3), 208–214.

Krendl, A. C., & Ambady, N. (2010). Older adults' decoding of emotions: Role of dynamic versus static cues and age-related cognitive decline. *Psychology and Aging, 25*(4), 788–793.

Kunzmann, U., Little, T. D., & Smith, J. (2000). Is age-related stability of subjective well-being a paradox?: Cross-sectional and longitudinal evidence from the Berlin Aging Study. *Psychology and Aging, 15*(3), 511–526.

Labouvie-Vief, G. (2003). Dynamic integration affect, cognition, and the self in adulthood. *Current Directions in Psychological Science, 12*(6), 201–206.

Lambrecht, L., Kreifelts, B., & Wildgruber, D. (2012). Age-related decrease in recognition of emotional facial and prosodic expressions. *Emotion, 12*(3), 529–539.

Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

Li, K. Z., Lindenberger, U., Freund, A. M., & Baltes, P. B. (2001). Walking while memorizing: Age-related differences in compensatory behavior. *Psychological Science, 12*(3), 230–237.

Lindenberger, U., & Mayr, U. (2014). Cognitive aging: Is there a dark side to environmental support? *Trends in Cognitive Sciences, 18*(1), 7–15.

Mather, M., Canli, T., English, T., Whitfield, S., Wais, P., Ochsner, K., et al. (2004). Amygdala responses to emotionally valenced stimuli in older and younger adults. *Psychological Science, 15*(4), 259–263.

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences,* 9(10), 496–502.

Mroczek, D. K., & Kolarz, C. M. (1998). The effect of age on positive and negative affect: A developmental perspective on happiness. *Journal of Personality and Social Psychology, 75*(5), 1333–1349.

Murphy, N. A., & Isaacowitz, D. M. (2010). Age effects and gaze patterns in recognizing emotional expressions: An in-depth look at gaze measures and covariates. *Cognition and Emotion, 24*(3), 436–452.

Murphy, N. A., Lehrfeld, J. M., & Isaacowitz, D. M. (2010). Recognition of posed and spontaneous dynamic smiles in young and older adults. *Psychology and Aging, 25*(4), 811–821.

Ngo, N., & Isaacowitz, D. (2015). Use of context in emotion perception: The role of top-down control, cue type, and perceiver's age. *Emotion, 15*(3), 292–302.

Nikitin, J., & Freund, A. M. (2011). Age and motivation predict gaze behavior for facial expressions. *Psychology and Aging, 26*(3), 695–700.

Noh, S. R., & Isaacowitz, D. M. (2013). Emotional faces in context: Age differences in recognition accuracy and scanning patterns. *Emotion, 13*(2), 238–249.

Noh, S. R., Lohani, M., & Isaacowitz, D. M. (2011). Deliberate real-time mood regulation in adulthood: The importance of age, fixation and attentional functioning. *Cognition and Emotion, 25*(6), 998–1013.

Ogilvie, D. M., Rose, K. M., & Heppen, J. B. (2001). A comparison of personal project motives in three age groups. *Basic and Applied Social Psychology, 23*(3), 207–215.

Opitz, P. C., Gross, J. J., & Urry, H. L. (2012). Selection, optimization, and compensation in the domain of emotion regulation: Applications to adolescence, older age, and major depressive disorder. *Social and Personality Psychology Compass,* 6(2), 142–155.

Orgeta, V. (2010). Effects of age and task difficulty on recognition of facial affect. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 65*(3), 323–327.

Orgeta, V., & Phillips, L. H. (2008). Effects of age and emotional intensity on the recognition of facial emotion. *Experimental Aging Research, 34*(1), 63–79.

Perera, S., Mody, S. H., Woodman, R. C., & Studenski, S. A. (2006). Meaningful change and responsiveness in common physical performance measures in older adults. *Journal of the American Geriatrics Society, 54*(5), 743–749.

Pessoa, L. (2009). How do emotion and motivation direct executive control? *Trends in Cognitive Sciences, 13*(4), 160–166.

Phillips, L. H., MacLean, R. D. J., & Allen, R. (2002). Age and the understanding of emotions: Neuropsychological and sociocognitive perspectives. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 57*(6), 526–530.

Raz, N., Lindenberger, U., Rodrigue, K. M., Kennedy, K. M., Head, D., Williamson, A., et al. (2005). Regional brain changes in aging healthy adults: General trends, individual differences and modifiers. *Cerebral Cortex, 15*(11), 1676–1689.

Richter, D., Dietzel, C., & Kunzmann, U. (2011). Age differences in emotion recognition: The task matters. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences,* 66(1), 48–55.

Rovenpor, D. R., Skogsberg, N. J., & Isaacowitz, D. M. (2013). The choices we make: An examination of situation selection in younger and older adults. *Psychology and Aging, 28*(2), 365–376.

Ruffman, T., Henry, J. D., Livingstone, V., & Phillips, L. H. (2008). A meta-analytic review of emotion recognition and aging: Implications for neuropsychological models of aging. *Neuroscience and Biobehavioral Reviews, 32*(4), 863–881.

Salthouse, T. A., Atkinson, T. M., & Berish, D. E. (2003). Executive functioning as a potential mediator of age-related cognitive decline in normal adults. *Journal of Experimental Psychology: General, 132*(4), 566–594.

Samanez-Larkin, G. R., & Carstensen, L. L. (2011). Socioemotional functioning and the aging brain. In J. Decety & J. T. Cacioppo (Eds.), *The handbook of social neuroscience* (pp. 507–521). New York: Oxford University Press.

Sasson, N. J., Pinkham, A. E., Richard, J., Hughett, P., Gur, R. E., & Gur, R. C. (2010). Controlling for response biases clarifies sex and age differences in facial affect recognition. *Journal of Nonverbal Behavior, 34*(4), 207–221.

Scheibe, S., & Blanchard-Fields, F. (2009). Effects of regulating emotions on cognitive performance: What is costly for young adults is not so costly for older adults. *Psychology and Aging, 24*(1), 217–223.

Shiota, M. N., & Levenson, R. W. (2009). Effects of aging on experimentally instructed detached reappraisal, positive reappraisal, and emotional behavior suppression. *Psychology and Aging, 24*(4), 890–900.

Stacey, C. A., & Gatz, M. (1991). Cross-sectional age differences and longitudinal change on the Bradburn Affect Balance Scale. *Journal of Gerontology, 46*(2), 76–78.

Stanley, J., & Isaacowitz, D. M. (2014). Putting emotional aging in context: Contextual influences on age-related changes in emotion regulation and recognition. In *The Oxford handbook of emotion, social cognition, and problem solving in adulthood* (pp. 99 –114). New York: Oxford University Press.

Sullivan, S., & Ruffman, T. (2004a). Emotion recognition deficits in the elderly. *International Journal of Neuroscience, 114*, 403–432.

Sullivan, S., & Ruffman, T. (2004b). Social understanding: How does it fare with advancing years? *British Journal of Psychology,* 95(1), 1–18.

Sullivan, S., Ruffman, T., & Hutton, S. B. (2007). Age differences in emotion recognition skills and the visual scanning of emotion faces. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 62*(1), 53–60.

Suzuki, A., & Akiyama, H. (2013). Cognitive aging explains age-related differences in face-based recognition of basic emotions except for anger and disgust. *Aging, Neuropsychology and Cognition, 20*(3), 253–270.

Suzuki, A., Hoshino, T., Shigemasu, K., & Kawamura, M. (2007). Decline or improvement?: Age-related differences in facial expression recognition. *Biological Psychology, 74*(1), 75–84.

Urry, H. L., & Gross, J. J. (2010). Emotion regulation in older age. *Current Directions in Psychological Science, 19*(6), 352–357.

Williams, L. M., Brown, K. J., Palmer, D., Liddell, B. J., Kemp, A. H., Olivieri, G., et al. (2006). The mellow years?: Neural basis of improving emotional stability over age. *Journal of Neuroscience, 26*(24), 6422–6430.

Wohlwill, J. F. (1970). The age variable in psychological research. *Psychological Review, 77*(1), 49.

Wong, B., Cronin-Golomb, A., & Neargarder, S. (2005). Patterns of visual scanning as predictors of emotion identification in normal aging. *Neuropsychology, 19*(6), 739–749.

Zhang, X., Fung, H. H., Stanley, J. T., Isaacowitz, D. M., & Ho, M. Y. (2013). Perspective taking in older age revisited: A motivational perspective. *Developmental Psychology, 49*(10), 1848–1858.

CHAPTER 20

EMOTIONAL DEVELOPMENT IN ADOLESCENCE

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Adolescence is a phase of the lifespan marked by dynamically changing emotional experiences, which are multiply determined by sociocultural, psychological, and neurobiological factors. Though adolescence follows childhood and precedes adulthood, it is not the case that adolescents' emotional behavior is a straightforward hybrid of earlier and younger ages. On the contrary, the emotional experiences and behaviors of adolescents are demonstrably unique. Adolescents' emotional experiences are robust and variable, emotional cues can strongly "trip up" their self-regulatory capacity, and certain contexts—most prominently, social contexts—powerfully shape adolescents' emotional experiences.

In this chapter, I highlight descriptive and empirical research that begins to characterize how adolescents' emotional experiences and behaviors are unique and the neurodevelopmental mechanisms that contribute to adolescents' unique emotions. In the first section of this chapter I consider the unique emotional landscape adolescents face, and their phenomenological experience of emotion. In the second section, I address what emotional subprocesses are dynamically changing through adolescence by highlighting empirical work that is capable of teasing apart different "ingredients" of affective experiences. In the third section, I propose a key role for brain development in "tipping" adolescents toward emotional reactivity in certain contexts.

The Emotional Landscape of Adolescence

What Is Adolescence, and How Do We Study Adolescents' Emotional Lives?

Adolescence is defined of a phase of the lifespan that begins around the transition into physical puberty and ends when an individual reaches adult-like levels of independence. As such, there are no particular ages that accurately encompass this phase of the lifespan for all individuals, and the boundary even within an individual is fuzzy at best. The earliest indicators of physical puberty occur around 10 years of age for girls and 11½ years of age for boys (Herman-Giddens et al., 1997; Herman-Giddens, Wang, & Koch, 2001), though there is substantial variability in age of onset. Whereas 18 years of age constitutes the legal definition of adulthood in the United States, the psychological endpoint of adolescence is thought to be the achievement of adult levels of independence and self-regulatory competence. The attributes that mark the achievement of the adult transition are highly dependent on culture (Arnett, 2012; Schlegel & Barry, 1991).

It should be acknowledged that research findings presented in this chapter define "adolescence" in different ways, a reflection of the struggle to place precise boundaries around this phase of the lifespan. A simple strategy is to operationalize adolescence as "the teen years" of 13–17, though scientists commonly voice the limitations of this approach and call for more sophisticated metrics that incorporate sex, hormonal changes, and other variables (Crone & Dahl, 2012). Another way of sidestepping this issue is to avoid categorical age comparisons altogether, instead measuring a wide range of ages and testing continuous linear and nonlinear models of age-related differences on the variables of interest (e.g., Somerville et al., 2013). Many research findings subdivide early and late adolescent phases given the heterogeneity of this phase of the lifespan, with pubertal hormonal being most prominent in "early" adolescence (approximately 12–14 years) and stressful transitions to independence more common in "late" adolescence (approximately 15–18 years). That said, the field is not yet sufficiently refined so as to pinpoint "early" and "late" changes in adolescent emotional processes.

Emotions have been defined as coordinated responses to salient environmental inputs that manifest at multiple levels (e.g., Scherer, 2005), including *affect* (subjective experiences of valence and arousal), *physiology* (arousal and stress responses via the peripheral nervous system), *expression* (facial, verbal, or action tendency), and in *appraisals* (cognitive evaluation of significance to self). In recent years, the coordinated nature of emotional reactions has been subject to intense debate (Barrett, 2006; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). Indeed, developmental changes in the degree of coordination itself could serve as a key mechanism underlying emotional development from childhood to adulthood. However, scant attention has been given to this issue thus far. As such, this chapter addresses the emotional challenges faced by adolescents, what is known about the development of different emotional subprocesses, the capacity to *regulate* (or alter emotional reactions once they are evoked), and the *modulatory influence* of emotion on concurrent information processing, without assuming anything about their coordination or lack thereof.

Concurrent Emotional Challenges in Adolescence

A primary feature of the adolescent transition is the need to navigate an environment that demands increasingly complex decision making and independent self-regulation. While adolescents function with more independence than they did during childhood, they must also take on more responsibilities at home, school, and in their social relationships (Larson, 2001; Spear, 2000). Yet they have a relatively shallow experience base to draw from in making independent choices, resulting in trial-and-error style navigation through complex decisions. In many cultures, concerns with academic and personal achievement become salient during this time of life as individuals face life-altering decisions concerning future educational and occupational goals (Csikszentmihalyi & Larson, 1984). Physical changes such as growth spurts, pubertal hormonal surges (Forbes & Dahl, 2010; Sisk & Zehr, 2005), and shifts in endogenous sleep patterns that "mismatch" the modern world (Peper & Dahl, 2013) are common in adolescence and can be experienced as quite stressful (Spear, 2000). Psychosocial models of adolescent development refer to these simultaneous domains of change as representing a "pileup" of emotional stressors (Petersen, 1988), highlighting the challenge adolescents face in managing concurrently changing bodies, relationships, and responsibilities.

A critical domain of change in adolescents' daily experiences is in the social realm, as adolescents strive to identify with increasingly complex and salient social groups (Pfeifer & Peake, 2012; Somerville, 2013). Adolescents spend less time with their family members than children do and more time with their peers (Barnes, Hoffman, Welte, Farrell, & Dintcheff, 2007). Family interactions are generally less warm and more prone to conflict compared with childhood (Smetana, 1995), a pattern that typically resolves into the transition out of adolescence (Steinberg, 1990). A large meta-analysis demonstrated that affective intensity is a key factor in adolescent family conflict: When family conflict occurs, it is accompanied by more intense affect in midadolescence relative to both early and late adolescence (Laursen, Coy, & Collins, 1998).

At the same time, peer groups become larger and more complex, and adolescents spend more time interacting with peers both digitally and in person (Barnes et al., 2007; Larson, 2001; Lenhart, Ling, Campbell, & Purcell, 2010) compared with childhood and adulthood. This rise in peer interaction is not unique to humans. For example, "adolescent"-age rats display a preference for social interaction (Douglas, Varlinskaya, & Speak, 2004) and spend more time engaged in social play than adult rats (Primus & Kellogg, 1989). While peer relationships become increasingly important and time-consuming in adolescence, they also tend to be unstable. Social networks fluctuate rapidly in adolescence (Cairns, Leung, Buchanan, & Cairns, 1995), thus instances of social acceptance and rejection become commonplace (Cairns et al., 1995; Wang, Iannotti, & Nansel, 2009).

Adolescents' Reported Affect

The previous section implies that adolescents' day-to-day environment is uncertain and stressful. Although the unique challenges faced by adolescents are very real, their daily reports of affect are far less extreme than the classic "storm-and-stress" stereotype (Hall, 1904) would suggest. Experience sampling studies show that adolescents report their daily affect as overall more positive than negative (as in younger and older ages; Larson, Moneta, Richards, & Wilson, 2002; Weinstein, Mermelstein, Hankin, Hedeker, & Flay, 2007). However, the frequency of positive affect over a given week reduces from early- to midadolescence (Larson et al., 2002; Weinstein et al., 2007) while the frequency of negative affect sharply rises from preadolescence to midadolescence (Larson et al., 2002). Furthermore, adolescents' daily affect fluctuates more in midadolescence compared with preadolescence (Rutter, Graham, Chadwick, & Yule, 1976), as indicated by greater cross-measurement variance in experience sampling over a 1-week period (Larson et al., 2002).

The social context is highly evocative of emotion during adolescence, with concern over social evaluation rising sharply from childhood (Westenberg, Drewes, Goedhart, Siebelink, & Treffers, 2004). Adolescents more frequently interpret themselves as being the target of social evaluation (leading to such phenomena as the *imaginary audience*; Elkind & Bowen, 1979), and reported daily self-conscious emotion reaches peak levels (Rankin, Lane, Gibbons, & Gerrard, 2004). As such, social feedback and perceived instances of social evaluation are thought to be a potent antecedent to both positive and negative affect in adolescence (Somerville, 2013), a possibility that is explored in detail in the next section.

During adolescence, emotional disturbances (e.g., Kring, 2008) also manifest in rapidly rising incidence of psychopathology. Epidemiological studies indicate that over half of lifetime cases of mood, anxiety, conduct, and substance abuse disorders are identified by midadolescence, and adolescence is the most common stage of development to initially present with depression and anxiety disorders (Beesdo, Knappe, & Pine, 2009; Burke, Burke, Regier, & Rae, 1990; Costello, Mustillo, Erkanli, Keeler, & Angold, 2003; Kandel & Davies, 1982; Kessler et al., 2005). Furthermore, individuals who show an onset of clinical and subclinical symptoms of psychopathology in adolescence have greater severity and chronicity of psychopathology across the lifespan (Hofstra, van der Ende, & Verhulst, 2002; Pine, Cohen, Gurley, Brook, & Ma, 1998).

Subclinical emotional disturbances are alarmingly common in adolescence as well. The Youth Risk Behavior Survey (YRBS; Eaton et al., 2008), a large-scale survey of health risk behaviors in adolescents, found that in the prior year, more than one in four adolescents (27.3%) had experienced significant symptoms of depression for at least 2 weeks, to the point that it interfered with his or her everyday functioning. Because adolescence represents a unique phase of simultaneous vulnerability for emotional disturbance and developmental malleability to intervention and training, clinical science has taken a keen interest in leveraging the plasticity of neurodevelopmental and behavioral change to target adolescent-specific interventions that could ultimately improve lifelong health (see Steinberg et al., 2006, for further discussion).

The Development of Emotional Subprocesses in Adolescence

At any given moment, an emotional state is a product of the psychological and physiological processes that generate an emotional response, and that contextualize, regulate, or otherwise alter such responses. Metaphorically speaking, is the emotional "temperature" of adolescence higher due to differences in "heating" (emotional reactivity), "cooling" (regulation), or both? When emotional reactivity and regulatory demands come into conflict, which ultimately guides behaviors and choices? A new wave of experimental research has begun to tease apart the developmental changes in emotional subprocesses that contribute to these behavioral tendencies. Together, these studies suggest that under some contexts, adolescents evoke exaggerated emotional reactivity patterns, which are paired with a still-maturing regulatory capacity. These behavioral patterns are paralleled by dynamic trajectories of brain development through this stage of life. Overall, this work supports the notion that dynamic interactions among emotional subprocesses give rise to unique emotional response profiles in adolescence.

Emotional Reactivity

How do adolescents react to emotional provocation? For the few studies that measure "pure" emotional reactivity (in the absence of competing or regulatory demands), the emerging answer appears to be "It depends what the provocation is, and how you measure it." Self-report studies have probed whether subjective affect (such as the strength of negative affect) differs in children, adolescents, and adults in response to passively viewing negative International Affective Picture System (IAPS) pictures (Lang, Bradley, & Cuthbert, 2008). The results of multiple studies have demonstrated that affective self-report measures of "reactivity" to negative images are comparable when comparing adolescents with individuals of older and younger ages (McRae et al., 2012; Silvers et al., 2012).

These findings contrast with measurements of adolescents' affective reactions within the social context. As stated earlier, social relations take on prime importance during adolescence. In response to laboratory manipulations designed to deliver supposedly genuine social acceptance and rejection cues, adolescents experience a greater drop in self-reported mood and greater increase in anxiety than adults do when excluded from a virtual ball-tossing game with a supposed peer (Sebastian, Viding, Williams, & Blakemore, 2010), and a greater self-reported increase in mood when receiving socially accepting feedback from a desirable peer (Guyer, Choate, Pine, & Nelson, 2012). Further, Silk and colleagues (2012) used eye tracking—an indirect measure of salience processing—to target implicit emotional and motivational responses to being accepted or rejected by peers for an online chat. Although all participants (9–17 years) showed a pupil difference to rejecting compared with accepting trials, this response was exaggerated in older adolescents. Further, heightened pupillary responses to rejecting social feedback predicted less connectedness in participants' real-life social relationships. Thus, new evidence is mounting to suggest that receiving social feedback elicits exaggerated positive and negative affective reactions in adolescents.

A related issue is whether the simple act of *being evaluated* is sufficient to generate strong emotional reactions in adolescents. Adolescents who underwent the Trier Social Stress Test (a laboratory-based social evaluative battery) experienced a greater release of cortisol (a potent stress hormone and index of hypothalamic–pituitary–adrenal [HPA] axis reactivity) compared with adults and preadolescents (Gunnar, Wewerka, Frenn, Long, & Griggs, 2009). Further, social conditions sufficient to evoke strong emotion in adolescents are quite minimal; a recent study (Somerville et al., 2013) demonstrated that merely being looked at by a peer yielded a rise in self-conscious affect (peaking at age 16) and autonomic nervous system arousal (peaking at age 14) as measured by skin conductance response (Dawson, Schell, & Filion, 2001). These findings indicate that the social environment is a potent emotional context for adolescents, who show exaggerated subjective affect and biological markers of affective response to overt feedback and even to simply being evaluated. This work is highly relevant to translational goals of determining the causes of, and potential interventions for, links among ostracism, symptoms of depression, and risk of suicide, particularly among adolescent girls (Hall-Lande, Eisenberg, Christenson, & Neumark-Sztainer, 2007; Lewinsohn et al., 1994).

Emotion Regulation

Classic research from cognitive development suggests that cognitive regulatory capacity continues to improve from childhood to adulthood in a progressive fashion (Davidson, Amso, Anderson, & Diamond, 2006; De Luca et al., 2003; Huizinga, Dolan, & van der Molen, 2006). Given that emotion regulation scaffolds on cognitive regulation, one might expect that from childhood through adolescence and into adulthood, the capacity to effectively engage emotion regulation continues to improve, a topic of recent study.

Reappraisal is a form of emotion regulation whereby an individual attempts to alter the meaning of an emotional cue through cognitive reinterpretation. Greater reductions in negative affect are observed after reappraisal than other emotion regulation techniques (Gross, 1998, 2002), indicating that reappraisal is a particularly effective form of emotion regulation. Reappraisal relies on numerous, complex cognitive processes, including working memory, abstract reasoning, and response selection (Ochsner & Gross, 2005). This has led scientists to speculate that reappraisal ability might be a late-developing psychological capability that contributes to adolescents' emotional reactivity (Silvers et al., 2012). Indeed, though adolescents make use of this regulation technique more effectively than children (Williams & McGillicuddy-De Lisi, 1999), they utilize reappraisal strategies in their daily lives less frequently than adults do (Garnefski, Legerstee, Kraaij, Van Den Kommer, & Teerds, 2002).

Silvers and colleagues (2012) asked 10- to 22-year-old participants to view negatively valenced images and reappraise their reaction to them so as to reduce their negative impact. Results showed robust age differences in the efficacy of reappraisal in reducing negative affect relative to a passive viewing condition, with increasing age predicting greater regulatory success. This finding is consistent with results of a similar study undertaken in the functional magnetic resonance imaging (fMRI) environment (McRae et al., 2012). Intriguingly, adolescents' reappraisal capacity was selectively worse for images depicting negative social interactions and social suffering (Silvers et al., 2012). This reduction was not observed for younger or older ages, suggesting that reappraisal might be especially challenged by potent social cues during adolescence.

Influence of Emotion on Cognition

Emotional content can modulate numerous cognitive processes, including memory, attention, and cognitive control. Experimental approaches in the cognitive tradition test the extent to which emotional cues modulate cognitive processes (e.g., cognition–emotion interactions) with differential strength across developmental stage. Taken together, this work demonstrates that adolescents' cognitive capacity is especially perturbed by emotional information, though the outcome of cognition–emotion interactions depends heavily on the context in which emotional cues are introduced.

We all know how difficult it is to ignore emotional cues: Imagine trying to focus on reading at a café while a patron is laughing or crying at a neighboring table. In this scenario, the presence of emotional cues captures attentional resources (Easterbrook, 1959; Fox, Russo, Bowles, & Dutton, 2001), selectively interrupting performance on a separate task. How capable are adolescents of disengaging from irrelevant emotional information to complete a primary task?

Cohen-Gilbert and Thomas (2013) asked children, adolescents, and adults to complete a go/no-go task where participants viewed rapidly presented target cues, and were to respond with a button press to a frequent go target, and withhold that response from a rare no-go target. For some trials, the screen backgrounds incidentally depicted arousing positive and negative images, while in others the background depicted a scrambled image. Task performance in the scrambled condition steadily improved across adolescence, consistent with the notion that behavioral regulation continues to improve during this time of life. However, task performance was disproportionally impaired in early adolescents (13- to 14-year-olds) when negative images served as backgrounds, relative to other ages and relative to their own performance on the neutral background trials. Similarly, adolescents show exaggerated response slowing while making physical judgments of faces posing fear relative to no expression (Monk et al., 2003), while detecting fearful relative to neutral target stimuli (Hare et al., 2008), and in a flanker task with fearful face distractors (Grose-Fifer, Rodrigues, Hoover, & Zottoli, 2013). These findings suggest that emotional distractors (in this case, negatively valenced ones) can inordinately disrupt performance on simple cognitive tasks in adolescence more than in earlier and later ages.

A related but distinct form of cognitive–emotion interaction entails placing the emotional content as the *target* of control. The emotional go/no-go task quantifies the relative influence of emotional content on the capacity to flexibly approach and withhold behavioral responses (Tottenham, Hare, & Casey, 2011). Of particular interest are differential commission rates (failing to withhold a response) depending on the emotional qualities of the stimulus. Are adolescents less capable of stopping themselves when a stimulus holds affective value? A study comparing children, adolescents, and adults found that adolescents were selectively worse than both children and adults at withholding a response toward emotionally arousing happy faces relative to emotionally neutral faces (Somerville, Hare, & Casey, 2011;, see Figure 20.1). Preliminary findings also show that emotion-impaired impulse control in adolescents might also be evident for fearful facial expressions (Dreyfuss, Caudle, Drysdale, Johnston, Cohen, et al., 2014), suggesting that it is perhaps the arousal value (rather than positive valence per se) that interferes with adolescents' reduced regulatory capacity.

These findings indicate that emotional content is particularly disruptive to cognitive performance when emotional information is (1) a distractor, or (2) the target of regulatory demand. However, an intriguing line of research suggests that adolescents' sensitivity to affectively salient cues can be "flipped" to selectively *improve* regulatory capacity in adolescents—that is, the promise of an affec-

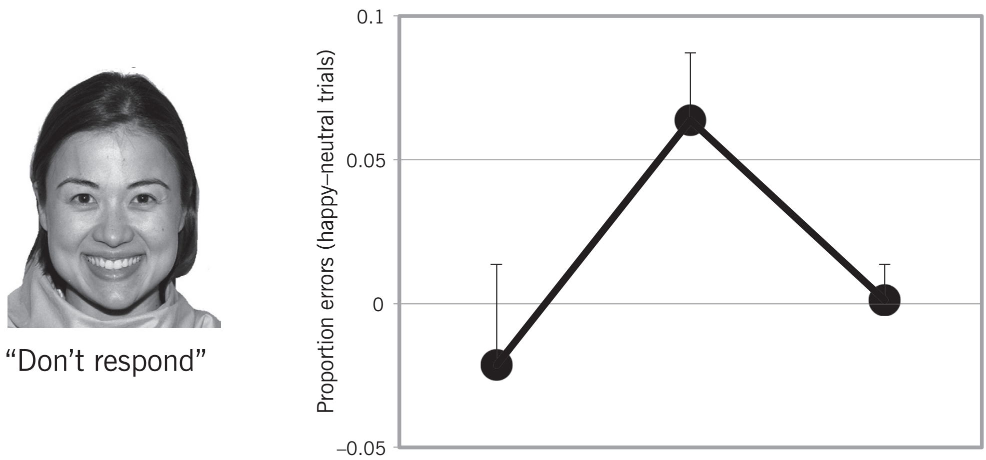

FIGURE 20.1. (*Left*) Sample "emotion no-go" trial from emotional go/no-go task. Participants view faces depicting emotional or neutral expressions and are instructed at the beginning of a task block to respond to ("go"), or withhold a response from ("no-go"), a face stimuli depending on the expression. (*Right*) False-alarm rates for emotional relative to neutral no-go trials. Adolescents were selectively impaired at withholding a response to arousing, happy faces relative to neutral faces as compared with children and adults.

tively salient *outcome* (such as monetary reward) results in a greater boost of cognitive regulation in adolescents than adults (Geier, Terwilliger, Teslovich, Velanova, & Luna, 2010; Hardin, Pine, & Ernst, 2009; Jazbec et al., 2006; Kohls, Petzler, Hepertz-Dahlmann, & Konrad, 2009; Padmanabhan, Geier, Ordaz, Teslovich, & Luna, 2011; see Somerville & Casey, 2010, for further discussion of this issue).

These findings underscore the notion that interactions between regulatory demands and affective/motivational load are highly context dependent. Overall, adolescents' regulatory capacity is especially swayed by emotional content. This can result in selectively disrupted or improved performance, depending on the contextual positioning of the affective information—as distractor, target, or outcome.

Decisions and Risk

A final line of work in this domain concerns whether emotional factors modulate adolescents' decision making. This research is motivated by alarming health statistics indicating that the top four causes of adolescent mortality are preventable (Eaton et al., 2008), and partially result from the dire outcomes of suboptimal decision making (Casey & Caudle, 2013; Steinberg, 2004). In particular, adolescents engage in significantly more risky driving, illicit drug use, criminal acts, and unsafe sexual behavior than children and adults (National Research Council, 2007; Substance Abuse and Mental Health Services Administration, 2007).

Intriguingly, adolescent risky decision making does not appear to be a product of lacking information about risk, poorly estimating risk, or lacking the capacity to make calculated decisions involving risk (Reyna & Farley, 2006). Further, although adolescents experience more freedom and less supervision by parents, risky decision making cannot solely be explained by greater access to risk-enabling situations, as an orientation toward risk can also be elicited in controlled laboratory settings and in animal models. Thus, researchers have sought more nuanced psychological explanations for adolescents' propensity toward risk. This work has indicated that emotional factors, including a motivation toward arousing and novel experiences, paired with contextual factors, play a key role in the uptick of risky behavior in adolescence (Albert, Chein, & Steinberg, 2013).

Sensation Seeking

Sensation seeking is a key psychological variable that plays an important role in adolescent risk taking. Sensation seeking is defined as the motivation to seek out complex, novel, and arousing experiences; adolescents endorse greater sensation-seeking motivation than adults do (Zuckerman, Eysenck, & Eysenck, 1978). Animal models of adolescence support this conception. A variety of behavioral indices of novelty seeking and risk-taking behavior reveal that "adolescent"-age rodents exhibit greater novelty seeking, reduced behavioral markers of anxiety to novelty, greater willingness to engage in "extreme" behavior, and more risky actions in navigation-based assays such as the elevated plus maze (see Laviola, Macri, Morley-Fletcher, & Adriani, 2003, for a review). Orientation toward novelty seeking could represent an advantageous mode of interacting with the environment during adolescence from an evolutionary perspective, given the heightened demands on adolescents to find novel territories, mates, and resources (Doremus-Fitzwater, Varlinskaya, & Spear, 2010; Ellis et al., 2012; Spear, 2000).

In addition to sensation seeking, one can examine the extent to which adolescents utilize emotionally relevant information (concerning the gain and loss of resources) in decision making. Cauffman and colleagues (2010) used the Iowa Gambling Task to quantify approach- and avoidance-based decision making in children, adolescents, and young adults. Using experimenter feedback to learn to approach "good" decks of cards (positive feedback) and avoid "bad" decks (negative feedback), experimenters measured participants' tendency to make decisions based on seeking reward and avoiding punishment. They found that levels of approach toward potential reward took on a curvilinear function, with the maximal sensitivity to positive feedback occurring during the adolescent years. In contrast, use of negative feedback to avoid negative outcomes strengthened with age in a linear fashion, not showing full maturity until the adult years. These findings suggest that adolescents have a disproportionate approach orientation, paired with a still-maturing avoidance orientation, which could strongly propel adolescents toward risky choices.

Decision Making in Affectively Charged Contexts

Recent work has highlighted the selectivity of risky behavior in adolescents. Though adolescents display an orientation toward novelty and sensation seeking, adolescents do not reveal these tendencies in all situations, leading some studies to find no evidence for risky decision making in adolescents (e.g., Van Leijenhorst, Westenberg, & Crone, 2008). This has led scientists to identify the particular contexts in which adolescents' decision-making capacity is swayed toward risk, focusing on (1) arousing or exciting contexts and (2) social contexts.

One task that can capture decision making in affectively "hot" relative to "cold" contexts is the Columbia Card Task, a risky decision-making task in which participants make odds-based gambling decisions in cold contexts that are designed to encourage deliberative decision making, or hot contexts with high emotional arousal (Figner, Mackinlay, Wilkening, & Weber, 2009). Adolescents showed greater risky decision making than children and adults, but selectively in the arousing hot context (Figner et al., 2009). Within the hot contexts, adolescents tended to disregard the information about the odds of gain and loss and report greater reliance on "gut-level" and "excitement" cues to shape their choices (ultimately impairing their performance more than younger and older ages). These findings and others (Burnett, Bault, Coricelli, & Blakemore, 2010; van Duijvenvoorde, Jansen, Visser, & Huizenga, 2010) support the notion that contexts with heightened arousal or salience selectively push adolescents' decision making toward riskiness. This conclusion mirrors adolescent risk taking in the real world, which often occurs in thrilling, exciting contexts (Casey & Caudle, 2013).

The social context can also propel adolescents' decision making in the direction of risk. Adolescents are more likely to make dangerous moves behind the wheel of a car in the presence of peers (Simons-Morton, Lerner, & Singer, 2005), and crime statistics indicate that adolescents are more prone to deviant behavior when with others than when alone (Zimring, 1998). The tendency to engage in risky choices in social contexts is also observed in the laboratory using simulated driving tasks (Chein, Albert, O'Brien, Uckert, & Steinberg, 2011; Gardner & Steinberg, 2005) and delay discounting tasks (O'Brien, Albert, Chein, & Steinberg, 2011; Weigard, Chein, Albert, Smith, & Steinberg, 2014; see Albert et al., 2013, for further discussion). There are many potential mechanisms underlying peer influence, including enhanced desire for impression management, peers introducing a "cognitive load," the capacity for peers to shift orientation toward reward (e.g., Chein et al., 2011), and heightened physiological and emotional arousal around peers and in contexts of peer evaluation (e.g., Somerville et al., 2013). Though the phenomenon of peer influence on adolescent risk taking is evident, more work is needed to clarify the underlying psychological mechanisms of peer influence.

Individual Differences Stratify during Adolescence: The Case of Developmental Timing

Though emotional responses are subject to individual differences at all points in the lifespan, variability seems to be particularly pronounced during adolescence. To take one example, a recent paper reported scatter plots for 9- to 22-year-olds' subjective, physiological, and neural reactivity patterns to being looked at by a supposed peer (Somerville et al., 2013). In all three graphs, the response variability stratifies during the adolescent years relative to earlier and younger ages. Why might this be? One critical factor is developmental timing, as age is a limited proxy for actual developmental stage. The onset of physical puberty varies across individuals as much as 4–5 years, with females tending to initiate puberty earlier than males. Widespread hormonal and neurodevelopmental changes underlying physical puberty sensitize physiological reactivity to stressors (Gunnar et al., 2009; Romeo, 2010), suggesting that some aspects of affective responding are more dependent on pubertal-dependent mechanisms than age-dependent mechanisms. In addition, early puberty can become an antecedent to emotional difficulties, as early puberty in females (relative to one's peers) predicts psychosocial difficulties during adolescence, risk for psychopathology, and delinquent behavior (Ge, Rand, & Elder, 1996). Therefore, developmental timing interacts with emotional functioning in complex ways during adolescence. Fortunately, the field is experiencing a surge of interest in teasing apart age- or experience-dependent mechanisms from pubertal-dependent mechanisms of adolescent emotional development (e.g., Crone & Dahl, 2012), which will lead to a more complete understanding of sources of variability in adolescent emotional response.

Neurodevelopmental Mechanisms of Adolescent Emotional Behavior

What role does the developing brain play in shaping adolescents' emotional experiences? In recent years, research has begun to uncover the unique biological contributions to adolescent emotional behavior. Key properties of brain development through adolescence (and hormonal fluctuations that influence brain function) are thought to play a mediating role in adolescents' propensity for frequent and intense emotional reactions, and for the influence of emotion on cognitive and decision-making behavior.

This theoretical framework stems from neurobiological models of the neural circuits that subserve valuation and regulation signals. In the past two decades, advances in neuroscientific tools have enabled a precise characterization of the neural systems that subserve affective processes, regulatory processes, and interactions between them that ultimately shape affective and behavioral outcomes. As such, measurements of brain development and brain function can offer insight into the constituent and interacting roles of emotion-generative and emotion regulatory processes in shaping adolescent emotional behavior.

Though the human brain reaches 95% of its adult size by middle childhood, the structure and function of the brain continue to change dynamically throughout adolescence and young adulthood. A key principle of neurodevelopment is that functionally distinct neural systems reach maturity in a staggered fashion. For instance, sensory and motor circuits undergo rapid development in infancy and toddlerhood, supporting the key environmental demands of this time of life (navigation, perception, learning), whereas other networks, including circuitry that supports inhibitory control and abstract reasoning, undergo major developmental refinement at a much later point (Casey, Galvan, & Hare, 2005).

This principle of staggered emergence of neurocircuitry can partially account for adolescents' propensity to emotional reactivity relative to both younger and older ages (Somerville & Casey, 2010; Somerville, Jones, & Casey, 2010). On one hand, brain circuitry that supports emotional and cognitive regulation is thought to be among the "final frontiers" of neurodevelopment, and continues to develop linearly throughout adolescence into early adulthood. On the other hand, brain circuitry that supports emotion- (and motivation-) generative processes is (1) largely structurally mature; and (2) functionally sensitized, due in part to pubertal modulation of neurotransmitter systems that affect brain function uniquely in adolescence (Figure 20.2). The combination of sensitized emotion-generative and intermediate emotion regulatory processes is thought to represent a developmentally normative "imbalance" within neural systems that could lead to a heightened influence of emotional processes on affective behavior and decisions. This

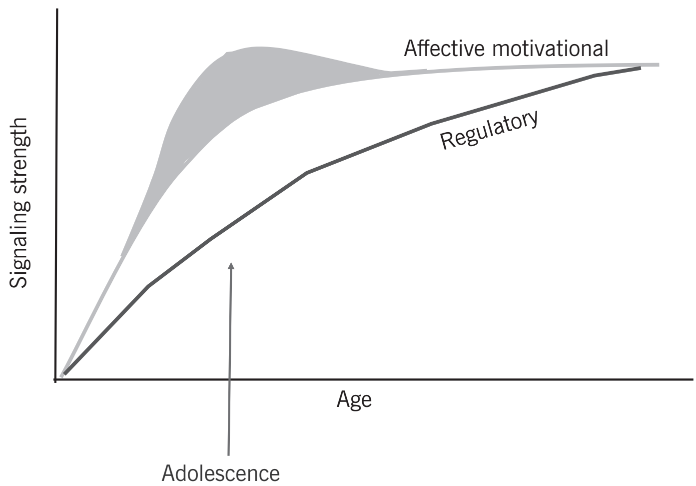

FIGURE 20.2. Cartoon diagram of "staggered emergence" hypothesis of adolescent emotional sensitivity. Early maturation of subcortical limbic regions such as the amygdala and ventral striatum (gray line) and functional sensitization (gray shaded area), combined with late maturation of regulatory strength subserved by the prefrontal cortex (black line), predicts a nonlinear enhancement in affectively driven behavior during adolescence.

framework distinguishes adolescents' brain function from both *adults*, who have mature regulatory capacity and less sensitized emotion-generative function, and *children*, who lack mature regulatory capacity but do not have such strong input from emotion-generative circuitry.

Similar versions of this framework have been put forth by various research teams (Ernst, Pine, & Hardin, 2006; Geier & Luna, 2009; Somerville et al., 2010; Steinberg, 2008; see Casey, 2015, for a discussion of differences among models). Though criticized for oversimplicity (Crone & Dahl, 2012) and for somewhat inexact neural hypothesis (Pfeifer & Allen, 2012), the staggered emergence or "imbalance" framework has received support from rodent, primate, and human data and presently represents a dominant viewpoint among the neurodevelopmental community.

Complex emotional behavior relies on interactions across a widespread network of brain structures (Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012). Due to the youth of the field, developmental models currently lack a comprehensive understanding of the full-scale network interactions that change across adolescence. A more common (albeit limited) approach thus far has been to pinpoint the structural or functional differences across development in particular subparts of emotion networks. As such, this discussion is inherently limited in addressing large-scale, network-based neurodevelopment (though it should be noted that domains of cognitive development have incorporated a sophisticated network-based developmental approach (Fair et al., 2007; Schlaggar et al., 2002). The next section briefly introduces three brain structures whose dynamic interactions are thought to uniquely influence the interaction among emotional, motivated, and regulatory behaviors in adolescence.

The Ventral Striatum

One critical player in this circuitry is the ventral striatum, a portion of the basal ganglia that contains the nucleus accumbens (NAc). The NAc contributes to decision-making behavior by signaling the anticipation and attainment of rewards, and serves to influence motivated behavior via connections with the prefrontal cortex (Cardinal, Parkinson, Hall, & Everitt, 2002; Delgado, 2007; Schultz, 2006).

Numerous studies have examined neural activity in response to the receipt or loss of monetary incentive or prizes. These studies show that the magnitude of neural response in the ventral striatum is exaggerated in adolescents as compared with children and adults (Cohen et al., 2010; Ernst et al., 2005; Galvan et al., 2006; Van Leijenhorst et al., 2010), and after pubertal onset relative to just before (Pfeifer et al., 2011). There is strong evidence from animal models to suggest that signals of the dopaminergic neurotransmitter system are sensitized in adolescence, a finding that specifies a key mechanism underlying the functional sensitization of the ventral striatum during this phase of life (see Spear, 2000; Ernst, Romeo, & Andersen, 2009, for a review).

The Prefrontal Cortex

Second, the prefrontal cortex has been implicated in wide-serving cognitive functions, including the implementation of cognitive control, regulation of emotion, decision making, and complex cognition (Casey et al., 2005; Miller & Cohen, 2001; Ochsner & Gross, 2005). Regions of the prefrontal cortex continue to reach structural and functional maturity throughout the adolescent years (Shaw, Kabani, Lerch, Eckstrand, Lenroot, et al., 2008; Somerville et al., 2011), and the connections between subcortical and cortical structures continue to strengthen (e.g., Asato, Terwilliger, Woo, & Luna, 2010; Liston, Watts, Tottenham, Davidson, Niogi, et al., 2006). As such, the final frontal maturational events that take place during adolescence are thought to limit the strength and efficiency of regulatory behavior, including emotion regulation. Brain imaging studies have shown that less robust regulatory signaling from the prefrontal cortex in adolescents parallels worse performance on a number of inhibitory control tasks, supporting the idea that functional maturity of the prefrontal cortex is a key factor in the ability to exert cognitive (and likely emotional) control (Luna et al., 2001; Rubia et al., 2006).

The Amygdala

Finally, the amygdaloid complex, bilateral clusters of nuclei situated in the medial temporal lobe, plays a critical role in processing information of biological significance (Aggleton, 2000; Davis & Whalen, 2001; LeDoux, 2000), including emotionally evocative stimuli, potential threats, and cues depicting the emotional states of conspecifics. A growing number of studies are reporting that the amygdala response to salient information is exaggerated in adolescents relative to children (Hare et al., 2008) and adults (Guyer, Monk, McClure-Tone, Nelson, Roberson-Nay, et al., 2008; Hare et al., 2008; Monk et al., 2003; Williams, Brown, Palmer, Liddell, Kemp, et al., 2006; see Somerville, Fani, & McClure-Tone, 2011, for a review). Further, these effects are influenced by pubertal development. Longitudinal investigations have demonstrated that the amygdala and prefrontal cortex response while viewing sad facial expressions (but not other expressions) is significantly greater after pubertal onset than just prior (Moore, Pfeifer, Masten, Mazziotta, Iacoboni, et al., 2012). Together, these studies suggest that emotionally salient stimuli recruit a stronger amygdala response in adolescents, perhaps reflecting their social communication value during a time of life characterized by social reorientation (Crone & Dahl, 2012; Nelson, Leibenluft, McClure, & Pine, 2005). However, rodent research is mixed with regard to how amygdala function differs in adolescence relative to childhood and adulthood (see Spear, 2011, for an alternative view).

From the Brain Back to Emotional Behavior

Based on the available evidence, it is clear that adolescent brain function is unique in its combination of (1) exaggerated incentive-based responding in the ventral striatum, (2) intermediate regulatory capacity via the continually developing prefrontal cortex, and (3) a possibly exaggerated amygdala response to affectively salient cues. What are the consequences of the functional "imbalance" just described for adolescents' emotional experiences and behavior? Returning to the temperature metaphor, one possibility is a combination of both "overheating" and "undercooling."

Risk-taking behavior is thought to emerge, in part, due to the capacity for strong-signaling regions of the striatum that code motivation and learning about potential rewards to "override" regulatory capacity in adolescence. In other words, the adolescent brain is thought to deliver a motivational push toward novel, exciting, and potentially rewarding situations. Such an explanation is bolstered by experimental studies simultaneously measuring behavioral performance and brain activity. For instance, failing to withhold a button response to arousing happy faces in adolescence was paralleled by exaggerated ventral striatal responding and exaggerated striatocortical functional connectivity (Somerville et al., 2011). In addition, adolescents demonstrated unique patterns of interactions between the ventral striatum and prefrontal cortex while "working for a reward" (Geier et al., 2010), and correlational evidence links ventral striatal reactivity to a monetary reward and a tendency to take risks in the real world (Galvan, Hare, Voss, Glover, & Casey, 2007). Ventral striatal responding is also exaggerated in adolescents while making risky decisions around peers compared with making similar decisions when alone (Chein et al., 2011), suggesting that arousing peer contexts might trigger a hyperreactive incentive–motivation system and promote risky decisions.

Studies involving the processing of aversive stimuli suggest that adolescents' proneness to emotional interference might arise from exaggerated salience-detection responses. For instance, Hare and colleagues (2008) demonstrated that the amygdala response to fearful faces was exaggerated in adolescents relative to children and adults, and predicted an exaggerated response slowing to fearful faces. More work is required to determine (1) whether salience processing systems of the brain are hypersensitive in adolescence, and (2) what kind of influence they might have on the day-to-day emotional functioning of adolescents. The relationships among brain function in adolescence, daily moods, and subjective affect are largely unknown, due to an extreme dearth of data that sample subjective affect and brain activity, paired with an inability to leverage animal models.

Finally, one can consider whether a still-maturing prefrontal cortex can accomplish emotion regulation as flexibly and effectively as adults can. Recall that behavioral studies of reappraisal indicated that adolescents were less effective than adults at leveraging reappraisal techniques to reduce negative affect (Garnefski et al., 2002; Silvers et al., 2012). McRae and colleagues (2012) observed that adolescents recruited the lateral prefrontal cortex more than children, but less than adults, while engaging in effortful reappraisal of negative images. This finding is consistent with the interpretation that the continuing maturation of the prefrontal cortex might constrain the effectiveness of reappraisal on decreasing negative affect. More work that incorporates subjective reports of regulatory success is needed to better understand the consequences of brain development on this component of emotional behavior.

Conclusions

The aim of understanding emotional development in adolescence and its neurodevelopmental mechanisms is manifold. Through this research, scientists can simultaneously shed light on the psychological development of emotion subprocesses, the fundamental functional properties of brain circuits and their links with emotional behavior, and the fundamental principles and trajectories of neurodevelopment.

Adolescents' emotional experiences differ from older and younger ages in various ways. Their affective states are frequent and intense. The social context is a primary arena in which adolescents exhibit strong affective reactions. In addition, they are at risk for deleterious outcomes of emotional reactivity, including suboptimal decision making in emotionally heated contexts and vulnerability for impairing clinical and subclinical emotional disturbances. Adolescents' cognition and decision-making behavior is prone to emotional influence, and this influence is particularly robust in emotionally charged and social contexts. These patterns reflect the multitude of changes that take place in adolescence ranging from hormonal to physical to psychosocial, to the changing goals that adolescents must learn to achieve with less "regulatory input" from authority figures.

Trajectories of brain maturation contribute to emotional reactivity in adolescence, although a comprehensive and precise model remains a work in progress. Tuning of brain circuitry underlying emotion reactivity and regulation reflects experience-dependent maturation that results from many causes, including normative hormonal shifts and adolescents interacting with their environments. Thus, developmental differences reported here should not be pathologized or interpreted as adolescent deficiencies. Despite the fundamental importance of this developmental phase, the majority of neurobehavioral findings reported here have emerged within the past decade. With a greater volume of comprehensive and careful empirical research, this area will continue to advance toward the dual objective of advancing theory and empirical understand of emotional processes, and translating these findings in ways that improve adolescent health.

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References

Aggleton, J. P. (2000). *The amygdala: A functional analysis*. New York: Oxford University Press.

Albert, D., Chein, J., & Steinberg, L. (2013). The teenage brain: Peer influences on adolescent descision making. *Current Directions in Psychological Science, 22*(2), 114–120.

Arnett, J. J. (2012). *Adolescence and emerging adulthood: A cultural approach, fifth edition*. New York: Pearson.

Asato, M. R., Terwilliger, R., Woo, J., & Luna, B. (2010). White matter development in adolescence: A DTI study. *Cerebral Cortex, 20*(9), 2122–2131.

Barnes, G. M., Hoffman, J. H., Welte, J. W., Farrell, M. P., & Dintcheff, B. A. (2007). Adolescents' time use: Effects of substance use, delinquency and sexual activity. *Journal of Youth and Adolescence, 36*, 697–710.

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science, 1*(1), 28–58.

Beesdo, K., Knappe, S., & Pine, D. S. (2009). Anxiety and anxiety disorders in children and adolescents: Developmental issues and implications for DSM-V. *Psychiatric Clinics of North America, 32*(3), 483–524.

Burke, K., Burke, J. D., Regier, D. A., & Rae, D. S. (1990). Age at onset of selected mental disorders in five community populations. *Archives of General Psychiatry, 47*(6), 511–518.

Burnett, S., Bault, N., Coricelli, G., & Blakemore, S.-J. (2010). Adolescents' heightened risk-seeking in a probabilistic gambling task. *Cognitive Development, 25*(2), 183–196.

Cairns, R. B., Leung, M.-C., Buchanan, L., & Cairns, B. D. (1995). Friendships and social networks in childhood and adolescence: Fluidity, reliability, and interrelations. *Child Development, 66*, 1330–1345.

Cardinal, R. N., Parkinson, J. A., Hall, J., & Everitt, B. J. (2002). Emotion and motivation: the role of the amygdala, ventral striatum, and prefrontal. *Neuroscience and Biobehavioral Reviews, 26*(3), 321–352.

Casey, B. J. (2015). Beyond simple models of self-control to circuit-based accounts of adolescent behavior. *Annual Review of Psychology, 66*, 295–319.

Casey, B. J., & Caudle, K. (2013). The teenage brain: Self control. *Current Directions in Psychological Science, 22*(2), 82–87.

Casey, B. J., Galvan, A., & Hare, T. A. (2005). Changes in cerebral functional organization during cognitive development. *Current Opinion in Neurobiology, 15*(2), 239–244.

Cauffman, E., Shulman, E. P., Steinberg, L., Claus, E., Banich, M. T., Graham, S. J., et al. (2010). Age differences in affective decision making as indexed by performance on the Iowa Gambling Task. *Developmental Psychology, 46*(1), 193–207.

Chein, J., Albert, D., O'Brien, L., Uckert, K., & Steinberg, L. (2011). Peers increase adolescent risk taking by enhancing activity in the brain's reward circuitry. *Developmental Science, 14*(2), F1–F10.

Cohen, J. R., Asarnow, R. F., Sabb, F. W., Bilder, R. M., Bookheimer, S. Y., Knowlton, B. J., et al. (2010). A unique adolescent response to reward prediction errors. *Nature Neuroscience, 13*(6), 669–671.

Cohen-Gilbert, J. E., & Thomas, K. M. (2013). Inhibitory control during emotional distraction across adolescence and early adulthood. *Child Development, 84*(6), 1954–1966.

Costello, E. J., Mustillo, S., Erkanli, A., Keeler, G., & Angold, A. (2003). Prevalence and development of psychiatric disorders in childhood and adolescence. *Archives of General Psychiatry, 60*(8), 837–844.

Crone, E. A., & Dahl, R. E. (2012). Understanding adolescence as a period of social–affective engagement and goal flexibility. *Nature Reviews Neuroscience, 13*(9), 636–650.

Csikszentmihalyi, M., & Larson, R. (1984). *Being adolescent*. New York: Basic Books.

Davidson, M. C., Amso, D., Anderson, L. A., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia, 44*, 2037–2078.

Davis, M., & Whalen, P. J. (2001). The amygdala: Vigilance and emotion. *Molecular Psychiatry, 6*(1), 13–34.

Dawson, M. E., Schell, A. M., & Filion, D. L. (2001). The electrodermal system. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of psychophysiology* (pp. 53–84). Cambridge, MA: Cambridge University Press.

De Luca, C. R., Wood, S. J., Anderson, V., Buchanan, J., Proffitt, T. M., Mahony, K., et al. (2003). Normative data from the CANTAB: I. Development of executive function over the lifespan. *Journal of Clinical and Experimental Neuropsychology, 25*(2), 242–254.

Delgado, M. R. (2007). Reward-related responses in the human striatum. *Annals of the New York Academy of Sciences, 1104*, 70–88.

Doremus-Fitzwater, T. L., Varlinskaya, E. I., & Spear, L. P. (2010). Motivational systems in adolescence: Possible implications for age differences in substance abuse and other risk-taking behaviors. *Brain and Cognition, 72*(1), 114–123.

Douglas, L. A., Varlinskaya, E. I., & Spear, L. P. (2004). Rewarding properties of social interactions in adolescent and adult male and female rats: Impact of social versus isolate housing of subjects and partners. *Developmental Psychobiology, 45*, 153–162.

Dreyfuss, M., Caudle, K., Drysdale, A. T., Johnston, N. E., Cohen, A. O., Somerville, L. H., et al. (2014). Teens impulsively react rather than retreat from threat. *Developmental Neuroscience, 36*, 220–227.

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review, 66*(3), 183–201.

Eaton, L. K., Kann, L., Kinchen, S., Shanklin, S., Ross, J., Hawkins, J., et al. (2008). Youth risk behavior surveillance—United States, 2007: Surveillance summaries. *Morbidity and Mortality Weekly Report, 57*(SS04), 1–131.

Elkind, D., & Bowen, R. (1979). Imaginary audience behavior in children and adolescents. *Developmental Psychology, 15*(1), 38–44.

Ellis, B. J., Del Giudice, M., Dishion, T. J., Figueredo, A. J., Gray, P., Griskevicius, V., et al. (2012). The evolutionary basis of risky adolescent behavior: Implications for science, policy, and practice. *Developmental Psychology, 48*(3), 598–623.

Ernst, M., Nelson, E. E., Jazbec, S., McClure, E. B., Monk, C. S., Leibenluft, E., et al. (2005). Amygdala and nucleus accumbens in responses to receipt and omission of gains in adults and adolescents. *NeuroImage, 25*(4), 1279–1291.

Ernst, M., Pine, D. S., & Hardin, M. (2006). Triadic model of the neurobiology of motivated behavior in adolescence. *Psychological Medicine, 36*(3), 299–312.

Ernst, M., Romeo, R. D., & Andersen, S. L. (2009). Neurobiology of the development of motivated behaviors in adolescence: A window into a neural systems model. *Pharmacology Biochemistry and Behavior, 93*(3), 199–211.

Fair, D. A., Dosenbach, N. U., Church, J. A., Cohen, A. L., Brahmbhatt, S., Miezin, F. M., et al. (2007). Development of distinct control networks through segregation and integration. *Proceedings of the National Academy of Sciences, USA, 104*(33), 13507–13512.

Figner, B., Mackinlay, R. J., Wilkening, F., & Weber, E. U. (2009). Affective and deliberative processes in risky choice: Age differences in risk taking in the Columbia Card Task. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*(3), 709–730.

Forbes, E. E., & Dahl, R. E. (2010). Pubertal development and behavior: Hormonal activation of social and motivational tendencies. *Brain and Cognition, 72*, 66–72.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General, 130*(4), 681–700.

Galvan, A., Hare, T., Voss, H., Glover, G., & Casey, B. J. (2007). Risk-taking and the adolescent brain: Who is at risk? *Developmental Science, 10*(2), F8–F14.

Galvan, A., Hare, T. A., Parra, C. E., Penn, J., Voss, H., Glover, G., et al. (2006). Earlier development of the accumbens relative to orbitofrontal cortex might underlie risk-taking behavior in adolescents. *Journal of Neuroscience, 26*(25), 6885–6892.

Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology, 41*, 625–635.

Garnefski, N., Legerstee, J., Kraaij, V., Van Den Kommer, T., & Teerds, J. A. N. (2002). Cognitive coping strategies and symptoms of depression and anxiety: A comparison between adolescents and adults. *Journal of Adolescence, 25*, 603–611.

Ge, X., Rand, D. C., & Elder, G. H. (1996). Coming of age too early: Pubertal influences on girls' vulnerability to psychological distress. *Child Development, 67*(6), 3386–3400.

Geier, C. F., & Luna, B. (2009). The maturation of incentive processing and cognitive control. *Pharmacology Biochemistry and Behavior, 93*(3), 212–221.

Geier, C. F., Terwilliger, R., Teslovich, T., Velanova, K., & Luna, B. (2010). Immaturities in reward processing and its influence on inhibitory control in adolescence. *Cerebral Cortex, 20*, 1613–1629.

Grose-Fifer, J., Rodrigues, A., Hoover, S., & Zottoli, T. (2013). Attentional capture by emotional faces in adolescence. *Advances in Cognitive Psychology, 9*(2), 81–91.

Gross, J. J. (1998). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology, 74*(1), 224–237.

Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology, 39*, 281–291.

Gunnar, M. R., Wewerka, S., Frenn, K., Long, J. D., & Griggs, C. (2009). Developmental changes in hypothalamus–pituitary–adrenal activity over the transition to adolescence: Normative changes and associations with puberty. *Development and Psychopathology, 21*, 69–85.

Guyer, A. E., Choate, V. R., Pine, D. S., & Nelson, E. E. (2012). Neural circuitry underlying affective responses to peer feedback in adolescence. *Social, Cognitive, and Affective Neuroscience, 7*(1), 82–91.

Guyer, A. E., Monk, C. S., McClure-Tone, E. B., Nelson, E. E., Roberson-Nay, R., Adler, A. D., et al. (2008). A developmental examination of amygdala response to facial expressions. *Journal of Cognitive Neuroscience, 20*(9), 1565–1582.

Hall, G. S. (1904). *Adolescence: In psychology and its relation to physiology, anthropology, sociology, sex, crime, religion, and education* (Vol. I and II). Englewood Cliffs, NJ: Prentice-Hall.

Hall-Lande, J. A., Eisenberg, M. E., Christenson, S. L., & Neumark-Sztainer, D. (2007). Social isolation, psychological health, and protective factors in adolescence. *Adolescence, 42*(166), 265–286.

Hardin, M. G., Pine, D. S., & Ernst, M. (2009). The influence of context valence in the neural coding of monetary outcomes. *Neuroimage, 48*(1), 249–257.

Hare, T. A., Tottenham, N., Galvan, A., Voss, H. U., Glover, G. H., & Casey, B. J. (2008). Biological substrates of emotional reactivity and regulation in adolescence during an emotional go-nogo task. *Biological Psychiatry, 63*(10), 927–934.

Herman-Giddens, M. E., Slora, E. J., Wasserman, R. C., Bourdony, C. J., Bhapkar, M. V., Koch, G. G., et al. (1997). Secondary sexual characteristics and menses in young girls seen in office practice: A study from the Pediatric Research in Office Settings network. *Pediatrics*, 99(4), 505–512.

Herman-Giddens, M. E., Wang, L., & Koch, G. G. (2001). Secondary sexual characteristics in boys: Estimates from the National Health and Nutrition Examination Survey III, 1988–1994. *Archives of Pediatrics and Adolescent Medicine, 155*(9), 1022.

Hofstra, M. B., van der Ende, J., & Verhulst, F. C. (2002). Child and adolescent problems predict DSM-IV disorders in adulthood: A 14 year follow up of a Dutch epidemoilogical sample. *Journal of the American Academy of Child and Adolescent Psychiatry, 41*(2), 182–190.

Huizinga, M., Dolan, C. V., & van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia, 44*, 2017–2036.

Jazbec, S., Hardin, M. G., Schroth, E., McClure, E., Pine, D. S., & Ernst, M. (2006). Age-related influence of contingencies on a saccade task. *Experimental Brain Research, 174*(4), 754–762.

Kandel, D. B., & Davies, M. (1982). Epidemiology of depressive mood in adolescents: An empirical study. *Archives of General Psychiatry, 39*(10), 1205–1212.

Kessler, R. C., Berglund, P., Delmer, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62*, 593–602.

Kohls, G., Petzler, J., Hepertz-Dahlmann, B., & Konrad, K. (2009). Differential effects of social and nonsocial reward on response inhibition in children and adolescents. *Developmental Science, 12*(4), 614–625.

Kring, A. M. (2008). Emotion disturbances as transdiagnostic processes in psychopathology. *Handbook of Emotion, 3*, 691–705.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual*. Technical Report A-8. Gainesville, FL: University of Florida.

Larson, R. W. (2001). How U.S. children and adolescents spend time: What it does (and doesn't) tell us about their development. *Current Directions in Psychological Science, 10*(4), 160–164.

Larson, R. W., Moneta, G., Richards, M. H., & Wilson, S. (2002). Continuity, stability, and change in daily emotional experience across adolescence. *Child Development, 73*(4), 1151–1165.

Laursen, B., Coy, K. C., & Collins, W. A. (1998). Reconsidering changes in parent–child conflict across adolescence: A meta-analysis. *Child Development, 69*(3), 817–832.

Laviola, G., Macri, S., Morley-Fletcher, S., & Adriani, W. (2003). Risk-taking behavior in adolescent mice: Psychobiological determinants and early epigenetic influence. *Neuroscience and Biobehavioral Reviews, 27*(1–2), 19–31.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience, 23*, 155–184.

Lenhart, A., Ling, R., Campbell, S. B., & Purcell, K. (2010). Teens and mobile phones. Pew Internet and American Life Project. Retrieved from *http://pewinternet.org/Reports/2010/Teens-and-Mobile-Phones.aspx*.

Lewinsohn, P. M., Roberts, R. E., Seeley, J. R., Rohde, P., Gotlib, I. H., & Hops, H. (1994). Adolescent psychopathology: II. Psychosocial risk factors for depression. *Journal of Abnormal Psychology, 103*(2), 302–315.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*(3), 121–143.

Liston, C., Watts, R., Tottenham, N., Davidson, M. C., Niogi, S., Ulug, A. M., & Casey, B. J. (2006). Frontostriatal microstructure modulates efficient recruitment of cognitive control. *Cerebral Cortex, 16*(4), 553–560.

Luna, B., Thulborn, K. R., Munoz, D. P., Merriam, E. P., Garver, K. E., Minshew, N. J., et al. (2001). Maturation of widely distributed brain function subserves cognitive development. *NeuroImage, 13*(5), 786–793.

Mauss, I. B., Levenson, R. W., McCarter, L., Wilhelm, F. H., & Gross, J. J. (2005). The tie that binds?: Coherence among emotion experience, behavior, and physiology. *Emotion, 5*(2), 175.

McRae, K., Gross, J. J., Weber, J., Robertson, E. R., Sokol-Hessner, P., Ray, R. D., et al. (2012). The development of emotion regulation: An fMRI study of cognitive reappraisal in children, adolescents and young adults. *Social, Cognitive, and Affective Neuroscience, 7*(1), 11–22.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience, 24*, 167–202.

Monk, C. S., McClure, E. B., Nelson, E. E., Zarahn, E., Bilder, R. M., Leibenluff, E., et al. (2003). Adolescent immaturity in attention-related brain engagement to emotional facial expressions. *NeuroImage, 20*, 420–428.

Moore, W. E., Pfeifer, J. H., Masten, C. L., Mazziotta, J. C., Iacoboni, M., & Dapretto, M. (2012). Facing puberty: associations between pubertal development and neural responses to affective facial displays. *Social, Cognitive, and Affective Neuroscience, 7*(1), 35–43.

National Research Council. (2007). *Preventing teen motor crashes: Contributions from the behavioral and social sciences*. Washington, DC: National Academies Press.

Nelson, E. E., Leibenluft, E., McClure, E. B., & Pine, D. S. (2005). The social re-orientation of adolescence: A neuroscience perspective on the process and its relation to psychopathology. *Psychological Medicine, 35*, 163–174.

O'Brien, L., Albert, D., Chein, J., & Steinberg, L. (2011). Adolescents prefer more immediate rewards when in the presence of their peers. *Journal of Research on Adolescence, 21*(4), 747–753.

Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Sciences, 9*(5), 242–249.

Padmanabhan, A., Geier, C. F., Ordaz, S. J., Teslovich, T., & Luna, B. (2011). Developmental changes in brain function underlying the influence of reward processing on inhibitory control. *Developmental Cognitive Neuroscience, 1*(4), 517–529.

Peper, J. S., & Dahl, R. E. (2013). The teenage brain: Surging hormones—brain–behavior interactions during puberty. *Current Directions in Psychological Science, 22*(2), 134–139.

Petersen, A. C. (1988). Adolescent development. *Annual Review in Psychology, 39*, 583–607.

Pfeifer, J. H., & Allen, N. B. (2012). Arrested development?: Reconsidering dual-systems models of brain function in adolescence and disorders. *Trends in Cognitive Sciences, 16*(6), 322–329.

Pfeifer, J. H., Masten, C. L., Moore, W. E., Oswald, T. M., Mazziotta, J. C., Iacoboni, M., et al. (2011). Entering adolescence: Resistance to peer influence, risky behavior, and neural changes in emotion reactivity. *Neuron, 69*(5), 1029–1036.

Pfeifer, J. H., & Peake, S. J. (2012). Self-development: Integrating cognitive, socioemotional, and neuroimaging perspectives. *Developmental Cognitive Neuroscience, 2*(1), 55–69.

Pine, D. S., Cohen, P., Gurley, D., Brook, J., & Ma, Y. (1998). The risk for early-adulthood anxiety and depressive disorders in adolescents with anxiety and depressive disorders. *Archives of General Psychiatry, 55*, 56–64.

Primus, R. J., & Kellogg, C. K. (1989). Pubertal-related changes influence the development of environment-related social interaction in the male rat. *Developmental Psychobiology, 22*(6), 633–643.

Rankin, J. L., Lane, D. J., Gibbons, F. X., & Gerrard, M. (2004). Adolescent self-consciousness: Longitudinal age changes and gender differences in two cohorts. *Journal of Research on Adolescence, 14*(1), 1–21.

Reyna, V. F., & Farley, F. (2006). Risk and rationality in adolescent decision making: Implications for theory, practice, and public policy. *Psychological Science in the Public Interest, 7*(1), 1–44.

Romeo, R. D. (2010). Adolescence: A central event in shaping stress reactivity. *Developmental Psychobiology, 52*(3), 244–253.

Rubia, K., Smith, A. B., Woolley, J., Nosarti, C., Heyman, I., Taylor, E., & Brammer, M. J. (2006). Progressive increase of frontostriatal brain activation from childhood to adulthood during event-related tasks of cognitive control. *Human Brain Mapping, 27*, 973–993.

Rutter, M., Graham, P., Chadwick, O. F. D., & Yule, W. (1976). Adolescent turmoil: Fact or fiction? *Journal of Child Psychology and Psychiatry, 17*, 35–56.

Scherer, K. R. (2005). What are emotions?: And how can they be measured? *Social Science Information, 44*(4), 695–729.

Schlaggar, B. L., Brown, T. T., Lugar, H. M., Visscher, K. M., Miezin, F. M., & Petersen, S. E. (2002). Functional neuroanatomical differences between adults and school-age children in the processing of single words. *Science, 296*(5572), 1476–1479.

Schlegel, A., & Barry, H. (1991). *Adolescence: An anthropological inquiry*. New York: Free Press.

Schultz, W. (2006). Behavioral theories and the neurophysiology of reward. *Annual Reviews of Psychology, 57*, 87–115.

Sebastian, C., Viding, E., Williams, K. D., & Blakemore, S. J. (2010). Social brain development and the affective consequences of ostracism in adolescence. *Brain and Cognition, 72*, 134–135.

Shaw, P., Kabani, N., Lerch, J. P., Eckstrand, K., Lenroot, R., Gotay, N., et al. (2008). Neurodevelopmental trajectories of the human cerebral cortex. *Journal of Neuroscience, 28*(14), 3586–3594.

Silk, J. S., Stroud, L. R., Siegle, G. J., Dahl, R. E., Lee, K. H., & Nelson, E. E. (2012). Peer acceptance and rejection through the eyes of youth: Pupillary, eyetracking and ecological data from the Chatroom Interact Task. *Social, Cognitive, and Affective Neuroscience, 7*, 93–105.

Silvers, J. A., McRae, K., Gabrieli, J. D. E., Gross, J. J., Remy, K. A., & Ochsner, K. N. (2012). Age-related differences in emotional reactivity, regulation, and rejection sensitivity in adolescence. *Emotion, 12*(6), 1235–1247.

Simons-Morton, B., Lerner, N., & Singer, J. (2005). The observed effects of teenage passengers on the risky driving behavior of teenage drivers. *Accident Analysis and Prevention, 37*(6), 973–982.

Sisk, C. L., & Zehr, J. L. (2005). Pubertal hormones organize the adolescent brain and behavior. *Frontiers in Neuroendocrinology, 26*(3–4), 163–174.

Smetana, J. G. (1995). Parenting styles and conceptions of parental authority during adolescence. *Child Development,* 66, 299–316.

Somerville, L. H. (2013). The teenage brain: Sensitivity to social evaluation. *Current Directions in Psychological Science, 22*(2), 129–135.

Somerville, L. H., & Casey, B. J. (2010). Developmental neurobiology of cognitive control and motivational systems. *Current Opinion in Neurobiology, 20*, 1–6.

Somerville, L. H., Fani, N., & McClure-Tone, E. B. (2011). Behavioral and neural representations of emotional facial expressions across the lifespan. *Developmental Neuropsychology, 36*(4), 408–428.

Somerville, L. H., Hare, T., & Casey, B. J. (2011). Frontostriatal maturation predicts cognitive control failure to appetitive cues in adolescents. *Journal of Cognitive Neuroscience, 23*(9), 2123–2134.

Somerville, L. H., Jones, R. M., & Casey, B. J. (2010). A time of change: Behavioral and neural correlates of adolescent sensitivity to appetitive and aversive environmental cues. *Brain and Cognition, 72*, 124–133.

Somerville, L. H., Jones, R. M., Ruberry, E. J., Dyke, J. P., Glover, G., & Casey, B. J. (2013). Medial prefrontal cortex and the emergence of self-conscious emotion in adolescence. *Psychological Science, 24*(8), 1554–1562.

Spear, L. P. (2000). The adolescent brain and age-related behavioral manifestations. *Neuroscience and Biobehavioral Reviews, 24*(4), 417–463.

Spear, L. P. (2011). Rewards, aversions and affect in adolescence: Emerging convergences across laboratory animal and human data. *Developmental Cognitive Neuroscience, 1*(4), 390–403.

Steinberg, L. (1990). Autonomy, conflict and harmony in the family relationship. In S. S. Feldman & G. R. Elliott (Eds.), *At the threshold: The developing adolescent* (pp. 54–89). Cambridge, MA: Harvard University Press.

Steinberg, L. (2004). Risk taking in adolescence: What changes, and why? *Annals of the New York Acadademy of Sciences, 1021*, 51–58.

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Developmental Review, 28*, 78–106.

Steinberg, L., Dahl, R., Keating, D., Kupfer, D. J., Masten, A. S., & Pine, D. S. (2006). The study of developmental psychopathology in adolescence: Integrating affective neuroscience with the study of context. In D. Cicchetti & D. J. Cohen (Eds.), *Developmental psychopathology: Vol 2. Developmental neuroscience* (2nd ed., pp. 710–741). Hoboken, NJ: Wiley.

Substance Abuse and Mental Health Services Administration. (2007). *Results from the 2006 National Survey on*

Drug Use and Health: National findings (NSDUH Series H32, Publication No. SMA 07-4293). Rockville, MD: Author.

Tottenham, N., Hare, T. A., & Casey, B. J. (2011). Behavioral assessment of emotion discrimination, emotion regulation, and cognitive control in childhood, adolescence, and adulthood. *Frontiers in Psycholology, 2*, 39.

van Duijvenvoorde, A. C., Jansen, B. R. J., Visser, I., & Huizenga, H. M. (2010). Afffective and cognitive decision-making in adolescents. *Developmental Psychology, 35*(5), 539–554.

Van Leijenhorst, L., Gunther Moor, B., Op de Macks, Z., Rombouts, S. A., Westenberg, P. M., & Crone, E. A. (2010). Adolescent risky decision-making: Neurocognitive development of reward and control regions. *NeuroImage, 51*, 345–355.

Van Leijenhorst, L., Westenberg, P. M., & Crone, E. A. (2008). A developmental study of risky decisions on the Cake Gambling Task: Age and gender analyses of probability estimation and reward evaluation. *Developmental Neuropsychology, 33*(2), 179–196.

Wang, J., Iannotti, R. J., & Nansel, T. R. (2009). School bullying among U.S. adolescents: Physical, verbal, relational, and cyber. *Journal of Adolescent Health, 45*(4), 368–375.

Weigard, A., Chein, J., Albert, D., Smith, A., & Steinberg, L. (2014). Effects of anonymous peer observation on adolescents' preference for immediate rewards. *Developmental Science, 17*(1), 71–78.

Weinstein, S. M., Mermelstein, R. J., Hankin, B. L., Hedeker, D., & Flay, B. R. (2007). Longitudinal patterns of daily affect and global mood during adolescence. *Journal of Research on Adolescence, 17*(3), 587–600.

Westenberg, P. M., Drewes, M. J., Goedhart, A. W., Siebelink, B. M., & Treffers, P. D. A. (2004). A developmental analysis of self-reported fears in late childhood through mid-adolescence: Social–evaluative fears on the rise? *Journal of Child Psychology and Psychiatry, 45*(3), 481–495.

Williams, L. M., Brown, K. J., Palmer, D., Liddell, B. J., Kemp, A. H., Olivieri, G., et al. (2006). The mellow years?: Neural basis of improving emotional stability with age. *Journal of Neuroscience, 26*(24), 6422–6430.

Williams, K. D., & McGillicuddy-De Lisi, A. (1999). Coping strategies in adolescents. *Journal of Applied Developmental Psychology, 20*, 537–549.

Zimring, F. E. (1998). *American youth violence*. Oxford, UK: Oxford University Press.

Zuckerman, M., Eysenck, S., & Eysenck, H. J. (1978). Sensation seeking in England and America: Cross-cultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology, 46*, 139–149.

PART IV

Social and Personality Perspectives

CHAPTER 21

Gender and Emotion

Theory, Findings, and Context

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Gender differences in emotion are widely documented, but are often inconsistent across personality, social, cultural, and situational variables, as well as types of emotional processes, specific quality of emotions, and measurement or task characteristics. This is not surprising, given the multiple processes involved in the umbrella term "emotion," including experiencing, expressing, perceiving, interpreting, and regulating emotions; and the multiple modes of assessing these processes (e.g., physiological arousal, self-report, observational data); as well as the complexity of gender itself. Each type of emotional process is influenced by interpersonal, situational, personality, biological, cognitive, motivational, and cultural factors, as well as interactions among them. The most useful and sophisticated research honors this complexity and attempts to understand the contexts in which gender differences in emotion occur and the moderating and mediating variables that can provide clues as to their nature and etiology.

The Gender Construct

The construct of gender is complex and can be understood through three independent lenses (Greenfield, 2008; Weinrich, 1987). The first lens, core gender identity, includes the conventional categories of men/males/boys and women/females/girls and is usually based on evident anatomy, genetics, assignment at birth, or upbringing. It also includes nonconventional identity as a consequence of ambiguous anatomy or choices made to change the physical or presentational aspects of gender (e.g., intersex, ambigender, transgender, and transsexual persons).

The second lens consists of gender roles (i.e., the behaviors, personality characteristics, occupations, thoughts, and emotions "prescribed" as appropriate for males and females) that are historically and socially constructed. Stereotypic gender roles traditionally associate communion/interdependence/caretaking roles with femininity and agency/independence/instrumental roles with masculinity. Communion and agency are best represented as two independent continua on which an individual can be characterized as having any combination of low or high communal and agentic qualities (Bem, 1981; Spence & Helmreich, 1978).

The third lens, sexual orientation, is also best represented as two independent continua: the degree to which individuals are attracted to women, ranging from not at all to extremely, and on a separate continuum, the degree to which they are attracted to men, also ranging from not at all to extremely (Greenfield, 2008). Terms used to reflect sexual orientation include "asexual," "heterosexual," "homosexual," "bisexual," "gay," and "lesbian," with the umbrella term "queer" used to refer to individuals with nonconventional core gender identity or sexual orientation. In addition to feelings of sexual attraction, sexual orientation can also include behaviors (the degree to which people act on their feelings) and self-concept (the internalization of a particular sexual orientation, e.g., having a sexual relationship with a same-sex partner does not necessarily translate into having an identity as a homosexual).

These lenses (core gender identity, gender roles, and sexual orientation) are conventionally thought of as binary, when in reality they are not, and people can have not only simultaneously existing multifaceted qualities of each aspect, but can also be fluid as to which qualities are expressed in different contexts. Further, these three aspects of gender are often mistakenly conflated—for example, men who have more "feminine" gender roles are stereotyped to be gay, a conflation that can result in confusion for adolescents who are figuring out their sexual orientation and can result in limited behavior choices for people of all sexual orientations.

In research on gender and emotion, only recently have researchers begun to make nuanced comparisons of emotional processes using all three lenses through which gender can be viewed. Furthermore, when more nuanced comparisons are made they are usually between individuals with different sexual orientations (gay, lesbian, and heterosexual people), not between people with nonconventional gender identities. Research on emotional processes in individuals with nonconventional gender identities would be very helpful in understanding the nature and etiology of gender/emotion relationships, but to our knowledge such research does not exist. Thus, this chapter focuses primarily on differences in emotional processes as a function of the binary gender identity categories that are typically studied (female/male, with the unstated presumption of heterosexuality), and includes research on the differences between heterosexual and homosexual individuals when available.

Gender and Context

Women and men have different life experiences that shape their emotions and are shaped by them, with emotion–experience relationships often taking the form of bidirectional feedback loops. Key among these are (1) culturally prescribed gender roles such as the role of child caretaker versus economic provider; (2) socialization experiences, including cultural display rules, norms that dictate and regulate the quality and intensity of emotions each gender can express; (3) social motives, such as needs for intimacy versus control; (4) power and status imbalances between the two sexes—women typically have lower power and status, have less access to economic and material resources, and are more likely to live in poverty than are men (Arulampalam, Booth, & Bryan, 2006; Blau & Kahn, 2006; Chant, 2006); and (5) differences in types of trauma exposure, with higher levels of rape, sexual molestation, and physical abuse experienced by women and higher rates of combat exposure and witnessing violence experienced by men (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Trauma exposure in the general population is not an aberration, but the norm: in a nationally representative sample of almost 6,000 individuals, 60% of men and 51% of women had a lifetime prevalence of at least one traumatic event (Kessler et al., 1995). Nine percent of women and less than 1% of men had a lifetime prevalence rate for rape, and a history of rape was the one trauma most likely to lead to a posttraumatic stress disorder (which is characterized by high levels of anxiety) in both men and women. These differential experiences both elicit and contribute to emotion in the two genders, with emotions serving motivational and communicative functions that are adaptive for particular circumstances and contexts. Individuals' emotions in response to experiences can also become generalized across contexts to form habitual and anticipatory response patterns, some of which may be adaptive and others maladaptive (see Leahy, 2012).

Other Aspects of Identity in Relation to Gender

Emotions differ not only based on experiences that vary as a function of gender but also as a function of multiple other aspects of identity, including age, social class, race, ethnicity, status, religion, interests, values, and professional and interpersonal roles that may be independent of and also interact with gender (Stewart & McDermott, 2004). Some aspects of identity that have been found to be significantly related to gender include interdependent self-construals and interests in working with people (associated with females), and independent self-construals and interests in working with things (associated with males) (Cross & Madson, 1997; Su, Rounds, & Armstrong, 2009). Identities and interests may become more or less salient in a particular context depending on several factors, including the individual's values, the content and goals of the situation (e.g., political vs. personal; Ethier & Deaux, 1994), and the multiple identities of the participants in a social interaction. Each identity may be associated with unique emotional processes that vary as a result of the social expectations, display rules, functions, motives, and goals corresponding to that identity. For example, Palomares (2008) found that women referenced emotions in e-mails significantly more often than men when gender was primed and thus made salient, but when student status was primed, the gender difference in references to emotion was reduced. Because specific aspects of identity are continually shifting in their relative salience depending on the particular situation, gender differences in emotional processes will fail to generalize broadly, instead varying as a function of these same contextual factors.

In this chapter, we highlight contextual, moderating, and mediating variables for gender differences in several different emotional processes, focusing primarily on nonclinical populations. The majority of the research we review is based on European-American adult participants living in the United States. We also present a theoretical model for the etiology of gender differences that addresses the complex transaction between distal and proximal contextual variables, including biological, sociocultural, experiential, developmental, and situational factors.

Stereotypes and Display Rules

The stereotype that women are more emotional than men is pervasive across many different cultures (Timmers, Fischer, & Manstead, 2003). Among North American samples, women are believed to be more emotionally intense (Robinson & Johnson, 1997), as well as more emotionally expressive (e.g., smiling, laughing, crying) and more skilled in the use of nonverbal cues related to emotion (Briton & Hall, 1995). However, stereotypes are also emotion specific: Happiness, embarrassment, surprise, sadness, fear, shame, and guilt are believed to occur more in women, and anger, contempt, and pride more in men (e.g., Hess et al., 2000; Plant, Hyde, Keltner, & Devine, 2000). Although the distinction between expression and experience is not always made, when it is, the results consistently show stereotypes to be stronger for expression than for experience (Plant et al., 2000).

Some of the stereotypes about specific emotions have been found to vary with the ethnicity of the person holding the stereotypes. Participants who were African American, Hispanic American, European American, and Asian American believed that women express and experience more fear, guilt, love, sadness, surprise, shame, and sympathy than men. However, European Americans reported the highest levels of gender-stereotypic beliefs (e.g., anger for men and love for women) when compared with other ethnic groups (Durik et al., 2006).

How well are the stereotypes supported by self-reports and behavioral data? In general, rather well. Stereotypes about gender differences in emotional expression tend to correspond with self-reports of expression (see below), and stereotypes about gender differences in nonverbal behavior correspond well with measured gender differences (Briton & Hall, 1995; Hall & Carter, 1999). Moreover, the belief that gender differences in expression are stronger than gender differences in experience is corroborated when both are measured simultaneously. Kring and Gordon (1998), and Dunsmore, Her, Halberstadt, and Perez-Rivera (2009) found gender differences in facial expressions but not in self-reports of experience, in response to films.

To find that stereotypes are somewhat confirmed in self-reports and in actual behavior should be relatively unsurprising, because our most automatically encoded and retrievable memories are based on frequently occurring behaviors, which may form the basis for many stereotypes (Hasher & Zacks, 1984). On the other hand, gender and emotion stereotypes are imprecise, overly general, and ignore the importance of the modality in which an emotion is expressed, as well as the situational and cultural context within which it occurs. Because stereotypes ignore social context and individual differences, they often lead to the erroneous assumption that gender differences are exclusively biological in origin. This assumption is sometimes reinforced by authors of brain imaging studies who often assume that the brain's functional architecture is the origin of gender differences, rather than vice versa (Fine, 2013).

Despite these cautions, stereotypes warrant a closer analysis, because they powerfully shape the reality of gender differences. In any given interaction, gender stereotypes can generate expectancies about same- and opposite-sex partners that influence and elicit particular behaviors and emotional expressions, becoming self-fulfilling prophecies (Hall & Briton, 1993). Gender stereotypes about the experience and/or expression of emotion are potent enough that they can override the accurate perception of expressions actually conveyed by men and women. Several studies have shown that identical or equivalent facial expressions of men and women produce biases in interpretation (Adams, Nelson, Soto, Hess, & Kleck, 2012; Algoe, Buswell, & DeLamater, 2000; Hess, Adams, & Kleck, 2004; MacGregor & Davidson, 2000; Plant et al., 2000; Plant, Kling, & Smith, 2004). For example, Plant et al. (2004) altered the same faces to appear to be either male or female and gathered perceivers' emotion ratings of them. The "female" faces were judged to be sadder than the "male" faces. Gender-emotion stereotypes are even strong enough to make perceivers erroneously attribute the wrong and more stereotypic emotion to a target male or female face when that emotion is actually being expressed by a *different* face in proximity to the target face; happy male target faces were misperceived as angry when the neighboring face was angry, and angry female faces were misperceived as happy when the neighboring face was happy (Neel, Becker, Neuberg, & Kenrick, 2012). It is not clear in such studies whether the perceived gender of the target face actually influences how the expression is processed (e.g., through selective attention to certain cues) or whether perceivers' judgments follow from their general, base-rate beliefs about men's and women's emotional experience/expression, regardless of what the face is displaying.

The direction of bias does not always match stereotypes in a straightforward way. Hess et al. (2004) found that when the same faces were presented as either male or female, perceivers saw the angry "woman" as especially angry and the happy "man" as especially happy, which suggests that the contrast between stereotypic expectations and actual expressions led to attributions of more extreme emotional experience. But even if the perceiver says, "Women don't usually show anger, so that angry-looking woman must be really angry," it is still the case that stereotypes are guiding interpretation.

Stereotypes also have a strong implicit prescriptive aspect in the form of display rules, which are cultural norms regulating how, when, and where emotions can be expressed by males and females in any particular culture. For example, across 48 countries, adults reported that happiness was more desirable for girls and that fearlessness and anger suppression were more desirable for boys (Diener & Lucas, 2004). A comparison across samples from Canada, the United States, and Japan found that in all three countries men said it was more appropriate for men to display anger, contempt, and disgust than women said of women, while women said it was more appropriate for women to display sadness, fear, and happiness than men said of men (Safdar et al., 2009). However, in a different study, Singaporean males reported it was more appropriate for them to express sadness outside of work than Singaporean females reported for themselves (Moran, Diefendorff, & Greguras, 2013), indicating cultural specificity in display rules.

Violating stereotypic display rules can lead to negative social consequences, such as social rejection and discrimination (Brody, 1999). For example, depressed men were rated as "unmanly" and evaluated more negatively than depressed women (Brody, 1999). Angry women were rated as having lower status and competence and were accorded lower wages than were angry men, sad women, and unemotional women in a laboratory study (Brescoll & Uhlmann, 2008). Among 8- and 10-year-olds, girls who were better at substituting negative displays with positive affective expressions (i.e., emotional substitution) were more accepted by other girls, whereas boys who were better at masking or hiding their negative displays were more accepted overall (Young & Zeman, 2003). For seventh- and eighth-grade boys, peer acceptance was positively related to peer-rated sadness inhibition and inversely related to sadness disinhibition (Perry-Parrish & Zeman, 2011).

Women and men are judged for both under- and overexpressing emotions that are perceived as stereotypic for their sex. For example, women's over- and underreactions to happiness were both evaluated as less socially appropriate than the same reactions displayed by men (Kelly & Hutson-Comeaux, 2000), and men's over- and underreactions to angry events were judged as less socially appropriate than women's comparable reactions. These data are consistent with Shields's (1987) theory that women are placed in a double bind: Because emotionality is expected of women, women who do not express emotions are negatively evaluated, but women's stereotypic emotionality is also negatively evaluated as an "overreaction." Kelly and Hutson-Comeaux's data also extend the idea of a "double bind" about emotional expression to men.

Especially in many professional and business settings, women and men are pressured to conform to display rules for emotions in order to succeed. This is termed "surface acting," hiding one's true feelings about a situation in order to appear professional and competent. Simpson and Stroh (2004) asked human resources professionals to report on the extent to which they were required to cover up and pretend to experience various emotions at work. Women reported having to display positive emotions (e.g., contentment, calmness) and suppress negative emotions (e.g., anger) more than men did, whereas men reported having to display negative and suppress positive emotions more than women did. Although the different job characteristics performed by men and women (e.g., working in administration vs. human resources) were found to account for some of these differences, even after job characteristics were controlled women reported more pressure than men did to display positive emotions they did not feel. Similarly, in a study of over 1,300 career state service workers in the southern United States, Sloan (2012) found that women reported hiding or changing their anger more than men, and men reported hiding or changing their happiness more than women. The gender difference for anger management became nonsignificant when job status was entered into the model; workers who had higher status were disproportionately male and managed anger less.

Conforming to stereotypes has physical and emotional health costs and can result in increased negative affect, especially for women. Although both sexes may be subject to double-bind messages about expressing emotions stereotypically appropriate for their gender, it seems that women are more distressed by the consequences of these messages than are men. The stereotype that women should be "cheerful" and display positive emotions means that underlying negative affective states may persist and fester, producing a cascade of negative effects (Scott & Barnes, 2011). For example, Johnson and Spector (2007) asked customer service employees to report how much they engaged in surface acting and to complete measures of burnout and job-related well-being. Among women, more surface acting predicted more emotional exhaustion and less affective well-being, but this was not the case among men. This result was confirmed in a study of bus drivers using experience sampling methodology over a 2-week period, where surface acting, as in "faking a good mood," was significantly associated with negative affect for women more than for men (Scott & Barnes 2011). Finally, in the study done by Simpson and Stroh (2004) discussed above, among human resources professionals only the women's pattern of feeling pressured to display positive emotions and to suppress negative emotions was significantly associated with feelings of inauthenticity at work. Women who adopted the men's pattern of responding (i.e., displaying negative emotions and suppressing positive emotions) were the least likely to report feelings of inauthenticity.

Surface acting may occur not only in response to display rules but may also occur in response to stereotype threats about gender and emotion. In stereotype threat (Steele & Aronson, 1995), concern about confirming a negative stereotype about one's group (e.g., women are more "emotional" than are men) negatively affects performance on stereotype-related tasks. Impaired performance may be mediated by increased anxiety (Beilock, Rydell, & McConnell, 2007; Osborne, 2001). For example, women exposed to implicit stereotype threat about their leadership abilities (being told that their performance would be diagnostic of their leadership abilities after they had identified their gender) expressed more anxiety in narratives relative to women not exposed to stereotype threat (Brody et al., 2009; Kelso & Brody, 2014). Stereotype threat is also accompanied by negative, self-deprecating thoughts (Cadinu, Maass, Rosabianca, & Kiesner, 2005), such as "People won't respect me if I'm too emotional." It is possible that pervasive stereotype threat about emotionality as well as in other domains (e.g., math or leadership abilities) may contribute to women's heightened tendency to ruminate and engage in repetitive negative thinking, which has been found to mediate higher levels of anxiety and depression (Nolen-Hoeksema, Larson, & Grayson, 1999). Thus, stereotype threat about women's emotionality might ironically increase women's emotionality in the form of anxiety.

Self-Report Measures

Self-report measures, though serving as the basis of much of the available evidence about emotion and expression, are hard to interpret for three reasons. First, gender stereotypes may color participants' self-concepts and therefore their self-descriptions (Robinson & Clore, 2002). Some research supports this idea (Grossman & Wood, 1993). Second, stereotypical responding may be exacerbated by social desirability motives, which in turn may be influenced by display rules. And third, the conceptual distinction between emotional experience and emotional expression is frequently blurred. The items to which participants are asked to respond may not make the distinction; the commonly used term "emotional" implies both experience and expression. Or, participants may have difficulty making this distinction even if asked to do so. With these cautions in mind, we review studies that have used self-report measures.

Self-Reports of General Emotional Experience and Expression

Many studies find that women rate themselves as more emotionally expressive than men rate themselves to be (e.g., Simon & Nath, 2004). Gross and John (1998) factor analyzed six frequently used self-report measures of emotional expression and identified five factors: positive expressivity, negative expressivity, the intensity of emotional expression, expressive confidence (such as enjoying acting), and masking or emotional regulation (such as suppressing anger). Women rated themselves significantly higher on the first three of these factors. Greater intensity is found for women both in their descriptions of specific emotional experiences (Hess et al., 2000; Tobin, Graziano, Vanman, & Tassinary, 2000) and on global self-report measures such as the Affect Intensity Measure (AIM; Diener, Sandvik, & Larsen, 1985). However, intensity must be distinguished from frequency. In the 1996 General Social Survey, involving more than 1,300 respondents, there was no gender difference in reports of overall frequency of emotional experience (Simon & Nath, 2004). Estimates of overall frequency may mask differences for specific emotions.

Consistent with our theoretical framework emphasizing contextualism, even these generally predictable self-report differences do not always appear. In a survey of over a thousand high-level managers (e.g., chief executive officers, executive vice presidents), men reported themselves to be more emotionally expressive in their jobs than women in equivalent leadership positions (Callahan, Hasler, & Tolson, 2005). This result is not surprising because in a male-stereotypic job context women may be aware that "too much" expressiveness will work against them, especially the expression of negative emotion and anger in the workplace, as previously discussed (Simpson & Stroh, 2004). Moreover, global self-reports and cultural stereotypes reflecting the "nonemotionality" of men overlook the fact that men can be and are emotional in many settings, including leadership positions, competitive sports, the entertainment industry, the political arena, and intimate relationships (see Shields, 2013).

Finally, there is emotional contagion: women report a higher likelihood of "catching" the emotions of others than men report (Doherty, 1997). This self-reported difference is corroborated for certain emotions when facial muscle activity is recorded through electromyography. For example, Dimberg and Lundquist (1990) found that women's faces were more responsive to viewed facial expressions than men's. Emotional contagion combined with facial feedback processes (Strack, Martin, & Stepper, 1988) could contribute to women's greater reported intensity of experience in specific contexts.

Self-Reports of Specific Emotions

The specific emotions that women and men report more intensely or more frequently tend to vary depending on ethnicity (more intense gender differences for White and European-American samples than for other ethnic groups) and situational context (Else-Quest, Higgins, Allison, & Morton, 2012; Fischer, Rodriguez Mosquera, van Vianen, & Manstead, 2004). As with self-reports of general emotion, gender differences are larger when measures are more global and nonspecific as opposed to focusing on states and descriptive adjectives at particular moments in time (Else-Quest et al., 2012). This is consistent with the view that gender differences in specific emotions vary depending on the gender role relevance of the target situation (Ferguson, Eyre, & Ashbasker, 2000). The positive emotions sometimes reported more intensely or more frequently by women include joy, love, affection, warmth, and feelings of well-being (see Brody, 1993; Chentsova-Dutton & Tsai, 2007; Fischer & Manstead, 2000). In a meta-analysis, reports of pride showed no gender differences despite the stereotype that favors men (Else-Quest et al., 2012). Women also generally report more empathy and sympathy than do men; these emotions are hard to classify as positive or negative, although they are generally seen as socially valuable (Evers, Fischer, Rodriguez Mosquera, & Manstead, 2005; Lennon & Eisenberg, 1987). However, gender differences in empathy decrease from ages 22 to 92 (Schieman & Van Gundy, 2000), reflecting developmental and/or generational effects.

Higher female reporting of positive emotions is specific to particular measures and situations. For example, when participants are asked about total frequency of affect in the past week, women report significantly less positive affect than men report (Simon & Nath, 2004). Total frequency of emotions over the course of a week may be heavily influenced by the context in which participants are spending their time. When participants recorded their emotions in response to random pager beeps for 1 week, women reported more positive emotions (e.g., happy and friendly, as opposed to unhappy and angry) while at work than they did while at home. The opposite was true of men, who reported more positive emotions while at home (Larson, Richards, & Perry-Jenkins, 1994). Sloan (2012) also found that women reported more happiness at work than men in a sample of over 1,300 people who worked in state service positions, despite the fact that men had higher incomes and more influence in their jobs.

Many negative emotions, including disgust; sadness; feelings of vulnerability, such as fear, anxiety, and hurt; and feelings of dysphoric self-consciousness, such as shame and embarrassment, are reported more by women than by men (e.g., Balzer & Jacobs, 2011; Brody, 1999; Fischer et al., 2004; Hess et al., 2000; Rohrmann, Hopp, & Quirin, 2008; Simon & Nath, 2004). Else-Quest et al. (2012), in a meta-analysis of self-conscious emotions, including guilt, shame, and embarrassment, found that females in adolescence through older adulthood reported more guilt and shame than did males. Embarrassment also tended to be reported more by females than by males; this gender difference, however, was reversed in studies that assessed embarrassment specific to environmental issues such as littering. Extending these findings to earlier ages is work by Lewis and Ramsey (2002), showing higher levels of shame after task failure in 4-year-old girls than boys.

Sadness, depression, and dysphoria are also self-reported to be more intense and of longer duration by women than by men (Scherer, Wallbott, & Summerfield, 1986). In a study of bus drivers using experience sampling methodology over a 2-week period, female bus drivers reported higher levels of negative affect (being irritable, distressed, upset) than male bus drivers (Scott & Barnes, 2011). A study of women and men who had been victims of crime indicated that women endorsed more depression, anxiety, and anger in general than did men (Green & Diaz, 2008). In a study of adolescents, Perry-Parrish and Zeman (2011) found that although boys and girls did not differ in self-reports of the frequency with which they experienced sadness, boys reported inhibiting sadness expression more than girls. This study also underscores our earlier point that experience and expression are not synonymous.

Although men sometimes express more anger through vocal, facial, and behavioral modalities than women, gender differences in anger based on self-reports are inconsistent. When asked general questions about how many days per week they get angry, men and women reported no differences (Simon & Nath, 2004) and there were also no gender differences in reports of anger across 37 different countries (Fischer et al., 2004). However, when asked about the intensity of their anger, sometimes women report getting more intensely angry than men report of themselves, as indicated by a study of European and Hmong Americans asked to remember and relive significant memories (Chentsova-Dutton & Tsai, 2007). Reports of anger are sometimes, but not always, higher in women and girls when a situational context is specified, especially one involving conflict in interpersonal relationships (e.g., Buntaine & Costenbader, 1997; Chaplin, Cole, & Zahn-Waxler, 2005; Fischer & Evers, 2011; Kring, 2000). In a study of married couples who were either middle aged (40–50 years old) or older (60–70 years old), wives in both age groups reported more anger following a conflict discussion than did husbands and also rated their husbands as less friendly (Smith et al., 2009). However, lower reports of anger or unpleasant feelings by men in conflict situations may be a function of lower commitment levels to and salience of the relationship: women in the Netherlands reported less positive affect to treatment they considered to be unfair during relationship conflict than did men, but this gender difference disappeared when relationship commitment and identification were high and when the relationship was made salient by asking participants to name three ways in which they were interconnected with their partners (Kluwer, Tumewu, & van den Bos, 2009).

Gender differences in reports of anger may also be affected by status and power balances in specific relationships. Lower-status males directly express their anger around higher-status work colleagues significantly more often than do lower-status females, with status defined as having supervisory responsibilities (Domagalski & Steelman, 2007). Dutch women in traditional intimate relationships who were employed fewer hours and had less decision-making power than their male partners reported less direct anger and suppressed their anger more than did men, whereas there were no gender differences in egalitarian relationships (Fischer & Evers, 2011).

Compared with men, women also report more enduring experiences of anger (Simon & Nath, 2004), are more likely to report hurt or disappointment in response to anger-inducing situations (Brody, 1993), and are more likely to worry about the social consequences of getting angry than men (Evers et al., 2005), especially when they are in traditional relationships with less decision-making power and financial resources than men (Fischer & Evers, 2011). Women are more likely to express their anger using indirect means, such as crying, disclosing their anger to a third party, or gossiping (Fischer & Evers, 2011). They are more likely to view their anger as appropriate (Simon & Nath, 2004), but are also more likely to report feeling ashamed after expressing it (Kring, 2000). The shame–anger relationship has also been studied in reverse: both boys and girls from the Netherlands with narcissistic tendencies (an inflated sense of their importance) reported more anger after being shamed, but only boys were also nominated by peers as displaying more anger (Thomaes, Stegge, Olthof, Bushman, & Nezlek, 2011).

Emotions that males sometimes report expressing or are reported by others to express more frequently or intensely than females are contempt, loneliness, confidence, and excitement (Brody, 1993, 1999; Simon & Nath, 2004). However, gender differences in contempt and loneliness have been inconsistent across studies, depending on situational circumstances, the characteristics of the particular samples assessed, and methodological variables (including differences between scenario-based methods and trait measures of these emotions; Benetti-McQuoid, & Bursik, 2005; Ferguson et al., 2000).

What Do Self-Reports Measure?

Women's reports of higher affective intensity on global or retrospective self-report measures may not accurately reflect gender differences in emotion at the time feelings are initially expressed or experienced. When daily logs are used to report momentary emotions or mood states, either no gender differences have been found (Barrett, Robin, Pietromonaco, & Eyssell, 1998; Mor et al., 2010), or men have reported positive events in their lives to be more intense than women have reported theirs to be (Seidlitz & Diener, 1998). Moreover, subsequent global self-reports of emotion do not significantly relate to the intensity of emotional reactions reported at the time events occurred (Seidlitz & Diener, 1998). Robinson, Johnson, and Shields (1998) found that men and women retrospectively remembered their emotions as more gender stereotypic than they actually were.

In a theoretical review, Robinson and Clore (2002) argue that global and retrospective self-reports of emotion partially reflect memories for the contextual details of events. Women may have more sophisticated emotion concepts that can serve as retrieval cues, or they may encode emotional experiences in more detail than men do (Seidlitz & Diener, 1998). For example, Wang (2013) used a random sampling method in which participants received a text message three times a day during a 1-week period and were asked to record what was happening during the past 30 minutes. Compared with men, women recorded a greater number of event details at the encoding phase and provided more detailed and accurate memories at a delayed recall 1 week later, even after controlling for the frequency of details at encoding. More detailed encoding at the time of an emotional event may subsequently contribute to women's reports of more intense emotions relative to men's on global measures, even in the absence of gender differences in emotional intensity at the time feelings were initially experienced. These hypotheses are consistent with data that girls and women in the United States and Australia are faster in accessing, and are able to recall more, childhood memories of emotional experiences than their male counterparts (Davis, 1999). Polish women used more positive and negative emotion words when recalling vivid memories than men did (Niedzwienska, 2003). It is also possible that there are gender differences in the mental imagery surrounding emotional events; enhanced mental imagery has been found to be related to heightened affective responding (Miller et al., 1987).

Robinson and Clore (2002) also argue that as the delay lengthens between the occurrence of an emotional event and later recall, detailed memories fade, and self-reports of emotion increasingly rely on belief- and identity-consistent generalizations. Thus, gender-stereotypic beliefs and identity may contribute to gender differences in global self-report measures. This is supported by Wang (2013), who found that after a 1-week delay, women recalled initial experiences (measured with event sampling) by referring more to interpersonal activities than men did, independent of the degree to which they had reported those activities in their initial experiences, which had not differed by gender. Recalling more interpersonal activities is consistent with women's higher levels of motivation to maintain intimacy and affiliation.

Alternative explanations for the discrepancy between global and specific measures are also possible, including the idea that in the time elapsed since an event, women may cumulatively experience more emotion than men—perhaps, for example, ruminating over the event, which retriggers or amplifies emotional experiences. And, as pointed out earlier, global self-report measures often blur the distinction between emotional experience and emotional expressiveness. Finally, people need experiential self-awareness to report that an emotion has occurred and there may be gender differences in this awareness (Else-Quest et al., 2012), as suggested by the literature on emotional competence discussed below.

Verbalization of Emotion

Consistent with self-report data, women have been found to refer to emotions more often in conversations and in writing samples, although this finding holds more consistently for positive emotions than for negative emotions such as anger. For example, in writing a response story to a scenario in which they dealt with an obstructive travel agent, females made more emotional references than did males (Girdler, Turner, Sherwood, & Light, 1990; see also Brody, 1999). In a task involving narrating a wordless picture book, 6- and 7-year-old girls in a British sample used more emotion explanations and more emotion labels than did boys, regardless of the sex of the peer to whom they were "reading" the book (Tenenbaum, Ford, & Alkhedairy, 2011). Similarly, 10- to 13-year-old girls also used more emotion words than did boys when conversing with parents about story vignettes involving conflicts (Aldrich & Tenenbaum, 2006), although when sons conversed with fathers about these vignettes, they expressed more sadness than did daughters. These gender differences in naturalistic conversations may emerge in early school-age children, since emotions in preschoolers' naturalistic conversations were not found to vary by gender (Fabes, Eisenberg, Hanish, & Spinrad, 2001).

In interviews between potential clients and male psychiatrists, controlling for psychopathology, female clients' discourse contained more affect, as seen in the percentage of affect words, and was also more nonverbally expressive than men's (Lecours, Sanlian, & Bouchard, 2007). Further, an analysis of a random sample of 819 public comments to or from U.S. users on a social networking website revealed that females gave and received more positive comments than did males, but there was no gender difference for negative comments and no interaction of sender's gender with that of the receiver (Thelwall, Wilkinson, & Uppal, 2010).

In both self-descriptions and observations of marital interactions, wives are more willing to tell their husbands when they are feeling tense; initiate discussions about areas of disagreement; disclose their feelings, especially distress and anger; and try to explain their feelings than are husbands (Burke, Weir, & Harrison, 1976; Baucom, McFarland, & Christensen, 2010; Smith et al., 2009; Stets, 1997). Men have been found to withdraw from criticism and marital conflict by "stonewalling," which involves inhibiting facial action and minimizing listening and eye contact, more than their wives do (Levenson, Carstensen, & Gottman, 1994; Smith et al., 2009). An observational study of dating couples indicated that in interactions involving high-stress situations, gender differences were maximized, with men being less emotionally expressive and higher in restricted affect and withdrawal than women, as compared with interactions in which low-stress situations were discussed, where no gender differences were observed in these variables (Vogel, Wester, Heesacker, & Madon, 2003).

In lesbian, gay, and heterosexual couples' videotaped interactions in which couples were asked to discuss areas of disagreement (Gottman et al., 2003), across all couples, men expressed more anger than women; women expressed more excitement and joy (as measured by facial expressions, vocal tone, and speech content); and women were sadder when they were the recipient of a conflict-laden message from their partner than men were. When initiating conflict, lesbian women were angrier than gay men, used more humor, and showed more excitement/joy. When listening to an issue, lesbian women showed more humor and interest than did gay men.

Studies also indicate that same- and cross-sex couples engage in demanding and withdrawing behaviors in highly similar ways. Across all couples, women demanded at higher levels than men, including using requests and demands, nagging, blaming, accusing, or criticizing partners, and men withdrew at higher levels than women, including becoming silent, refusing to discuss topics, disengaging from the discussion, hesitating, changing topics, diverting attention, or delaying the discussion (Baucom et al., 2010).

Facial Expressions and Other Nonverbal Behaviors

Women are more accurate facial expressers of most emotions, both when posing in response to experimental instructions and when being observed unobtrusively (Dunsmore et al., 2009; Hall

& Gunnery, 2013). A measure integrating facial, vocal, and postural expressions indicated that girls expressed more sadness and anxiety than boys at ages 4 and 6, and over this 2-year period, boys decreased their expression of these emotions (Chaplin et al., 2005). Similarly, Buck (1977) found that boys between the ages of 4 and 6 showed steadily decreasing facial expressiveness when watching affectively arousing slides, while there was no age effect for girls.

Generally, studies measuring researcher, peer, teacher, and parent observations concur that boys more frequently express negative emotions (e.g., anger, aggression, frustration) with some studies indicating that boys also more frequently express high-intensity positive emotions (e.g., excitement) and girls more frequently express low or moderately intense positive emotions (e.g., happiness) as well as sadness (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006; Perry-Parrish & Zeman, 2011; Schultz, Izard, & Bear, 2004; Zhou, Eisenberg, Wang, & Reiser, 2004). However, some studies indicate that parents and teachers differ from each other in their ratings of emotional expressivity by child gender, perhaps because display rules in school and home settings differ (Sallquist et al., 2009). It is important to note that peer, parent, and teacher nominations may be confounded by gender stereotypes.

The results for nominations of anger expression being higher for males are borne out by research showing that men convey anger more clearly in their facial expressions than women do. For example, when participants were videotaped as they discussed angry, sad, and happy emotional memories, judges were able to identify men's facial displays of anger (independent of verbal content) more accurately than women's. Although stereotypes, in which observers are more apt to associate anger with men, may spuriously account for these different accuracy rates, this caveat is rendered less likely by the finding that higher sociometric status was associated with anger encoding ability for men and with happiness encoding ability for women (Coats & Feldman, 1996). Men are also more facially reactive in response to angry stimuli than are women, as measured by facial electromyographic activity (Dimberg & Lundquist, 1990).

Quantitative reviews have concluded that women are more generally expressive with their faces and hands, and smile, laugh, and nod more than men do (Hall & Gunnery, 2013; LaFrance, Hecht, & Levy Paluck, 2003). Both European American and Hmong American women showed more smiles than men did when recalling and reliving experiences involving happiness and love (Chentsova-Dutton & Tsai, 2007). Szarota (2010) measured cross-national gender differences in smiling, using adults' pictures that were self-posted on Internet sites as the source of data (100 of each gender in each of 10 countries). Across nine European countries plus the United Kingdom, women smiled significantly more in all but three countries (East and West Germany, Hungary), though even there women smiled more than men.

It is important to note, however, that smiling in particular and other emotion-suggestive nonverbal behaviors do not necessarily reflect actual emotional states (Chovil, 1991–1992; Krauss, Chen, & Chawla, 1996). Smiling is notably ambiguous as to its "real" emotional meaning. Even the supposedly involuntary Duchenne smile has now been shown to be deliberately producible by a substantial number of people (Gunnery, Hall, & Ruben, 2013; Krumhuber & Manstead, 2009). The Duchenne smile engages both the mouth and the cheek-raiser muscle that makes crows' feet and was theorized for many years to reflect spontaneous happy affect without the possibility of willful control.

Some authors have suggested that smiling in women reflects false positivity and thus insincerity—for example, women's smiles were less congruent with the content of verbal statements than was the case for men (Bugental, Love, & Gianetto, 1971). However, women's facial expressions were *less* discrepant from their words than were men's in the better-designed research of Halberstadt, Hayes, and Pike (1988), and women and men displayed Duchenne and non-Duchenne (involving only the mouth) smiles equally in Hecht and LaFrance's (1998) study, which argues against the notion that women's smiles are less "authentic" than men's.

Women are also smiled at more than men (Hinsz & Tomhave 1991; Patterson & Tubbs 2005). The combination of this target effect with the actor main effect described above would lead to frequency of smiling being greatest in same-gender dyads (female–female compared with male–male), which is the case (Hall, 1984). However, a provocative reversal of people's tendency to smile more at women has been documented in studies of group members' unobtrusively observed reactions to female leaders during group interaction. In German and American women and men who were studied during group interactions, female leaders were the recipients of more negative affect by both sexes than were male leaders, even when the leaders' contributions were held constant (Butler & Geis, 1990; Koch, 2005). This suggests that the nonverbal behaviors directed toward women in casual social encounters may be different from those directed toward them in task-oriented or hierarchical situations, especially those stereotyped as inappropriate for women.

Nonverbal Decoding Skill

Across many studies, females score higher than males in identifying the meanings of nonverbal cues of face, body, and voice (Hall, 1984; Hall & Gunnery, 2013; Kirkland, Peterson, Baker, Miller, & Pulos, 2013; McClure, 2000). Most of the studies have tested sensitivity to expressions of affect, which is a female-stereotypic knowledge domain. When the knowledge domain is male stereotypic, such as judging status or dominance (Schmid Mast & Hall, 2004), or nongender stereotypic, such as lie detection (Aamodt & Custer, 2006), the sex differences appear to be much smaller or nonexistent. It has been suggested that the female advantage on nonverbal decoding tasks stems from motivational differences between men and women (Ickes, Gesn, & Graham, 2000), but studies manipulating motivation to influence the accuracy of judging nonverbal cues give very limited support to this hypothesis (Hall et al., 2009).

Emotional Competence

Theories of emotional competence and intelligence define several emotion-related traits and skills to be important for adaptive intrapsychic and interpersonal functioning (Matthews, Zeidner, & Roberts, 2002), including perceiving emotions accurately, using emotion to facilitate thought, and understanding and managing emotion. Women score higher than men on all of these components on the Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT; Day & Carroll, 2004; Mayer, Caruso, & Salovey, 2000), including women in a large Greek sample who scored higher than men on empathy, expression, and recognition of emotions, but lower on the use of emotions and no differently on control of emotions (Tsaousis & Kazi, 2013). Consistent with the results favoring women on emotional competence is the large literature showing female advantage in interpreting nonverbally communicated emotions discussed above.

In videotapes of married couples' interactions, Mirgain and Cordova (2007) found that husbands and wives were similar on some dimensions of emotional competence, but when significant differences occurred they showed wives to be more competent (e.g., lack of defensiveness), and trends favored wives for several other coded dimensions (e.g., eliciting positive emotions). In that study, emotional competence predicted own and spouse's marital satisfaction in both husbands and wives. Emotional competence is also relevant in the domain of medical practice, where patient-centered care is now the gold standard for quality medical practice around the world (Mead & Bower, 2000). Female medical students and physicians exceed their male peers on behaviors such as partnership and psychosocial orientation, positivity in verbal and nonverbal communication, accurate interpersonal perception, empathy, focus on feelings, verbal and nonverbal encouragement, and expressions of respect or praise (Roter, Hall, & Aoki, 2002).

Gohm and Clore (2000) found that women reported a greater tendency to pay attention to their emotions. When participants were clustered according to their pattern of scores on attention, clarity, and intensity, women predominated among those who were high on all three but also those high on intensity but low on clarity ("overwhelmed"), while men predominated among those low on all three and those low on intensity and high on clarity ("cerebral").

Women and girls display more complex emotion knowledge than men and boys do when describing the emotions of self and others in hypothetical scenarios. A motivational manipulation brought men's performance up to the level of women's, but only after men spent significantly longer on the task (Ciarrochi, Hynes, & Crittenden, 2005). On tasks where extra effort and thought are beneficial, motivational factors may play an important role, in contrast to the case of accuracy in decoding nonverbal cues (Hall et al., 2009).

Emotional competence is related to a wide variety of adaptive behaviors for both sexes (Nelis et al., 2011), but expressing emotions in words may matter more to women's health than men's. The ability to mindfully describe experiences with words predicted healthier behaviors for females (including physical activity, diet, and self-efficacy), while the ability to step back and observe experience predicted healthier behaviors for males (Gilbert & Waltz, 2010).

Emotion Regulation

Emotion regulation or management consists of behavioral, cognitive, attentional, physiological, or emotional strategies to eliminate, maintain, or change emotional experience and/or expression

(Ochsner & Gross, 2005), in accordance with cultural pressures (display rules, stereotypes, and power/status imbalances), and/or in accordance with personality-related factors (self-construals, motives, conflicts, and goals), with a primary goal being the avoidance of painful affect that might come from negative self- or social judgment and/or relational loss (Cramer, 2002; Matsumoto, Takeuchi, Andayani, Kouznetsova, & Krupp, 1998). Because cultural pressures and personality-related factors differ by gender, it should not be surprising to find gender differences in emotion regulation strategies for specific emotions. For example, females report regulating anger to protect others' feelings and to avoid relational loss, in accordance with interdependence motives, whereas males report regulating anger to avoid nonsupportive interpersonal reactions and to maintain control, in accordance with individualistic motives (Jack & Dill, 1992; Timmers, Fischer, & Manstead, 1998; Zeman & Shipman, 1998).

Several reviews have concluded that girls are more likely than boys to exert voluntary control over emotional reactions (Else-Quest et al., 2006). Similarly, adult women engage in more types of emotion regulation strategies than do men, including rumination, reappraisal, seeking social support that involves emotional disclosure, acceptance, distraction, and problem solving (Cramer, 2002; Nolen-Hoeksema, 2012). Women also report or are observed to use more internalizing strategies such as blaming themselves, and also more emotion-focused strategies such as ruminating, rather than taking active steps (Cramer, 2002; Nolen-Hoeksema & Jackson, 2001; Thayer, Newman, & McClain, 1994). In particular, rumination has been found to significantly mediate gender differences found in depression (Nolen-Hoeksema, 2012) and may partly explain why women have higher rates of depression than do men. The gender difference in rumination has been found to be mediated by trauma and chronic strain histories (Nolen-Hoeksema et al., 1999), as well as by several attributions, including the uncontrollability of negative emotions (Nolen-Hoeksema & Jackson, 2001).

Some research indicates that men use more behavioral and externalizing emotion regulation strategies than do women, including blaming others, taking active steps, seeking social support through shared activities; using humor, withdrawal, disengagement, and distancing in the face of conflict; and engaging in distracting or avoidance activities such as exercise; as well as in impulsive, reward-seeking behaviors such as substance use (Brody, Muderrisoglu, & Nakash-Eisikovits, 2002; Cramer, 2002; Davis et al., 2012; Gross & John, 2003; Lecours et al., 2007; Nolen-Hoeksema, 2012; Zlomke & Hahn, 2010).

Gender differences in emotion regulation strategies need to be qualified by type of emotion. For example, women report that they exert more control over anger, contempt, and disgust than do men, and men report that they exert more control over fear and surprise than do women in the United States, Japan, Russia, and South Korea (Matsumoto et al., 1998). In Kenya, the United States, and Ghana, boys reported more control over sadness than girls, who reported more undercontrol of sadness and more control over anger than boys (Morelen, Zeman, Perry-Parrish, & Anderson, 2012). Women choose rumination strategies when in neutral or depressed moods, but choose distraction when in angry moods (Rusting & Nolen-Hoeksema, 1998).

Although both avoidance and emotion-focused coping strategies tend to be nonadaptive for both sexes (Thayer et al., 1994), evidence indicates that some regulation and defense strategies may be differentially adaptive for each gender, varying in complex ways as a function of type of situation, how gender stereotypic the emotional regulation strategy is, and the quality of the emotion being regulated (Brody et al., 2002; Zlomke & Hahn, 2010).

Relationship Specificity

Gender differences in emotional processes often emerge within the context of interpersonal relationships and are affected by the characteristics of the participants in the interaction (including their identities—e.g., their gender, sexual orientation, and ethnicity) and the nature of their relationship, including their level of familiarity, intimacy, and power and status with respect to each other. For example, women who were treated unfairly by a confederate expressed less anger when they were told they would meet the confederate than when they were not (Evers et al., 2005). Both men and women express more emotions and more intense emotions to people they know intimately and feel closer to (Barrett et al., 1998).

Women from a wide variety of cultures also express emotions to a greater number of people than men, who tend to limit themselves to expressing emotions only to intimate partners (Rimé, Mesquita, Philippot, & Boca, 1991). Women also report controlling their emotions less with family members than males do (Matsumoto et al., 1998). Both genders are more comfortable disclosing feelings (with the possible exception of anger) to women than to men (Timmers et al., 1998). In a meta-analysis of sex differences in self-disclosure, which includes but is not limited to the disclosure of feelings, women self-disclosed more to female partners, but not more to male partners, than males did (Dindia & Allen, 1992). Anger may be the only feeling that is verbally disclosed or directed more toward men than toward women, especially in situations in which no provocation is involved (Bettencourt & Miller, 1996).

Cultural Similarities and Differences

As discussed throughout the chapter, there are cultural differences in the association between gender and emotions (e.g., Fischer & Manstead, 2000; Moran et al., 2013; Novin, Tso, & Konrath, 2013; Szarota, 2010). On the other hand, often similarities are notable. Across 37 countries, women reported more intense emotions that last longer and are expressed more overtly than do men (Fischer & Manstead, 2000), and women in both China and the United States reported a higher intensity of emotion than men after viewing emotionally evocative photographs of negative events, with Chinese men reporting the lowest intensities and American women the highest (Davis et al., 2012). In other cross-cultural studies, females express more nonverbal emotional reactions—including facial reactions, vocal reactions, body movements, laughing, and smiling—when expressing joy, sadness, fear, and anger than males do (Scherer et al., 1986). Moreover, in a six-nation study using U.S. and Japanese college students as posers of facial expressions, the emotions portrayed by females were more accurately judged by every cultural group, even though the photographs were intended to be standardized exemplars (Biehl et al., 1997). However, interactions among gender of judge, gender of poser, and culture have also been found to exist for at least some emotions (Matsumoto, 1992).

Gender differences in emotional expression across cultures are likely to vary as a function of cultural values, especially individualistic versus collectivistic values (giving priority to personal goals vs. loyalty to collective/group goals). Collectivism needs to be distinguished from relational values, which prioritize maintaining intimate relationships and are more characteristic of women than men across cultures (Kashima et al., 1995). In Fischer and Manstead's (2000) data, the extent of gender differences in the intensity and duration of joy, shame, disgust, and guilt, and in the nonverbal behaviors associated with those emotions, were greater in individualistic than in collectivistic countries (see also Novin, Tso, & Konrath, 2013, for similar findings concerning anger). Similarly, gender differences in the reported intensity of emotion in response to scenarios depicting joy, fear, and anger were not significant in a sample of American blacks, who are hypothesized to have more collectivistic values than other American ethnic groups (Vrana & Rollock, 2002). Fischer and Manstead (2000) theorize that males in individualistic cultures are apt to minimize emotional expressions because expressing emotions might threaten the control that is critical to their status.

The expression of specific emotions is also likely to be affected by the gender role norms that characterize each culture. For example, women have been found to express their anger more directly than men in countries with a more egalitarian gender ideology (Fischer et al., 2004). In a recent study, Chinese and American participants were instructed to "just feel" versus "to try not to have an emotional reaction" in response to distressing images (Davis et al., 2012). Chinese women's and American men's responses varied as a function of the two conditions, but Chinese men and American women's responses did not, showing that Chinese men conformed to emotional moderation norms, and American women conformed to emotional expression norms.

Physiological Arousal

Research suggests that gender differences in physiological arousal, including changes in heart rate, blood pressure, skin conductance levels, and levels of catecholamines (epinephrine and norepinephrine), are specific to particular physiological measures and emotions, as well as to particular tasks, sample characteristics, and circumstances (including participants' motives and goals; see Brody, 1999). Studies of neuroendocrine functioning and blood pressure mostly show men to be more aroused than women, while studies of cardiovascular reactivity and skin conductance levels show inconsistent gender difference patterns, most probably because of moderating contextual variables (Chentsova-Dutton & Tsai, 2007; Fernández et al., 2012; Kring & Gordon, 1998; Labouvie-Vief, Lumley, Jain, & Heinze, 2003; Neumann & Waldstein, 2001; Polefrone & Manuck, 1987). Recent research also explores how sex hormones and menstrual cycle phase influence emotion learning processes such as fear conditioning and extinction (Aue & Vuilleumier, 2013).

Internalizers, Externalizers, Generalizers, and Low Responders

Gender differences in the patterns of correspondence between physiological arousal and other modes of emotional expression, such as self-reports and facial expressions, are consistent with gender differences in emotion regulation, and in fact often provide clues as to emotion control strategies. Earlier work (Buck, 1977; Manstead, 1991) suggested that men were more often "internalizers," showing physiological arousal with no overt emotional expressions, whereas women were more often "externalizers," showing overt emotional expressions with no corresponding physiological arousal. More recent studies confirm these patterns (Ordaz & Luna, 2012), but also indicate that women are relatively more likely than men to be "generalizers" (Brody, 1999), showing concordance in their expression of emotion, even at young ages (Quas, Hong, Alkon, & Boyce, 2000), and especially at high levels of physiological reactivity (Avero & Calvo, 1999). In contrast, men are more likely than women to be "low responders" (Kring & Gordon, 1998), showing no or low levels of expression across modalities.

A recent study confirmed these patterns in measuring verbal reports of disgust and skin conductance levels in response to disgusting images, such as vomit, on the part of opponents and supporters of gay marriage. Women's self-reports of disgust and skin conductance levels both predicted gay marriage attitudes; for men, there were physiological, but not self-reported, differences between supporters and opponents of gay marriage (Balzer & Jacobs, 2011). Discordance among males may be related to maintaining control or suppressing the behaviors and self-reports that correspond to arousal (Avero & Calvo, 1999), whereas concordance among females may be related to heightened emotional awareness of self and others and to female-stereotypic gender roles that encourage emotional expression.

Exceptions to these patterns sometimes occur in studies of marital interaction, in which husbands' arousal is more likely to correspond to negative affect than wives' (Levenson et al., 1994; but see Kiecolt-Glaser et al., 1996). Further, men's cardiovascular reactivity is more often related to their expression and suppression of anger than is women's (Burns & Katkin, 1993).

Neural Substrates of Emotion

Using functional magnetic resonance imaging (fMRI) and positron emission tomography (PET), researchers are studying potential sex differences in the brain regions involved in emotional expression, perception, and experience (Proverbio, Adorni, Zani, & Trestianu, 2009), especially in limbic system activation and brain lateralization (Schienle, Schafer, Stark, Watler, & Vaitl, 2005). Although fMRI and PET data are intriguing, they are also plagued with small sample sizes, the lack of a coherent theoretical model incorporating the idea that biological development is both influenced by and influences the social context, and inconsistencies or confusion in interpreting whether and how a gender difference in brain activity might translate to differences in specific mental processes (Fine, 2013). Researchers often fail to consider that gender differences in the activation of a specific brain region in response to emotional stimuli can result from a multitude of processes, including differences in attention, the quality of emotional experience, the imagery associated with the experience, or the expression of emotion in different modalities (Wager & Ochsner, 2005). Activation itself has been interpreted in different and sometimes contradictory ways. Some researchers infer that if a brain area is activated, it means that the area is strong for mediating a particular function, such as language or attention, while in direct contradiction, other researchers infer that activation means the brain area is weak for a particular function, with the area needing to compensate and work harder (see Brody, 1999). Similarly, when sex differences in brain size or activation are observed, results are sometimes interpreted to mean that the biological difference prevents sex differences in behavior, an interpretation made when no behavioral differences are found, and at other times to mean that the biological sex difference creates behavioral sex differences (Cahill, 2006).

Moreover, as pointed out by Fine (2013), false-positive errors are often made because null findings of gender differences (both original studies and attempted replications) are frequently not published. Although biological differences are undoubtedly a contributing factor to gender differences in emotion, and new technologies are an exciting tool to further that understanding, relevant research needs to incorporate a more contextual understanding of gender and a more thoughtful approach to interpreting gender difference results.

Etiology of Gender Differences

Gender-related differences in motives, goals, social circumstances, and life experiences are consistent with many of the data we have reviewed about gender differences in emotion. For instance, the emotions that women tend to express more than men (e.g., warmth, happiness, shame, fear, anxiety, and nervousness), their relatively stronger abilities in emotional decoding, higher levels of emotional awareness and competence, and higher facial and nonverbal expressiveness may be related to motives and interests in affiliation and intimacy; a self-schema based on interdependence; perceived vulnerability in the face of lower resources and power; a history of interpersonal trauma; and traditional gender roles, including child caretaking and social bonding, which necessitate reading others' emotion signals.

Higher levels of shame, guilt, and self-blame have been associated with being a victim of interpersonal trauma (Beck et al., 2011), and women suffer from posttraumatic stress disorder with accompanying heightened anxiety at higher rates than men (Breslau, Davis, Andreski, & Peterson, 1991; Kessler et al., 1995). New research on economic scarcity, suffered by women more than men, indicates that it is associated with impaired problem-solving abilities, perhaps mediated by higher levels of anxiety (Mullainathan & Shafir, 2014). As argued by Chrisler (2008), women's lower power and status affords them fewer opportunities to exercise control over their lives than men have, and leads to feelings of incompetence and self-derogation.

In fact, women rate their emotional intelligence as lower than men rate theirs (in contradiction to their measured emotional intelligence; see earlier section), conforming to a pattern of self-derogation for women and self-enhancement for men even in the emotional realm (Petrides & Furnham, 2000). In German fifth-grade students (Frenzel, Pekrun, & Goetz, 2007), girls' lower competence beliefs about their math abilities compared with boys partly contributed to girls' reports of lower enjoyment and pride, and higher anxiety, hopelessness, and shame in math achievement, even though girls and boys had received similar math grades. Not only do lower status and control lead to more dysphoric emotions but they are also associated with the perception that risks are less manageable, which is in turn associated with the experience of higher fear and anxiety. In fact, women experience stronger negative affect in response to negative outcomes than do men, especially fear and anxiety (Ranehill & Boschini, 2013).

Higher levels of male loneliness and contempt sometimes reported are consistent with male roles of differentiating from and competing with others, with maintaining a relatively high-status position, and with a self-schema based on individualism. Emotional withdrawal and constriction may be adaptive in the face of exposure to combat and violence, experiences more typical of men than women. The types of emotion regulation strategies that differ for women and men, and their differing rationales for using them (maintaining intimacy vs. maintaining control), are consistent with gender role-related motives and undoubtedly contribute to some of the gender differences in patterns of expressiveness, including concordance/externalizing and discordance/internalizing. That gender differences in some aspects of emotion grow weaker as adults age is also consistent with the idea that emotions are adaptive for gender roles, which become less rigid in later life (Gutmann, 1987).

However, sociocultural and gender-related variables (especially in isolation, as main effects) cannot always account for gender differences in emotion. For example, evidence indicates that status differences do not account well for gender differences in nonverbal behavior (Hall, Coats, & Smith LeBeau, 2005). In our view, multiple interrelated factors contribute to the etiology of gender differences that span cultural, biological, societal, interpersonal, and intrapersonal levels of analysis, and that coexist with multiple moderating and mediating factors. We propose two etiological models that encompass proximal and distal factors; interpersonal and intrapersonal feedback processes; and the complex intertwining of situational, sociocultural, biological, personality, and cognitive factors both over time and in specific situations.

A Developmental Perspective

The first model includes distal factors, such as gender differences in temperament, family socialization history, gender-segregated play patterns, and cultural values, all of which contribute to the nature of gender differences. An integration of these factors involves a feedback loop in which differing temperamental characteristics of male and female infants elicit differential responses from caretakers and peers, who are conforming to cultural pressures and display rules for gender socialization.

Differing temperamental characteristics include higher activity and arousal levels in males and faster maturation rates for inhibitory control processes and attention focusing in females (see Brody, 1999; Else-Quest et al., 2006; Goldberg & Lewis, 1969). Females' higher levels of self-control may partly contribute to their higher levels of agreeableness and sociability later in development (Goodwin & Gotlib, 2004), because higher levels of self-control (along with early language development) would make it more likely that girls would attend to socioemotional relationships and rules. In turn, agreeableness significantly predicts other emotional processes that are heightened in women, including emotional intensity and attempts to regulate emotion (Tobin et al., 2000). The finding that 13-month-old boys are less likely to play in close proximity to their mothers as compared with 13-month-old girls (Goldberg & Lewis, 1969) may be partly due to sons' higher activity levels, and this pattern of behavior may result in boys becoming less attuned to the emotional expression of others.

The socialization of emotion is especially influenced by characteristics of the family system, including the parents' own temperaments, their gender role attitudes and behaviors, the quality of their marital relationships, their cultural and socioeconomic backgrounds, and the gender constellation of the children in their families (Brody, 1999). The quality of parent–child narrative discourse and interaction has been found to vary as a function of the gender composition of the parent–child dyad, the type of emotion expressed, and the family's ethnic background, which affects the particular display rules surrounding gender and emotion (Nelson, Leerkes, O'Brien, Calkins, & Marcovitch, 2012). For example, fathers attend more to their preschool daughters' emotions of sadness and anxiety than to their sons', and to their sons' expressions of anger than to their daughters'; parental attention also predicts the later expression of sadness and anxiety 2 years later (Chaplin et al., 2005). In both Chinese and American samples, mothers provide more explanations about the causes of emotion to their 3-year-old daughters than to their sons of the same age (Wang, 2001). American mothers also use more emotion labels in conversations with preschool daughters than with sons, and mothers' use of emotion labels significantly predicts individual differences in children's use of emotion labels (Cervantes & Callanan, 1998; see also Cassano, Perry-Parrish, & Zeman, 2007). These patterns change with age in accordance with display rules (e.g., 11- to 16-year-old boys and their parents reported that boys were punished more for their expression of anger than girls; Klimes-Dougan et al., 2007). Although fathers who were more involved in child care had sons and daughters who expressed less gender role-stereotypic emotions as compared with less involved fathers (Brody, 1997), fathers generally respond more strongly than mothers when their children violate gender stereotypes about emotional expression (Cassano et al., 2007). Parents, especially fathers, were less likely to respond in a supportive manner when they were led to believe that their 8- to 10-year-old children, especially sons, violated gender role expectancies for sadness expression (Cassano & Zeman, 2010). The nature of these gendered parent–child interactions varies by child's age, ethnicity, and culture (Lewis, 1972; Nelson et al., 2012).

Finally, gender-segregated peer groups and differentiated patterns of play and conflict both elicit and reinforce gender role-specific emotional styles (Rose & Rudolph, 2006; Noakes & Rinaldi, 2006). Children report regulating emotions in interactions with peers more than parents for fear of interpersonal consequences (Zeman & Garber, 1996). Teachers also engage in gender-differentiated emotional interactions. More distance and conflict are reported in teacher–male student relationships than teacher–female student relationships in first and second graders (perhaps as a function of boys' higher arousal levels and girls' higher control), which may in turn affect the quality of emotions boys experience and express (Koepke & Harkins, 2008).

Putting Distal and Proximal Causes Together: The Example of Smiling

The second model integrates distal factors—such as gender differences in social roles and cultural values, social knowledge, and developmental history—with proximal factors (including characteristics of the situation, quality of affect, and expectations and treatment by others) to account for gender differences in expressiveness, using smiling as an illustration (Hall, Carter, & Horgan, 2000). Key to the model are feedback processes that intensify women's positive affect during social interactions, thereby increasing their smiling. In turn, smiling enhances positive affect through physiological mechanisms and attributional processes (Strack et al., 1988).

If we take women's greater smiling as a starting point, regardless of its immediate cause, facial feedback would produce more positive affect in women than in men. Positive psychological feedback can also follow from smiling due to gender-related motives and traits. For example, if women smile partly to fulfill their internalized conception of how a woman is expected to behave, this would reinforce feelings of adequacy and generate positive affect, which would produce more smiling. Other gender-related motives are interpersonal trust, liking for others, and capacity for intimacy. Some of these motives intrinsically imply more positive affect and smiling (such as liking others). But, in addition, the knowledge that one has acted on these motives (showing that one is trusting, that one likes others, etc.) produces positive affect, because one is acting in concordance with a gender-relevant value (Wood, Christensen, Hebl, & Rothgerber, 1997). In turn, others respond favorably, contributing to the cycle. Women may also use smiling in the service of social skills to put others at ease, facilitate interaction, and defuse conflict. Again there would be positive feedback, because it is reinforcing to feel socially competent and to know that one has promoted comfort and communication, which in turn promotes more smiling. And others' favorable reactions produce positive affect and more smiling. Finally, smiling itself is highly reciprocal: The more one is smiled at, the more one will smile back (Hinsz & Tomhave, 1991). Because women are smiled at more than men, this could contribute to women's smiling and produce a self-fulfillment of others' expectations. And reciprocity (or mimicry as behavioral matching is often called) is itself rewarding, contributing yet more to the intensity of women's positive affect and smiling.

Thus, women experience numerous positive feedback cycles involving their own behavior, their cognitions, their physiological processes, and others' expectations and behaviors. These combine to create enhanced positive affect in their immediate social interactions compared with men's, which ultimately influences how much they smile relative to men. No research has connected all of the elements in this model so it remains hypothetical at present (see also Hankin & Abramson, 2001, for a similar model explaining women's depression).

Concluding Thoughts

In this chapter, we have emphasized that gender itself is multifaceted and that participants categorized as "women" or "men" based on an assumption of shared biology do not necessarily share a common identity or identical biological and social experiences. Further, the pattern and complexity of gender differences in emotional processes (with "gender" needing specific definition and deconstruction) can only be understood as a function of the motivational, situational, social, and cultural contexts in which they occur, as well as with reference to the characteristics of the specific participants, emotional tasks, and processes being investigated (see also Shields, 2013). Understanding the etiology of gender differences involves integrating multiple interacting variables, including those that are distal (e.g., temperament) and proximal (e.g., situational context). The most productive strategy for future research involves incorporating a diverse set of variables as both mediators and moderators, seeking to understand the types of contexts in which gender, as one aspect of identity among many, becomes salient; studying samples that vary in ethnicity, country of origin, sexual orientation, gender roles, and gender identities; recognizing the complex reciprocal interactions among biological and social processes; and understanding the role that different socialization experiences and life circumstances, including exposure to poverty and different types of trauma, play in gender differences in emotional processes.

References

Aamodt, M. G., & Custer, H. (2006). Who can best catch a liar?: A meta-analysis of individual differences in detecting deception. *The Forensic Examiner, 15*, 6–11.

Adams, R. B., Jr., Nelson, A. J., Soto, J. A., Hess, U., & Kleck, R. E. (2012). Emotion in the neutral face: A mechanism for impression formation? *Cognition and Emotion, 26*, 431–441.

Aldrich, N. J., & Tenenbaum, H. R. (2006). Anger, sadness, and frustration: Gendered patterns in early adolescents' and their parents' emotion talk. *Sex Roles, 55*, 775–785.

Algoe, S. B., Buswell, B. N., & DeLamater, J. D. (2000).

Gender and job status as contextual cues for the interpretation of facial expression of emotion. *Sex Roles, 42*, 183–208.

Arulampalam, W., Booth, A. L., & Bryan, M. L. (2006). Is there a glass ceiling over Europe?: Exploring the gender pay gap across the wages distribution. *Industrial and Labor Relations Review, 60*, 163–186.

Aue, T., & Vuilleumier, P. (2013). Gender and the affective brain: Neuroscientific perspectives. In I. Latu, M. Schmid Mast, & S. Kaiser (Eds.), *Gender and emotion: An interdisciplinary perspective* (pp. 93–105). Bern, Switzerland: Lang.

Avero, P., & Calvo, M. G. (1999). Emotional reactivity to social–evaluative stress: Gender differences in response systems concordance. *Personality and Individual Differences, 27*, 155–170.

Balzer, A., & Jacobs, C. M. (2011). Gender and physiological effects in connecting disgust to political preferences. *Social Science Quarterly, 92*, 1297–1313.

Barrett, L. F., Robin, L., Pietromonaco, P. R., & Eyssell, K. M. (1998). Are women the "more emotional" sex?: Evidence from emotional experiences in social context. *Cognition and Emotion, 12*, 555–578.

Baucom, B. R., McFarland, P. T., & Christensen, A. (2010). Gender, topic, and time in observed demand–withdraw interaction in cross- and same-sex couples. *Journal of Family Psychology, 24*, 233–242.

Beck, J. G., McNiff, J., Clapp, J. D., Olsen, S. A., Avery, M. L., & Hagewood, J. H. (2011). Exploring negative emotion in women experiencing intimate partner violence: Shame, guilt, and PTSD. *Behavior Therapy, 42*, 740–750.

Beilock, S. L., Rydell, R. J., & McConnell, A. R. (2007). Stereotype threat and working memory: Mechanisms, alleviation, and spillover. *Journal of Experimental Psychology: General, 136*, 256–276.

Bem, S. L. (1981). Gender schema theory: A cognitive account of sex typing. *Psychological Review, 88*, 354–364.

Benetti-McQuoid, J., & Bursik, K. (2005). Individual differences in experiences of and responses to guilt and shame: Examining the lenses of gender and gender role. *Sex Roles, 53*, 133–142.

Bettencourt, B. A., & Miller, N. (1996). Gender differences in aggression as a function of provocation: A meta-analysis. *Psychological Bulletin, 119*, 422–447.

Biehl, M., Matsumoto, D., Ekman, P., Hearn, V., Heider, K., Kudoh, T., et al. (1997). Matsumoto and Ekman's Japanese and Caucasian Facial Expressions of Emotion (JACFEE): Reliability data and cross-national differences. *Journal of Nonverbal Behavior, 21*, 3–21.

Blau, F. D., & Kahn, L. M. (2006). The U.S. gender pay gap in the 1990s: Slowing convergence. *Industrial and Labor Relations Review, 60*, 45–66.

Brescoll, V. L., & Uhlmann, E. L. (2008). Can an angry woman get ahead?: Status conferral, gender, and expression of emotion in the workplace. *Psychological Science, 9*, 268–275.

Breslau, N., Davis, G. C., Andreski, P., & Peterson, E. (1991). Traumatic events and posttraumatic stress disorder in an urban population of young adults. *Archives of General Psychiatry, 48*, 216–222.

Briton, N. J., & Hall, J. A. (1995). Beliefs about female and male nonverbal communication. *Sex Roles, 32*, 79–90.

Brody, L. R. (1993). On understanding gender differences in the expression of emotion: Gender roles, socialization and language. In S. Ablon, D. Brown, E. Khantzian, & J. Mack (Eds.), *Human feelings: Explorations in affect development and meaning* (pp. 89–121). Hillsdale, NJ: Analytic Press.

Brody, L. R. (1997). Beyond stereotypes: Gender and emotion. *Journal of Social Issues, 53*, 369–393.

Brody, L. R. (1999). *Gender, emotion and the family*. Cambridge, MA: Harvard University Press.

Brody, L. R., Kelso, G. W., Kim, J. H., Hirsch, S., Ferguson, T., Bullis, J., et al. (2009, February). *Male and female role models as moderating emotional responses to stereotype threats about women's leadership abilities*. Poster session at the Society for Personality and Social Psychology, Tampa, FL.

Brody, L. R., Muderrisoglu, S., & Nakash-Eisikovits, O. (2002). Emotions, defenses, and gender. In R. F. Bornstein & J. M. Masling (Eds.), *The psychodynamics of gender and gender role* (pp. 203–249). Washington, DC: American Psychological Association.

Buck, R. (1977). Nonverbal communication accuracy in preschool children: Relationships with personality and skin conductance. *Journal of Personality and Social Psychology, 33*, 225–236.

Bugental, D. E., Love, L. R., & Gianetto, R. M. (1971). Perfidious feminine faces. *Journal of Personality and Social Psychology, 17*, 314–318.

Buntaine, R. L., & Costenbader, V. K. (1997). Self-reported differences in the experience and expression of anger between girls and boys. *Sex Roles, 36*, 625–637.

Burke, R. J., Weir, T., & Harrison, D. (1976). Disclosure of problems and tensions experienced by marital partners. *Psychological Reports, 38*, 531–542.

Burns, J. W., & Katkin, E. S. (1993). Psychological, situational, and gender predictors of cardiovascular reactivity to stress: A multivariate approach. *Journal of Behavioral Medicine, 16*, 445–465.

Butler, D., & Geis, F. L. (1990). Nonverbal affect responses to male and female leaders: Implications for leadership evaluations. *Journal of Personality and Social Psychology, 58*, 48–59.

Cadinu, M., Maass, A., Rosabianca, A., & Kiesner, J. (2005). Why do women underperform under stereotype threat?: Evidence for the role of negative thinking. *Psychological Science, 16*, 572–578.

Cahill, L. (2006). Why sex matters for neuroscience. *Nature Reviews Neuroscience, 7*, 477–484.

Callahan, J. L., Hasler, M. G., & Tolson, H. (2005). Perceptions of emotion expressiveness: Gender differences among senior executives. *Leadership and Organization Development Journal, 26*, 512–528.

Cassano, M., Perry-Parrish, C., & Zeman, J. (2007). Influence of gender on parental socialization of children's sadness regulation. *Social Development, 16*, 210–231.

Cassano, M. C., & Zeman, J. L. (2010). Parental socialization of sadness regulation in middle childhood: The role of expectations and gender. *Developmental Psychology, 46*, 1214–1226.

Cervantes, C. A., & Callanan, M. A. (1998). Labels and explanations in mother–child emotion talk: Age and gender differentiation. *Developmental Psychology, 34*, 88–98.

Chant, S. (2006). Re-thinking the "feminization of poverty" in relation to aggregate gender indices. *Journal of Human Development, 7*, 201–220.

Chaplin, T. M., Cole, P. M., & Zahn-Waxler, C. (2005). Parental socialization of emotion expression: Gender differences and relations to child adjustment. *Emotion, 5*, 80–88.

Chentsova-Dutton, Y. E., & Tsai, J. L. (2007). Gender differences in emotional response among European Americans and Hmong Americans. *Cognition and Emotion, 21*, 162–181.

Chovil, N. (1991–1992). Discourse-oriented facial displays in conversation. *Research on Language and Social Interaction, 25*, 163–194.

Chrisler, J. C. (2008). Fear of losing control: Power, perfectionism, and the psychology of women. *Psychology of Women Quarterly, 32*, 1–12.

Ciarrochi, J., Hynes, K., & Crittenden, N. (2005). Can men do better if they try harder?: Sex and motivational effects on emotional awareness. *Cognition and Emotion, 19*, 133–141.

Coats, E. J., & Feldman, R. S. (1996). Gender differences in nonverbal correlates of social status. *Personality and Social Psychology Bulletin, 22*, 1014–1022.

Cramer, P. (2002). The study of defense mechanisms: Gender implications. In R. F. Bornstein & J. M. Masling (Eds.), *The psychodynamics of gender and gender role* (pp. 81–128). Washington, DC: American Psychological Association.

Cross, S. E., & Madson, L. (1997). Models of the self: Self-construals and gender. *Psychological Bulletin, 122*, 5–37.

Davis, E., Greenberger, E., Charles, S., Chen, C., Zhao, L., & Dong, Q. (2012). Emotion experience and regulation in China and the United States: How do culture and gender shape emotion responding? *International Journal of Psychology, 47*, 230–239.

Davis, P. J. (1999). Gender differences in autobiographical memory for childhood emotional experiences. *Journal of Personality and Social Psychology, 76*, 498–510.

Day, A. L., & Carroll, S. A. (2004). Using an ability-based measure of emotional intelligence to predict individual performance, group performance, and group citizenship behaviors. *Personality and Individual Differences, 36*, 1443–1458.

Diener, E., Sandvik, E., & Larsen, R. J. (1985). Age and sex effects for emotional intensity. *Developmental Psychology, 21*, 542–546.

Diener, M. L., & Lucas, R. E. (2004). Adults' desires for children's emotions across 48 countries. *Journal of Cross-Cultural Psychology, 35*, 525–547.

Dimberg, U., & Lundquist, L. (1990). Gender differences in facial reactions to facial expressions. *Biological Psychology, 30*, 151–159.

Dindia, K., & Allen, M. (1992). Sex differences in self-disclosure: A meta-analysis. *Psychological Bulletin, 112*, 106–124.

Doherty, R. W. (1997). The Emotional Contagion Scale: A measure of individual differences. *Journal of Nonverbal Behavior, 21*, 131–154.

Domagalski, T. A., & Steelman, L. A. (2007). The impact of gender and organization status on workplace anger expression. *Management Communication Quarterly, 20*, 297–315.

Dunsmore, J. C., Her, P., Halberstadt, A. G., & Perez-Rivera, M. B. (2009). Parents' beliefs about emotions and children's recognition of parents' emotions. *Journal of Nonverbal Behavior, 33*, 121–140.

Durik, A. M., Hyde, J. S., Marks, A. C., Roy, A. L., Anaya, D., & Schultz, G. (2006). Ethnicity and gender stereotypes of emotion. *Sex Roles, 54*, 429–445.

Else-Quest, N. M., Higgins, A., Allison, C., & Morton, L. C. (2012). Gender differences in self-conscious emotional experience: A meta-analysis. *Psychological Bulletin, 138*, 947–981.

Else-Quest, N. M., Hyde, J. S., Goldsmith, H. H., & Van Hulle, C. A. (2006). Gender differences in temperament: A meta-analysis. *Psychological Bulletin, 132*, 33–72.

Ethier, K. A., & Deaux, K. (1994). Negotiating social identity when contexts change: Maintaining identification and responding to threat. *Journal of Personality and Social Psychology, 67*, 243–251.

Evers, C., Fischer, A. H., Rodriguez Mosquera, P. M., & Manstead, A. R. (2005). Anger and social appraisal: A "spicy" sex difference? *Emotion, 5*, 258–266.

Fabes, R. A., Eisenberg, N., Hanish, L., & Spinrad, T. (2001). Preschoolers' spontaneous use of emotion language: Relations to likeability. *Journal of Early Education and Development, 12*, 11–27.

Ferguson, T. J., Eyre, H. L., & Ashbasker, M. (2000). Unwanted identities: A key variable in shame–anger links and gender differences in shame. *Sex Roles, 42*, 133–157.

Fernández, C., Pascual, J. C., Soler, J., Elices, M., Portella, M. J., & Fernández-Abascal, E. (2012). Physiological responses induced by emotion-eliciting films. *Applied Psychophysiology and Biofeedback, 37*, 73–79.

Fine, C. (2013). Is there neurosexism in functional neuroimaging investigations of sex differences? *Neuroethics, 6*, 369–409.

Fischer, A. H., & Evers, C. (2011). The social costs and benefits of anger as a function of gender and relationship context. *Sex Roles, 65*, 23–34.

Fischer, A. H., & Manstead, A. S. R. (2000). The relation between gender and emotion in different cultures. In A. H. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 71–98). New York: Cambridge University Press.

Fischer, A. H., Rodriguez Mosquera, P. M., van Vianen, A. E. M., & Manstead, A. S. R. (2004). Gender and culture differences in emotion. *Emotion, 4*, 87–94.

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007). Girls and mathematics—a "hopeless" issue?: A control–value approach to gender differences in emotions towards mathematics. *European Journal of Psychology of Education, 22*, 497–514.

Gilbert, D., & Waltz, J. (2010). Mindfulness and health behaviors. *Mindfulness, 1*, 227–234.

Girdler, S. S., Turner, J. R., Sherwood, A., & Light, K. C. (1990). Gender differences in blood pressure control during a variety of behavioral stressors. *Psychosomatic Medicine, 52*, 571–591.

Gohm, C. L., & Clore, G. L. (2000). Individual differences in emotional experience: Mapping available scales to processes. *Personality and Social Psychology Bulletin, 26*, 679–697.

Goldberg, S., & Lewis, M. (1969). Play behavior in the year-old infant: Early sex differences. *Child Development, 40*, 21–31.

Goodwin, R. D., & Gotlib, I. H. (2004). Gender differences in depression: The role of personality factors. *Psychiatry Research, 126*, 135–142.

Gottman, J. M., Levenson, R. W., Swanson, C., Swanson, K., Tyson, R., & Yoshimoto, D. (2003). Observing gay, lesbian and heterosexual couples' relationships: Mathematical modeling of conflict interaction. *Journal of Homosexuality, 45*, 65–91.

Green, D. L., & Diaz, N. (2008). Gender differences in coping with victimization. *Brief Treatment and Crisis Intervention, 8*, 195–203.

Greenfield, J. (2008). Coming out: The process of forming a positive identity. In H. J. Makadon, K. H. Mayer, J. Potter, & H. Goldhammer (Eds.), *Fenway guide to lesbian, gay, bisexual, and transgender health* (pp. 45–74). Philadelphia: College of Physicians Press.

Gross, J. J., & John, O. P. (1998). Mapping the domain of expressivity: Multimethod evidence for a hierarchical model. *Journal of Personality and Social Psychology, 74*, 170–191.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*, 348–362.

Grossman, M., & Wood, W. (1993). Sex differences in intensity of emotional experience: A social role interpretation. *Journal of Personality and Social Psychology, 65*, 1010–1022.

Gunnery, S. D., Hall, J. A., & Ruben, M. A. (2013). The deliberate Duchenne smile: Individual differences in expressive control. *Journal of Nonverbal Behavior, 37*, 29–41.

Gutmann, D. (1987). *Reclaimed powers: The new psychology of men and women in later life*. New York: Basic Books.

Halberstadt, A. G., Hayes, C. W., & Pike, K. M. (1988). Gender and gender role differences in smiling and communication consistency. *Sex Roles, 19*, 589–604.

Hall, J. A. (1984). *Nonverbal sex differences: Communication accuracy and expressive style*. Baltimore, MD: Johns Hopkins University Press.

Hall, J. A., Blanch, D. C., Horgan, T. G., Murphy, N. A., Rosip, J. C., & Schmid Mast, M. (2009). Motivation and interpersonal sensitivity: Does it matter how hard you try? *Motivation and Emotion, 33*, 291–302.

Hall, J. A., & Briton, N. J. (1993). Gender, nonverbal behavior, and expectations. In P. D. Blanck (Ed.), *Interpersonal expectations: Theory, research, and applications* (pp. 276–295). Cambridge, UK: Cambridge University Press.

Hall, J. A., & Carter, J. D. (1999). Gender-stereotype accuracy as an individual difference. *Journal of Personality and Social Psychology, 77*, 350–359.

Hall, J. A., Carter, J. D., & Horgan, T. G. (2000). Gender differences in the nonverbal communication of emotion. In A. H. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 97–117). New York: Cambridge University Press.

Hall, J. A., Coats, E. J., & Smith LeBeau, L. (2005). Nonverbal behavior and the vertical dimension of social relations: A meta-analysis. *Psychological Bulletin, 131*, 898–924.

Hall, J. A., & Gunnery, S. D. (2013). Gender differences in nonverbal communication. In J. A. Hall & M. L. Knapp (Eds.), *Nonverbal communication* (Vol. 2, pp. 639–669). Berlin, Germany: deGruyter Mouton.

Hankin, B. L., & Abramson, L. Y. (2001). Development of gender differences in depression: An elaborated cognitive vulnerability–transactional stress theory. *Psychological Bulletin, 127*, 773–796.

Hasher, L., & Zacks, R. T. (1984). Automatic processing of fundamental information: The case of frequency of occurrence. *American Psychologist, 39*, 1372–1388.

Hecht, M. A., & LaFrance, M. (1998). License or obligation to smile: The effect of power and sex on amount and type of smiling. *Personality and Social Psychology Bulletin, 24*, 1332–1342.

Hess, U., Adams, R. B., Jr., & Kleck, R. E. (2004). Facial appearance, gender, and emotional expression. *Emotion, 4*, 378–388.

Hess, U., Senecal, S., Kirouac, G., Herrera, P., Philippot, P., & Kleck, R. E. (2000). Emotional expressivity in men and women: Stereotypes and self-perceptions. *Cognition and Emotion, 14*, 609–642.

Hinsz, V. B., & Tomhave, J. A. (1991). Smile and (half) the world smiles with you, frown and you frown alone. *Personality and Social Psychology Bulletin, 17*, 586–592.

Ickes, W., Gesn, P. R., & Graham, T. (2000). Gender differences in empathic accuracy: Differential ability or differential motivation? *Personal Relationships, 7*, 95–109.

Jack, D. C., & Dill, D. (1992). The Silencing the Self Scale: Schemas of intimacy associated with depression in women. *Psychology of Women Quarterly, 16*, 97–106.

Johnson, H. M., & Spector, P. E. (2007). Service with a smile: Do emotional intelligence, gender, and autonomy moderate the emotional labor process? *Journal of Occupational Health Psychology, 12*, 319–333.

Kashima, Y., Yamaguchi, S., Kim, U., Choi, S., Gelfand, M. J., & Yuki, M. (1995). Culture, gender and self: A perspective from individualism–collectivism research. *Journal of Personality and Social Psychology, 69*, 925–937.

Kelly, J. R., & Hutson-Comeaux, S. L. (2000). The appropriateness of emotional expression in women and men: The double-bind of emotion. *Journal of Social Behavior and Personality, 15*, 515–528.

Kelso, G., & Brody, L. R. (2014). Implicit processes and emotions in stereotype threat about women's leadership. In J. Zheng (Ed.), *Exploring implicit cognition: Learning, memory, and social–cognitive processes* (pp. 118–137). Hershey, PA: IGI Global.

Kessler, R. C., Sonnega, A., Bromet, E., Hughes, M., & Nelson, C. B. (1995). Posttraumatic stress disorder in the National Comorbidity Study. *Archives of General Psychiatry, 52*, 1048–1060.

Kiecolt-Glaser, J. K., Newton, T., Cacioppo, J. T., MacCallum, R. C., Glaser, R., & Malarkey, W. B. (1996). Marital conflict and endocrine function: Are men really more physiologically affected than women? *Journal of Consulting and Clinical Psychology, 64*, 324–332.

Kirkland, R. A., Peterson, E., Baker, C. A., Miller, S., & Pulos, S. (2013). Meta-analysis reveals adult female superiority in "Reading the Mind in the Eyes" Test. *North American Journal of Psychology, 15*, 121–146.

Klimes-Dougan, B., Brand, A. E., Zahn-Waxler, C., Usher, B., Hastings, P. D., Kendziora, K., et al. (2007). Parental emotion socialization in adolescence: Differences in sex, age and problem status. *Social Development, 16*, 326–342.

Kluwer, E. S., Tumewu, M., & van den Bos, K. (2009). Men's and women's reactions to fair and unfair treatment in relationship conflict. *Personal Relationships, 16*, 455–474.

Koch, S. C. (2005). Evaluative affect display toward male and female leaders of task-oriented groups. *Small Group Research, 36*, 678–703.

Koepke, M. F., & Harkins, D. A. (2008). Conflict in the classroom: Gender differences in the teacher–child relationship. *Early Education and Development, 19*, 843–864.

Krauss, R. M., Chen, Y., & Chawla, P. (1996). Nonverbal behavior and nonverbal communication: What do conversational hand gestures tell us? In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 28. pp. 389–450). San Diego, CA: Academic Press.

Kring, A. M. (2000). Gender and anger. In A. H. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 211–231). New York: Cambridge University Press.

Kring, A. M., & Gordon, A. H. (1998). Sex differences in emotion: Expression, experience, and physiology. *Journal of Personality and Social Psychology, 74*, 686–703.

Krumhuber, E. G., & Manstead, A. S. R. (2009). Can Duchenne smiles be feigned?: New evidence on felt and false smiles. *Emotion, 9*, 807–820.

Labouvie-Vief, G., Lumley, M. A., Jain, E., & Heinze, H. (2003). Age and gender differences in cardiac reactivity and subjective emotion responses to emotional autobiographical memories. *Emotion, 3*, 115–126.

LaFrance, M., Hecht, M. A., & Levy Paluck, E. (2003). The contingent smile: A meta-analysis of sex differences in smiling. *Psychological Bulletin, 129*, 305–334.

Larson, R. W., Richards, M. H., & Perry-Jenkins, M. (1994). Divergent worlds: The daily emotional experience of mothers and fathers in the domestic and public spheres. *Journal of Personality and Social Psychology, 67*, 1034–1046.

Leahy, R. L. (2012). Introduction: Emotional schemas, emotion regulation, and psychopathology. *International Journal of Cognitive Therapy, 5*, 359–361.

Lecours, S., Sanlian, N., & Bouchard, M. (2007). Assessing verbal elaboration of affect in clinical interviews: Exploring sex differences. *Bulletin of the Menninger Clinic, 71*, 227–247.

Lennon, R., & Eisenberg, N. (1987). Gender and age differences in empathy and sympathy. In N. Eisenberg & J. Strayer (Eds.), *Empathy and its development* (pp. 195–217). Cambridge, UK: Cambridge University Press.

Levenson, R. W., Carstensen, L. L., & Gottman, J. M. (1994). The influence of age and gender on affect, physiology, and their interrelations: A study of long-term marriages. *Journal of Personality and Social Psychology, 67*, 56–68.

Lewis, M. (1972). State as an infant–environment interaction: An analysis of mother–infant interaction as a function of sex. *Merrill–Palmer Quarterly, 18*, 95–121.

Lewis, M., & Ramsay, D. (2002). Cortisol response to embarrassment and shame. *Child Development, 73*(4), 1034–1045.

MacGregor, M. W., & Davidson, K. (2000). Men's and women's hostility is perceived differently. *Journal of Research in Personality, 34*, 252–261.

Manstead, A. S. R. (1991). Expressiveness as an individual difference. In R. S. Feldman & B. S. Rimé (Eds.), *Fundamentals of nonverbal behavior* (pp. 285–328). Cambridge, UK: Cambridge University Press.

Matsumoto, D. (1992). American–Japanese cultural differences in the recognition of universal facial expressions. *Journal of Cross-Cultural Psychology, 23*, 72–84.

Matsumoto, D., Takeuchi, S., Andayani, S., Kouznetsova, N., & Krupp, D. (1998). The contribution of individualism vs. collectivism to cross-national differences in display rules. *Asian Journal of Social Psychology, 1*, 147–165.

Matthews, G., Zeidner, M., & Roberts, R. D. (2002). *Emotional intelligence: Science and myth*. Cambridge, MA: MIT Press.

Mayer, J. D., Caruso, D. R., & Salovey, P. (2000). Emotional intelligence meets traditional standards for an intelligence. *Intelligence, 27*, 267–298.

McClure, E. B. (2000). A meta-analytic review of sex differences in facial expression processing and their development in infants, children, and adolescents. *Psychological Bulletin, 126*, 424–453.

Mead, N., & Bower, P. (2000). Patient-centredness: A conceptual framework and review of the empirical literature. *Social Science and Medicine, 51*, 1087–1110.

Miller, G. A., Levin, D. N., Kozak, M. J., Cook, E. W., McLean, A., & Lang, P. J. (1987). Individual differences in imagery and the psychophysiology of emotion. *Cognition and Emotion, 1*, 367–390.

Mirgain, S. A., & Cordova, J. (2007). Emotion skill and marital health: The association between observed and self-reported emotion skills, intimacy, and marital satisfaction. *Journal of Social and Clinical Psychology, 26*, 983–1009.

Mor, N., Doane, L. D., Adam, E. K., Mineka, S., Zinbarg, R. E., Griffith, J. W., et al. (2010). Within-person variations in self-focused attention and negative affect in depression and anxiety: A diary study. *Cognition and Emotion, 24*, 48–62.

Moran, C. M., Diefendorff, J. M., & Greguras, G. J. (2013). Understanding emotional display rules at work and outside of work: The effects of country and gender. *Motivation and Emotion, 37*, 323–334.

Morelen, D., Zeman, J., Perry-Parrish, C., & Anderson, E. (2012). Children's emotion regulation across and within nations: A comparison of Ghanaian, Kenyan, and American youth. *British Journal of Developmental Psychology, 30*, 415–431.

Mullainathan, S., & Shafir, E. (2014). Freeing up intelligence. *Scientific American Mind, 25*, 58–63.

Neel, R., Becker, D. V., Neuberg, S. L., & Kenrick, D. T. (2012). Who expressed what emotion?: Men grab anger, women grab happiness. *Journal of Experimental Social Psychology, 48*, 583–586.

Nelis, D., Kotsou, I., Quoidbach, J., Hansenne, M., Weytens, F., Dupuis, P., et al. (2011). Increasing emotional competence improves psychological and physical well-being, social relationships, and employability. *Emotion, 11*, 354–366.

Nelson, J. A., Leerkes, E. M., O'Brien, M., Calkins, S. D., & Marcovitch, S. (2012). African American and European American mothers' beliefs about negative emotions and emotion socialization practices. *Parenting: Science and Practice, 12*, 22–41.

Neumann, S. A., & Waldstein, S. R. (2001). Similar patterns of cardiovascular response during emotional activation as a function of affective valence and arousal and gender. *Journal of Psychosomatic Research, 50*, 245–253.

Niedzwienska, A. (2003). Gender differences in vivid memories. *Sex Roles, 49*, 321–331.

Noakes, M. A., & Rinaldi, C. M. (2006). Age and gender differences in peer conflict. *Journal of Youth and Adolescence, 35*, 881–891.

Nolen-Hoeksema, S. (2012). Emotion regulation and psychopathology: The role of gender. *Annual Review of Clinical* Psychology, 8, 161–187.

Nolen-Hoeksema, S., & Jackson, B. (2001). Mediators of the gender difference in rumination. *Psychology of Women Quarterly, 25*, 37–47.

Nolen-Hoeksema, S., Larson, J., & Grayson, C. (1999). Explaining the gender difference in depressive symptoms. *Journal of Personality and Social Psychology, 77*, 1061–1072.

Novin, S., Tso, I. F., & Konrath, S. H. (2013, August 3). Self-related and other-related pathways to subjective well-being in Japan and the United States. *Journal of Happiness Studies*. Retrieved from *http://link.springer.com.ezproxy.proxy.library.oregonstate.edu/article/10.1007%2Fs10902-013-9460-9*.

Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Sciences, 9*, 242–249.

Ordaz, S., & Luna, B. (2012). Sex differences in physiological reactivity to acute psychosocial stress in adolescence. *Psychoneuroendocrinology, 37*, 1135–1157.

Osborne, J. W. (2001). Testing stereotype threat: Does anxiety explain race and sex differences in achievement? *Contemporary Educational Psychology, 26*, 291–310.

Palomares, N. (2008). Explaining gender-based language use: Effects of gender identity salience on references to emotion and tentative language in intra- and intergroup contexts. *Human Communication Research, 34*, 263–286.

Patterson, M. L., & Tubbs, M. E. (2005). Through a glass darkly: Effects of smiling and visibility on recognition and avoidance in passing encounters. *Western Journal of Communication, 69*, 219–231.

Perry-Parrish, C., & Zeman, J. (2011). Relations among sadness regulation, peer acceptance, and social functioning in early adolescence: The role of gender. *Social Development, 20*, 135–153.

Petrides, K. V., & Furnham, A. (2000). Gender differences in measured and self-estimated trait emotional intelligence. *Sex Roles, 42*, 449–461.

Plant, E. A., Hyde, J. S., Keltner, D., & Devine, P. G. (2000). The gender stereotyping of emotions. *Psychology of Women Quarterly, 24*, 81–92.

Plant, E. A., Kling, K. C., & Smith, G. L. (2004). The influence of gender and social role on the interpretation of facial expressions. *Sex Roles, 51*, 187–196.

Polefrone, J. M., & Manuck, S. B. (1987). Gender differences in cardiovascular and neuroendocrine response to stressors. In R. Barnett, L. Biener, & G. Baruch (Eds.), *Gender and stress* (pp. 13–38). New York: Free Press.

Proverbio, A., Adorni, R., Zani, A., & Trestianu, L. (2009). Sex differences in the brain response to affective scenes with or without humans. *Neuropsychologia, 47*, 2374–2388.

Quas, J., Hong, M., Alkon, A., & Boyce, W. T. (2000). Dissociations between psychobiologic reactivity and emotional expression in children. *Developmental Psychobiology, 37*, 153–175.

Ranehill, E., & Boschini, A. (2013). Gender differences in risk aversions: The role of emotions. In I. Latu, M. Schmid Mast, & S. Kaiser (Eds.), *Gender and emotion: An interdisciplinary perspective* (pp. 133–153). Bern, Switzerland: Lang.

Rimé, B., Mesquita, B., Philippot, P., & Boca, S. (1991). Beyond the emotional event: Six studies on the social sharing of emotion. *Cognition and Emotion, 5*, 435–465.

Robinson, M. D., & Clore, G. L. (2002). Belief and feeling: Evidence for an accessibility model of emotional self-report. *Psychological Bulletin, 128*, 934–960.

Robinson, M. D., & Johnson, J. T. (1997). Is it emotion or is it stress?: Gender stereotypes and the perception of subjective experience. *Sex Roles, 36*, 235–258.

Robinson, M. D., Johnson, J. T., & Shields, S. A. (1998). The gender heuristic and the database: Factors affecting the perception of gender-related differences in the experience and display of emotions. *Basic and Applied Social Psychology, 20*, 206–219.

Rohrmann, S., Hopp, H., & Quirin, M. (2008). Gender differences in psychophysiological responses to disgust. *Journal of Psychophysiology, 22*, 65–75.

Rose, A. J., & Rudolph, K. D. (2006). A review of sex differences in peer relationship processes: Potential trade-offs for the emotional and behavioral development of girls and boys. *Psychological Bulletin, 132*, 98–131.

Roter, D. L., Hall, J. A., & Aoki, Y. (2002). Physician gender effects in medical communication: A meta-analytic review. *Journal of the American Medical Association, 288*, 756–764.

Rusting, C. L., & Nolen-Hoeksema, S. (1998). Regulating responses to anger: Effects of rumination and distraction on angry mood. *Journal of Personality and Social Psychology, 74*, 790–803.

Safdar, S., Friedlmeier, W., Matsumoto, D., Yoo, S. H., Kwantes, C. T., Kakai, H., et al. (2009). Variations of emotional display rules within and across cultures: A comparison between Canada, USA, and Japan. *Canadian Journal of Behavioural Science, 41*, 1–10.

Sallquist, J., Eisenberg, N., Spinrad, T. L., Reiser, M., Hofer, C., Liew, J., et al. (2009). Positive and negative emotionality: Trajectories across six years and relations with social competence. *Emotion, 9*, 15–28.

Scherer, K. R., Wallbott, H. G., & Summerfield, A. B. (1986). *Experiencing emotion: A cross-cultural study*. New York: Cambridge University Press.

Schieman, S., & Van Gundy, K. (2000). The personal and social links between age and self-reported empathy. *Social Psychology Quarterly, 63*, 152–174.

Schienle, A., Schafer, A., Stark, R., Walter, B., & Vaitl, D. (2005). Gender differences in the processing of disgust and fear-inducing pictures: An fMRI study. *NeuroReport, 16*, 277–280.

Schmid Mast, M., & Hall, J. A. (2004). Who is the boss and who is not?: Accuracy of judging status. *Journal of Nonverbal Behavior, 28*, 145–165.

Schultz, D., Izard, C. E., & Bear, G. G. (2004). Emotionality, emotion information processing, and aggression. *Development and Psychopathology, 16*, 371–387.

Scott, B. A., & Barnes, C. M. (2011). A multilevel field investigation of emotional labor, affect, work withdrawal, and gender. *Academy of Management Journal, 54*, 116–136.

Seidlitz, L., & Diener, E. (1998). Sex differences in the recall of affective experiences. *Journal of Personality and Social Psychology, 74*, 262–271.

Shields, S. A. (1987). Women, men, and the dilemma of emotion. In P. Shaver & C. Hendrick (Eds.), *Sex and gender* (pp. 229–250). Thousand Oaks, CA: Sage.

Shields, S. A. (2013). What we think we know, what we need to know, and why it matters. *Psychology of Women Quarterly, 37*, 423–435.

Simon, R. W., & Nath, L. E. (2004). Gender and emotion in the United States: Do men and women differ in self-reports of feelings and expressive behavior? *American Journal of Sociology, 109*, 1137–1176.

Simpson, P. A., & Stroh, L. K. (2004). Gender differences: Emotional expression and feelings of personal inauthenticity. *Journal of Applied Psychology, 89*, 715–721.

Sloan, M. M. (2012). Controlling anger and happiness at work: An examination of gender differences. *Gender, Work and Organization, 19*, 370–391.

Smith, T. W., Berg, C. A., Florsheim, P., Uchino, B. N., Pearce, G., Hawkins, M., et al. (2009). Conflict and collaboration in middle-aged and older couples: I. Age differences in agency and communion during marital interaction. *Psychology and Aging, 24*, 259–273.

Spence, J. T., & Helmreich, R. L. (1978). *Masculinity and femininity: Their psychological dimensions, correlates and antecedents*. Austin: University of Texas Press.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69*, 797–811.

Stets, J. E. (1997). Status and identity in marital interaction. *Social Psychology Quarterly, 60*, 185–217.

Stewart, A. J., & McDermott, C. (2004). Gender in psychology. *Annual Review of Psychology, 55*, 519–544.

Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: A nonobtrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology, 54*, 768–777.

Su, R., Rounds, J., & Armstrong, P. (2009). Men and things, women and people: A meta-analysis of sex differences in interests. *Psychological Bulletin, 135*, 859–884.

Szarota, P. (2010). The mystery of the European smile: A comparison based on individual photographs provided by internet users. *Journal of Nonverbal Behavior, 34*, 249–256.

Tenenbaum, H. R., Ford, S., & Alkhedairy, B. (2011). Telling stories: Gender differences in peers' emotion talk and communication style. *British Journal of Developmental Psychology, 29*, 707–721.

Thayer, R. E., Newman, J. R., & McClain, T. M. (1994). Self-regulation of mood: Strategies for changing a bad mood, raising energy, and reducing tension. *Journal of Personality and Social Psychology, 67*, 910–925.

Thelwall, M., Wilkinson, D., & Uppal, S. (2010). Data mining emotion in social network communication: Gender differences in MySpace. *Journal of the American Society for Science and Technology, 61*, 190–199.

Thomaes, S., Stegge, H., Olthof, T., Bushman, B. J., & Nezlek, J. B. (2011). Turning shame inside-out: "Humiliated fury" in young adolescents. *Emotion, 11*, 786–793.

Timmers, M., Fischer, A. H., & Manstead, A. S. R. (1998). Gender differences in motives for regulating closeness. *Personality and Social Psychology Bulletin, 24*, 974–985.

Timmers, M., Fischer, A. H., & Manstead, A. S. R. (2003). Ability versus vulnerability: Beliefs about men's and women's emotional behavior. *Cognition and Emotion, 17*, 41–63.

Tobin, R. M., Graziano, W. G., Vanman, E. J., & Tassinary, L. G. (2000). Personality, emotional experience, and efforts to control emotions. *Journal of Personality and Social Psychology, 79*, 656–669.

Tsaousis, I., & Kazi, S. (2013). Factorial invariance and latent mean differences of scores on trait emotional intelligence across gender and age. *Personality and Individual Differences, 54*, 169–173.

Vogel, D. L., Wester, S. R., Heesacker, M., & Madon, S. (2003). Confirming gender stereotypes: A social role perspective. *Sex Roles, 48*, 519–528.

Vrana, S. R., & Rollock, D. (2002). The role of ethnicity, gender, emotional content, and contextual differences in physiological, expressive, and self-reported emotional responses to imagery. *Cognition and Emotion, 16*, 165–192.

Wager, T. D., & Ochsner, K. N. (2005). Sex differences in the emotional brain. *NeuroReport, 16*, 85–87.

Wang, Q. (2001). "Did you have fun?": American and Chinese mother–child conversations about shared emotional experiences. *Cognitive Development, 16*, 693–715.

Wang, Q. (2013). Gender and emotion in everyday event memory. *Memory, 21*, 503–511.

Weinrich, J. D. (1987). *Sexual landscapes: Why we are what we are, why we love whom we love*. New York: Scribner.

Wood, W., Christensen, P. N., Hebl, M. R., & Rothgerber, H. (1997). Conformity to sex-typed norms, affect, and the self-concept. *Journal of Personality and Social Psychology, 73*, 523–535.

Young, G., & Zeman, J. (2003, April). *Emotional expression management and social acceptance in childhood*. Presented at the biennial meeting of the Society for Research in Child Development, Tampa, FL.

Zeman, J., & Garber, J. (1996). Display rules for anger, sadness, and pain: It depends on who is watching. *Child Development, 67*, 957–973.

Zeman, J., & Shipman, K. (1998). Influence of social context on children's affect regulation: A functionalist perspective. *Journal of Nonverbal Behavior, 22*, 141–165.

Zhou, Q., Eisenberg, N., Wang, Y., & Reiser, M. (2004). Chinese children's effortful control and dispositional anger/frustration: Relations to parenting styles and children's social functioning. *Developmental Psychology, 40*, 352–366.

Zlomke, K. R., & Hahn, K. S. (2010). Cognitive emotion regulation strategies: Gender differences and associations to worry. *Personality and Individual Differences, 48*, 408–413.

CHAPTER 22

The Cultural Psychology of Emotions

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Cultural differences in emotions inform us about the ways in which socio-cultural environments influence emotions. Cultural differences make us aware of our own culture: They challenge what we assume to be "natural," and they show the boundary conditions of the emotional processes as we know them. Most of all, cultural differences in emotions show the plasticity of emotions, and their adaptation to the specific socio-cultural environment in which they occur. In this chapter we discuss the many ways in which emotions differ across cultures.

Evidence for cultural differences in emotions is not sufficient in and of itself to prove the accuracy of particular theories of emotion. Yet, it does render certain theoretical claims about emotions more plausible and more useful than others. This chapter not only reviews cultural differences in emotions but also speaks to the power of various theoretical perspectives to account for the established differences.

In order to understand why there may be cultural differences in emotions at all, it is important to see that emotions imply the positioning of individuals in their context. "The point is that an emotion is not merely a 'feeling,' as, say, pain is a feeling. It is . . . a reaching out to the world" (Solomon, 2003, p. 49). Emotions are not just subjective experiences, but rather, they claim a particular representation of the world and they represent the individual's (intended) dealings with this relationship (Frijda, 1986, 2007; Mesquita, 2010; Parkinson, Fischer, & Manstead, 2005). For instance, anger is a claim that the individual is entitled to more than he or she receives, and it represents a stance of nonacceptance. Emotions (aim to) change relationships in a given direction, or alternatively, maintain their current state. They are thus consequential to the individual's social environment.

Because emotions stand for certain interpretations of reality, they are culturally "moralized" (Shweder, Haidt, Horton, & Joseph, 2008). Emotions that fit the cultural ideals are valued or condoned, whereas emotions that violate the cultural ideals are condemned. In the previous edition of this volume, Shweder and his colleagues illustrated this principle by comparing American *anger* with its Tibetan counterpart, *lung lang.* Whereas the dictionary translation of *lung lang* is "being angry," *lung lang* and anger have divergent moral connotations. Anger fits the central American value of autonomy and assertiveness, and is regarded as a natural response that should be accepted by an individual. In contrast, *lung lang* is considered a morally bad feeling because it is at odds with the Buddhist emphasis on compassion and the ethical code of speaking, acting, and living in nonharmful ways. The Buddhist Tibetans regard *lung lang* as "a fundamentally destructive sentiment, equally harmful to self and others . . . as arising from an intrinsically flawed motivational state (a desire to harm another sentient being) and generative of ultimately bad results" (p. 416). Shweder and colleagues showed how these different moral connotations translate into differences in the quality, prevalence, intensity, and duration of the respective emotions themselves. In many cases, cultural differences in emotions can be understood from differences in the moral meaning of the interpretations they represent. Cultural differences in morality of particular emotions make the landscape of cultural differences in emotions meaningful and coherent.

In this chapter, we review evidence for cultural differences in the experience, expression, and regulation of emotion. In doing so, we discuss how cultural variations in emotions may be adaptive in the respective cultural contexts.

Cultural Differences in Emotional Experience

Cultural differences in emotional experience have been established in different ways. A first line of research has established cultural differences in the prevalence and intensity of particular emotional experiences, such as anger and shame. The guiding assumption in this type of research is that there is overlap in the experiences cross-culturally associated with the emotion concepts included in the study. For example, anger and shame are, at some level, comparable across cultures; starting from this assumption, the research then compares the prevalence and intensity of these experiences. A second line of research starts from one or more particular emotion concepts that have comparable equivalents across cultures, and investigates the degree to which these emotion concepts in fact reflect similar (or different) experiences. Here the assumption is that, while different concepts for anger can be meaningfully compared, they diverge in equally meaningful ways. A third line of research takes a slightly different approach, and studies cultural differences in the kinds of phenomena that are recognized as emotional. It assumes that an emotion like shame does not just exist but rather is constructed from available information, and it studies cross-culturally which types of information are required in order to have an emotional experience of shame. We discuss these different types of evidence.

Cultural Differences in the Most Prevalent and Intense Emotions

The most prevalent and intense emotions differ across cultures in ways that can be understood from differences in their moral connotations (Mesquita, 2003; Mesquita & Leu, 2007). Emotions that are conducive to important cultural ideals tend to be more prevalent and intense, and emotions that violate cultural ideals tend to be rare and suppressed (see Mesquita, 2003; Mesquita & Leu, 2007, for overviews). Many ethnographies evolve around the conspicuous presence of emotions that are conducive to cultural ideals, or the conspicuous absence of emotions that violate them. For instance, the anthropologist Lila Abu-Lughod (Abu-Lughod, 1986) describes the ubiquity of shame (*haslam*) in the Awlad 'Ali, a Beduin tribe in Egypt. Shame occurs whenever one's honor is threatened or violated, but every event that reveals a person's lack of autonomy or dependence is interpreted as such, including every encounter with people higher in the hierarchy (for women: men). In contrast, in *Never in Anger* the anthropologist Jean Briggs (Briggs, 1970) takes the near absence of anger as the starting point of her ethnography on the Utku Inuits in Northern Canada. Because the Utku Inuits depend on one another for survival during the long, severe winter, maintaining harmony is a central goal that is cultivated in many ways. Avoidance of anger, and the confrontations that ensue, is one of them.

Cross-culturally comparative research has similarly yielded cultural differences in the most prevalent and intense emotions that can be understood from important cultural ideals (Kitayama, Markus, & Kurokawa, 2000; Kitayama, Mesquita, & Karasawa, 2006). Shinobu Kitayama and his colleagues compared the prevalence and intensity of emotions in North American and Japanese college students. The emotions included in this research were sampled from the four quadrants of a two-dimensional space defined by valence (positive, negative) and social engagement (socially engaged, socially disengaged). Previous research had yielded the same two dimensions in the United States and Japan (Kitayama et al., 2000). In this space, the social engagement dimension describes the extent to which emotions reflect the relatedness, or conversely, the separation between people. For example, friendliness (positive) and shame (negative) are engaging emotions that underscore the relatedness and interdependence with other people. That friendliness emphasizes relatedness is obvious; for shame it may be less obvious. However, shame reflects concern with (the opinion of) others and promotes alignment with the social rules; in this sense, it is focused on restoring the relationship as well. In contrast, pride (positive) and anger (negative) underline the separation between people, and thus serve independence and autonomy.

Cross-cultural comparison of the frequency and intensity of emotions yielded a clear pattern (Kitayama et al., 2006). In each culture, emotions that promoted culturally central goals and values were more frequent and more intense. In (middle-class) European American contexts, where individuals strive to be both independent and autonomous, socially disengaging emotions were found to be more intense and more frequent; in contrast, in Japanese cultural contexts, where the main goals are interdependence, relatedness, and harmony, socially engaging emotions were found to be more intense and more frequent (Kitayama et al., 2000; Kitayama et al., 2006). The cultural differences were replicated across different methods: They were found for frequency ratings in a retrospective self-report study (Kitayama et al., 2000), for intensity ratings with regard to the most important emotional event in a daily diary study (Kitayama et al., 2006, Study 1), and for intensity ratings with respect to recently experienced instances of a standard list of about 20 situation types (Kitayama et al., 2006, Study 2). The latter study suggests that cultural differences in intensity were not merely due to differences in the types of situations that people from different cultures typically encounter (but see the section "Cultural Promotion of Situations"). The findings are corroborated by observations from other research, and thus inspire confidence. For instance, other researchers have also described shame as a focal and valued emotion in Japanese cultural contexts (e.g., Benedict, 1946; Heine, Lehman, Markus, & Kitayama, 1999; Lebra, 1983).

Other evidence for nonrandom culturally different patterns of emotions comes from research comparing the intensity profiles on a variety of emotional experiences across different cultural groups. In this research, participants described their experience in response to a number of well-chosen, standardized situational prompts. The prompts were representative of the domain of emotional experience, and varied with respect to valence (positive, negative), social engagement (engaged, disengaged), and context (work/school, home). For each prompt, we compared individuals' patterns of emotion ratings (on 20–30 different emotions) to a cultural average pattern for the same prompt (De Leersnyder, Mesquita, & Kim, 2011). In two studies, we respectively compared the emotional patterns of European Americans against those of Koreans, and of Belgians against those of Turks (De Leersnyder, Kim, & Mesquita, 2015). All participants resided in their native countries, and in both studies, cultures were chosen to differ in important ways. Same-culture fit was consistently higher in all cultures, meaning that there are cultural differences in the typical patterns of emotions.

In the same studies, we also included immigrant groups: first and later generations of Korean Americans and Turkish Belgians, respectively. We found that immigrants' fit with the new culture's average emotional pattern held the middle between that of individuals from the new and from the heritage culture (De Leersnyder et al., 2011, 2015). For instance, Turkish Belgians fit the average Belgian emotional patterns significantly better than did Turks in Turkey, but worse than the Belgian majority. This suggests the possibility that exposure to a new culture changes the most prevalent/intense emotions. Consistently, immigrants' emotional fit with the new culture's emotions could be predicted from the number of years spent in the new culture and number of contacts with majority members of the new culture; this was true for Turkish immigrants in Belgium and Korean immigrants in the United States. Other studies replicated these findings: Contacts with majority members predicted fit with the new culture's emotions in a nationally representative sample of minority youth in Belgium (Jasini, De Leersnyder, & Mesquita, 2015) as well as with four different groups of immigrant minority women in the United States (Consedine, Chentsova-Dutton, & Krivoshekova, 2014), rendering more confidence in the results. We have not yet examined the nature of the changes in detail, but would predict that emotional patterns change to better fit the ideals and values of the new culture. The data with immigrants suggest that engagement in the culture contributes to the cultural shaping of emotions. Moreover, cultural shaping may happen throughout life and is not restricted to early socialization.

Cultural Varieties of Emotional Experience

The research reviewed so far suggests that there are differences in the frequency and intensity of emotions, but is not conclusive with respect to the quality or nature of emotions. There is increasing evidence that the quality of emotions varies across cultures as well (see Mesquita, 2003; Mesquita & Frijda, 1992; Mesquita, Frijda, & Scherer, 1997; Mesquita & Leu, 2007; Shweder et al., 2008). We distinguish two approaches to research on the varieties of emotion. In a first approach, researchers cross-culturally compare the characteristic components of a given emotion. This approach has essentialist overtones, in that it assumes the correspondence of an emotion concept to one particular experience (see the section "Characteristic Components of Emotions"). The question addressed by this research is to what extent the experience is similar or different in different cultures. In a second approach, researchers are interested in the different varieties of experience subsumed under one emotion concept. This approach starts from the assumption that, in each culture, people use a given emotion concept to refer to a variety of experiences (see the section "Varieties of Emotional Experience"). The question addressed by research following this second approach is to what extent certain varieties of an emotion cross-culturally occur at different rates.

Characteristic Components of Emotions

One strand of research starts from the idea that there may be cross-cultural differences in the components characterizing certain emotions. Much of the cross-cultural research has used a single format: Across various cultures, participants describe a situation in which they experienced a given emotion, and rate the presence of different aspects of that emotion—most notably appraisals, action tendencies, and somatic changes. Given that this type of research starts from the lexical equivalents in different languages, it should not be surprising that most of this research yields a cross-culturally similar core of meaning for each emotion. In one of the key studies, students from 37 different countries across the world (Scherer, 1997a, 1997b; Scherer & Wallbott, 1994) reported instances of joy, fear, anger, sadness, disgust, shame, and guilt. Each of these emotions was characterized by a similar core of appraisal and action readiness. For instance, joy was characterized as very pleasant, expected, requiring no action, and enhancing self-esteem, and was associated with "moving toward."

Against the backdrop of these similarities, many studies have found meaningful cultural differences in appraisal as well. For instance, individual agency and control (self-responsibility vs. other responsibility) were more strongly associated with negative emotions in Western than in non-Western cultures (Mauro, Strefeler, Weeden, & Reisch, 1992; Scherer, 1997b, as cited in Mesquita & Ellsworth, 2001). In one of the early studies comparing emotions in Japanese and U.S. contexts (Matsumoto, Kudoh, Scherer, & Wallbott, 1988), agency was found to be a central aspect of negative emotional experience for U.S. students, but considered "not applicable" by many Japanese students. Differences in appraisal can often be related to the dominant cultural views on reality: In cultures that value the independence of individuals, personal agency and control are "chronically accessible," and, therefore, become readily part of the meaning of emotional events.

Differences in control appraisals were also central in a study that compared the experience of *amae* for North American and Japanese participants (Niiya, Ellsworth, & Yamaguchi, 2006). *Amae* is a Japanese emotion that does not have an equivalent in English. It has been described as the feeling you have when another person depends on your love, makes inappropriate requests, and expects you to indulge or help him or her. Despite the absence of an English equivalent, North American and Japanese participants in this particular study appraised situations in which Japanese participants had previously reported to feel *amae* (i.e., others making inappropriate requests) in similar ways—for example, both North American and Japanese participants perceived the relationship with the other as closer during *amae* situations than during similar situations that did not involve *amae*. However, against the background of this cross-culturally similar experience, there were differences in control appraisals, with North American participants experiencing higher levels of control than Japanese in situations of *amae*. These differences in control can be understood from differences in the meaning of *amae*: For Japanese, "Amae implies closeness, trust, and security in relationships," whereas for Americans, "issues of patronage and pity may lurk in the background, creating heightened sensitivity to issues of control and the balance of power" (p. 292). Amae is a good experience in Japan where it stands for the right kind of interdependence, but is ambivalent in the United States where it signals intimacy, but potentially a threat of independence as well. The different connotations of amae have consequences for the frequency of the emotion in the respective cultures as well: "in a culture that emphasizes interdependence, people may be more tolerant of inappropriate requests, may interpret them more as a sign of intimacy, and may consequently experience positive Amae more frequently. On the other hand, in a culture that emphasizes self-sufficiency, people may experience positive Amae in fewer situations, with a more limited number of close others, and hence less frequently" (p. 292). Differences in the experience of emotions may thus have consequences for the frequency and intensity of the emotion as well.

This is also clear in the example provided by Shweder and his colleagues (2008) in the previous edition of this volume. Shweder compared the North American emotion of anger with its Tibetan equivalent *lung lang*, with respect to different components. The affective phenomenology, appraisals, self-management, communication, symbolization, and social management of anger and *lung lang* were all different in ways that could be understood from the respective connotations of anger and *lung lang*. For instance, anger lingered longer than *lung lang*, which can be understood from its positive connotation. In contrast, *lung lang* felt "as though drunk or crazy," and it co-occurred with a host of other dysphoric emotions, such as regret, shame, and unhappiness (affective phenomenology), because *lung lang* is a morally bad emotion. Consistently, anger was expressed, channeled, cultivated, and sometimes controlled, but *lung lang* was transformed, calmed, prevented, and extinguished by the respective cultural practices.

Cultural Differences in Appraisals

Some cross-cultural research has moved away from comparing emotions and toward comparing the particular ways in which people in different cultures make meaning of similar situations; this is what cognitive theories of emotion have called "appraisal." The findings from this type of cross-cultural research suggest, once again, that cultural differences in appraisal can be reduced to, and understood from, the prevalent cultural meanings and practices.

For example, claiming responsibility and having a sense of personal control is particularly important to independent cultural contexts, especially the European American; success thus stems from personal accomplishment (Markus & Kitayama, 1991b). In contrast, East Asian models of self stress fate and the interdependence of an individual and his or her social context; outcomes thus stem from a combination of circumstances (Fiske, Kitayama, Markus, & Nisbett, 1998; Heine et al., 1999; Nisbett, Peng, Choi, & Norenzayan, 2001). Indeed, it has been widely documented that European Americans have a pervasive tendency to attribute success to themselves, and failure to others or the situation, whereas the opposite is true for East Asians (e.g., Heine et al., 1999). A recent study tested what consequences these cultural differences in the appraisal of causal agency would have for emotional experience (Imada & Ellsworth, 2011). In this study, Japanese and European American college students were asked to remember success and failure situations; indicate if these situations had been caused by themselves, others, or circumstances; and rate the intensity of their feelings. The pattern of success and failure attributions was consistent with the observed self-enhancing tendency that is characteristic of European American contexts (attributing success to the self and failure to the context) and the tendency to focus on self-improvement that is characteristic of interdependent Japanese contexts (attributing success to circumstances and failure to the self). Furthermore, this cultural difference in appraisal was reflected in cultural differences in experience: European Americans reported to feel pride in success, and anger or bad luck when they failed; Japanese reported to feel lucky in success, and shame when they failed. Thus, people's habitual appraisals may differ across cultures in ways that make culturally valued emotional experiences more likely.

Similarly, some studies have further documented how cultural differences in the appraisals of agency and control may be linked to differences in the experience of frustration and anger. In fact, to experience frustration or anger is to appraise the situation in terms of its inconsistency with personal goals, the responsibility of other people, and the possibility of gaining control over the situation by forcing others to accommodate to your wishes (Frijda, 1986). Because in independent cultural contexts there is an emphasis on pursuing personal goals, protecting high self-esteem, being in control, and on influencing others, people in these contexts may more readily make use of the appraisals that are central to anger and frustration, rendering these experiences more likely in independent than in interdependent cultural contexts (Boiger, Mesquita, Tsai, & Markus, 2012; Morling, Kitayama, & Miyamoto, 2002; Savani, Markus, Naidu, Kumar, & Berlia, 2010; Weisz, Rothbaum, & Blackburn, 1984). A study by Roseman and colleagues nicely illustrated this idea (Roseman, Dhawan, Rettek, Naidu, & Thapa, 1995). In this study, Indian and American college students reported instances of anger, sadness, and fear, and rated their experiences on several appraisal dimensions. Consistent with the reasoning outlined above, Roseman and colleagues (1995) found that Indian college students not only reported lower overall intensities of both sadness and anger but also rated their self-reported emotional events to be less "incongruent with their motives" than did their American counterparts; in fact, the cultural differences in emotion intensity were fully mediated by the perception of motive incongruency.

Another domain of appraisal on which cultures tend to differ is the domain of morality (Shweder et al., 2008; Shweder, Much, Mahapatra, & Park, 1997). In fact, three forms of ethics have been proposed: (1) the ethics of autonomy, which have to do with individual rights, freedom, and justice; (2) the ethics of community, which center around social hierarchy, duty, and loyalty; and (3) the ethics of divinity, which are about sanctity, purity, and "the natural order of things." There is some evidence that another person's violation of each of these ethics is paired to a rather specific negative emotional experience toward that person. Several vignette studies (Laham, Chopra, Lalljee, & Parkinson, 2010; Rozin, Lowery, Imada, & Haidt, 1999) have found that violations of the ethics of autonomy were more readily associated with anger, violations of community with contempt, and violations of divinity with disgust.

What most of these cross-cultural studies have in common is that they compare the average, modal, or typical emotional experiences in different cultures. This assumes that, within each culture, a given emotion concept corresponds to *one* characteristic experience. The next section describes a different approach to cultural differences in emotional experience.

Varieties of Emotional Experience

It may be more accurate to assume that there is more than one type of emotional experience associated with a given emotion concept, say anger (Kuppens, Van Mechelen, Smits, De Boeck, & Ceulemans, 2007). If this were the case, averaging responses by culture is not the best way of describing emotional experiences associated with an emotion concept: Averaging the ratings across different instances of an emotion has the disadvantage that cultural differences in the varieties of emotions can be over- or underestimated. For instance, anger may in most cases be felt in the same way as *lung lang*, with some notable differences that skew the average; or alternatively, anger may in most cases be a distinct experience from *lung lang*, but different varieties of, respectively, anger and *lung lang* average each other out, and conceal the differences.

In a recent study, we examined cross-cultural differences in the types of experiences most typically associated with anger and shame in three different cultures: the United States, Belgium, and Japan (Boiger, De Leersnyder, et al., 2013). We looked at respondents' intensity ratings of either anger or shame as well as their appraisals and action readiness in particular situations. We started from a representative sample of situations, which ensured that the varieties of anger and shame that emerged from the data reflect the range of experiences as they occur in the three cultures. To infer the varieties of anger and shame, we used a bottom-up classification program (CLASSI; Ceulemans & Van Mechelen, 2008) that infers different "types of people" from the data, using the associations between appraisal and action readiness patterns and emotions across many different data points—the different situations.

In this study, we found three different varieties of anger—actually three types of people who have unique patterns of appraisals and action tendencies associated with anger across the different situations included. All three varieties occurred in every culture, but not to the same extent. The most typical experiences of anger could be understood from the respective cultural models. There was a clear Japanese type of anger, in the sense that 55% of the Japanese respondents were classified under this "person type." Scrutinizing the specific appraisals and action tendencies revealed that this type of person experiences anger in ways that hurts the relationships with others least: nodding and smiling is a prominent response, and so is rumination. The American person type for anger (i.e., the type that described the largest proportion of Americans; 43%) emphasized the boundaries between the person and other people the clearest: It was strongly associated with both blaming the other person and giving him or her a piece of your mind. Finally, there was a third type of anger that can be referred to as the "Belgian type" (37%) in the sense that it was not taken by the other two cultural groups. Although the different person types did not fully coincide with the different cultural groups—all three types occurred in all three cultures—we were still able to correctly predict the culture of a particular respondent from the type of anger he or she experienced with 43% accuracy (which is significantly higher than chance level).

For shame we found two varieties: one "American" (85% of the American respondents belonged to this person type for shame) and one "Japanese" (92% of the Japanese belonged to this person type). Still, both varieties occurred in all three cultures. The specific appraisal and action readiness pattern associated with American shame involved a focus on what others were thinking and on your own responsibility for what happened. This is an understandable variety, given the American concern with self-esteem. In contrast, Japanese shame was characterized by an attempt to regain composure, which fits the Japanese emphasis on relational smoothness. Interestingly, the Belgian respondents were almost equally divided between these two varieties of shame. Based on these two varieties, we were able to correctly predict whether the respondent was Japanese or Western with more than 70% accuracy.

From this research, we conclude that there are multiple varieties of emotions, in terms of the appraisals and action tendencies associated with emotional experience. Even if the same varieties of experience can be found in different cultures, there appear to be cultural differences in the prevalence of each variety. The most typical variety appeared to be the one that best fit the cultural meanings and ideals. This new approach to study cultural differences in emotional experience—in terms of the frequency distributions of certain varieties of emotions—leads away from an essentialist notion of emotions: An emotion is a concept referring to a cluster of experiences, rather than a "thing." It is a first step to the question of how people "do emotions," and away from the question of which emotions people "have" (Mesquita, 2010). We return to this issue later.

Cultural Differences in the Experiences Recognized as Emotions

A final way to approach differences in emotional experience is to focus on differences in the types of phenomena recognized to constitute an emotion. This is what the anthropologist Paul Heelas (1986) refers to when he puts forward the hypothesis that

> Emotion talk functions as a kind of spotlight. Depending on culture, it dwells on whatever is taken to be associated with those raw experiences necessary for emotions . . . . How raw experiences are constituted as emotions depends on how they are illuminated. . . . Emotional elements which have no light thrown on them remain in the dark. And emotions which are focused on become enriched and highlighted in experience. (p. 257)

This perspective approximates a constructivist model of emotions (Barrett, 2012; Barrett & Russell, 2015), as it assumes that emotional experience emerges from the selective perception of a large variety of phenomena (subjective, physiological, situational, behavioral). There is anthropological evidence consistent with this hypothesis, but psychologists have started to test it as well.

Differences in the cultural "spotlight" on emotional phenomena reflect the differences in cultural models of behavior generally. In independent cultures, such as the United States, feelings, thoughts, and actions are understood to arise from the individual and his or her internal states. In contrast, in interdependent cultures, such as Japan, feelings, thoughts, and actions are understood to arise from the relationships between individuals; emotions here are an interdependent project, necessarily involving the psychological states and actions of others (Markus & Kitayama, 2004). Emotions are defined accordingly: either as phenomena within a person (in independent cultures) or as phenomena between people (in interdependent cultures).

In a series of studies, Uchida and colleagues found that emotions are differently defined in Japanese and American contexts (Uchida, Townsend, Markus, & Bergsieker, 2009). In Japanese contexts, emotions were understood as "between people," whereas in American contexts, emotions are understood as primarily "within people." The research provided four types of evidence for this idea by analyzing the emotions of Olympic athletes (2004 Olympic games in Athens). First, in television interviews, Japanese athletes used more emotion words than American athletes when talking about their relationships. Second, when Japanese and American students had to write about the typical reactions of an athlete who had just won, Japanese students wrote more about athletes' relationships than American students. Third, Japanese participants inferred more emotions when an athlete mentioned relationships, whereas American participants inferred more emotions when the athlete focused only on him- or herself. And finally, when viewing images of athletes, Japanese participants inferred more emotions for athletes pictured with teammates, whereas American participants inferred more emotions for athletes pictured alone. In sum, Americans saw emotions essentially as inner experiences, but Japanese focused on the interaction side of emotions. This finding is consistent with many early observations by anthropologists (e.g., Heelas, 1986; Heider, 1984; Lutz, 1982, 1983; Shweder & Bourne, 1982). As Catherine Lutz (1983) put it: "What we term emotion is seen by [other cultures] as relational, and as a product of social interaction, rather than as a purely mental [. . .] process occurring within the individual" (p. 251).

In a study with West Sumatran participants, Levenson, Ekman, Heider, and Friesen (1992) happened upon these different ways of defining and recognizing emotions. The participants were asked to pose certain facial expressions (using a directed facial action task), with the expectation that these expressions would elicit similar automatic nervous system (ANS) responses and similar emotional experiences in the West Sumatran participants as they had done in American college students. The West Sumatran participants showed many of the same ANS responses in response to posing the facial expressions, yet none of the West Sumatran participants reported *experiencing* "emotion": For them, emotions necessarily involved other people, and they did not recognize emotion when they were by themselves.

Conversely, in several facial recognition studies in which participants judged a target person's emotions (Masuda et al., 2008; Masuda, Wang, Ishii, & Ito, 2012), Westerners' ratings of the target's facial expressions were not at all influenced by the facial expressions of the people surrounding the target: The emotions of the surrounding people were deemed irrelevant to the target's emotions (which were read from his or her face). However, Japanese participants clearly used the surrounding people's facial expressions when judging the target person's emotions (e.g., the smiling target person was judged less happy if the surrounding people portrayed angry or sad expressions). For Japanese, emotions are "between people," whereas for Americans emotions are "within people."

Perhaps related is the finding by Chentsova-Dutton and Tsai (2010) that a focus on the individual self produced more intense positive emotions in European Americans, whereas a focus on a family member increased, in two out of three studies, the intensity of positive emotions in Asian Americans. Specifically, participants were asked to write about themselves in one condition, and to write about a family member in the other condition, after which they watched an amusement-inducing film, or listened to upbeat music. Participants' emotions during the viewing or listening part were more intense in the culture-relevant condition, as measured by self-report, facial behavior, and heart rate. One way of explaining this finding is that activation of the culture-relevant self (as either individual or as related) focused attention as well as thoughts on aspects of the situation that are consequently defined as "more emotional."

Some differences in emotion construction can be plotted along the dimension of "mentalistic" versus "somatic" interpretations. A well-known example comes from Robert Levy's (1973) ethnography about the Tahitians and concerns the emotion of sadness. The Tahitians have

> no unambiguous terms which represent the concepts of sadness, longing, or loneliness [. . .] People would name their condition, where I supposed the context called for "sadness" or "depression" as "feeling troubled" (the generic term for disturbances, either internal or external). (p. 305).

One way of understanding the absence of a word for "sadness" in Tahitian, and one that Levy himself favors (p. 224), is that Tahitians "somatize" an experience that is essentially mental (see Mesquita & Frijda, 1992, for a similar view). However, it is also possible to understand the Tahitians' "troubled feelings" as simply a different "spotlight" on the complex set of phenomena that we associate with "sadness." It is very possible that Tahitians focus on somatic impact, where many Westerners would focus on the meaning of the situations, and thus "mentalize" (the word is borrowed from Ryder & Chetsova-Dutton, 2012, who make a similar argument for cultural differences in the experience of depression).

That differences in the defining features of emotions go beyond semantics is suggested in a recent study by Immordino-Yang, Yang, and Damasio (2014). In this functional magnetic resonance imaging (fMRI) study, Chinese, Asian American, and European American participants viewed 40 video clips of admiration, compassion, or empathy-inducing narratives that had been introduced to them more extensively in a preparatory stage of the research. Half of the clips had been derived from Chinese true-life narratives, the other half from sources from the United States. During each clip, participants underwent blood-oxygenation-level-dependent (BOLD) fMRI with simultaneous electrocardiogram (ECG) recording, and reported the strength of their emotion by pressing a button. The researchers focused on the association between feeling strength and the activation of the anterior insula (AI), which has been found to be one of the sites of (emotional) experience. The ventral AI has been associated with autonomic processes, and the dorsal AI with somatosensory and cognitive processes. There were no cultural differences in the mean intensity of reported emotions, cardiac arousal, and magnitude of BOLD signals. However, there were cultural differences in the relative association of ventral and dorsal activity of the AI with feeling strength. In Chinese, feeling strength was associated with activation of the ventral AI, and thus relied on autonomic changes; in contrast, in European Americans, feeling strength was associated with activation of the dorsal AI, and thus relied more on expression and/or cognitive processes. The bicultural East Asian American group showed patterns of brain activity that were "in between" those of both monocultural groups. The study is consistent with the idea that cultural learning influences the types of information selected or highlighted when "constructing" emotional feeling (Barrett, 2012; Immordino-Yang, 2010).

Cultural differences in emotional experience may thus be seen as resulting from differences in the phenomena defined to be emotional—"the spotlight." This process is very close to what Barrett (2012) calls "collective intentionality":

> To create emotions, there must be a group of people who agree that certain instances (e.g., body states or physical actions) serve particular functions (to make sense of the world, to direct subsequent action, to communicate intentions, to control the actions of others). [. . .] One implication from this perspective is that the reality of emotion is always embedded in a certain situation or context, even though typically the context is not made explicit. (p. 420)

By ascribing differences in emotional experience to cultural differences in collective intentionality, we once again answer the question of how people "do emotions," rather than what emotions they "have."

How Do Cultures "Do" Emotions?

Describing these nonrandom cultural differences in emotions is only a first step toward understanding the relationship between culture and emotion. It does not reveal the processes by which cultures promote functional and suppress dysfunctional emotions (Mesquita, De Leersnyder, & Albert, 2014). Evidence on how cultures "do" emotions is scattered, and a full picture emerges only when combining the insights from different strands of the literature. We subsequently discuss several aspects of "doing emotions": (1) the cultural differences with respect to the norms and ideals of emotions; (2) the ways in which cultures promote situations that elicit norm-consistent emotions, and avoid or discourage situations that elicit norm-inconsistent emotions; and (3) how emotions unfold in culture-specific types of interactions and relationships.

Ideal Emotions, Emotion Norms

Cultures differ with respect to their emotion norms and ideal emotions and, while far from perfect, there is overlap between actual emotions and the respective norms for what emotions people should experience, as well as the ideals of what emotions people would like to experience (Eid & Diener, 2001; Tsai, Knutson, & Fung, 2006). A culture's emotion norms and ideals will motivate people to actually experience these emotions, even if the emotional outcomes are not perfectly matched.

Emotion norms and ideals tend to be meaningful in the light of the cultural models. For instance, Eid and Diener (2001) conducted a large cross-cultural study in which participants from both independent (European American and Australian) and interdependent (China and Taiwan) cultural contexts rated the desirability of several emotions, both positive and negative. The largest cultural differences in desirability were found for "pride" and "guilt." Feelings of pride were more positively valued in independent than interdependent cultures, whereas the opposite was true for feelings of guilt. This may be the case because pride signals a person's autonomy and uniqueness, which is valued in independent cultures, but at the same time, is considered "dangerous" in interdependent cultures that recognize the potential of pride to disrupt social harmony. Conversely, guilt may be desirable from the point of view of East Asian cultural models, because it signals an individual's concern for relational harmony (and the readiness to take full responsibility for a violation of this harmony), but not in Western cultures because it hints to a less-than-positive performance of the individual.

Systematic cultural differences in the emotions people "ideally would like to feel" (Tsai et al.,

2006) can equally be understood from the central cultural models. Tsai and her colleagues asked people from different cultures to rate their "ideal feelings" on emotion scales that represented the four quadrants of the affective circumplex; the affective circumplex is defined by the dimensions of pleasantness (unpleasant–pleasant) and activation (low–high). Tsai found consistent differences between European Americans, who "ideally" wanted to feel more high-activation positive states, such as excitement and elation, and East Asians, who preferred low-activation positive states, such as peaceful and serene feelings (e.g., Tsai et al., 2006). Further research showed that ideal emotions prepare individuals best for the tasks that are culturally central (Tsai, Miao, Seppala, Fung, & Yeung, 2007): High-activation positive emotions that are promoted in North American contexts prepare individuals for influencing others. In contrast, low-activation positive emotions that are promoted in East Asian contexts facilitate social adjustment.

Similarly, in a comparison between European American and German students, Koopmann-Holm and Tsai (2014) found that European Americans want to avoid negative emotions more than Germans. The differences in avoided negative affect were larger than the differences in actual negative affect, although they did seem to impact actual affect as well: Germans felt more sad, unhappy, and lonely than European Americans. The authors explain the difference in avoided negative affect from a difference in values: Whereas European Americans focus on achievement and mastery values, Germans prioritize harmony values. Achievement and mastery values are associated with "achieving one's goals, influencing others, and overcoming nature" (p. 19). Indeed, cultural differences in the avoidance of negative emotions was mediated by the achievement and mastery values.

Cultural differences in emotion norms and ideals are not only visible in terms of differences in attitudes but also in the different cultural worlds in which people engage. Several studies have compared popular children's books from different cultural contexts, because these books are important tools for socialization (at least in literate cultures). Tsai found that best-selling children's storybooks in the United States and Taiwan portrayed the culturally ideal emotions: Storybooks in North America typically portray their main characters with excited rather than calm smiles, whereas storybooks in Taiwan portray more calm smiles (Tsai, Louie, Chen, & Uchida, 2007, Study 2).

Boiger and colleagues compared the prevalence of shame and anger in popular children's books from the United States and Belgium (Boiger, De Deyne, & Mesquita, 2013, Study 2). Belgium, like the German culture described earlier, is less achievement and mastery oriented than the United States, and more focused on universalism (respect for everybody and everything), harmony, and equality. In line with these cultural differences, anger—as an emotion that facilitates achievement and mastery—was more frequently depicted by U.S. than Belgian children's books. In contrast, shame—as an emotion that points to failure and contrasts with mastery—was nonexistent in the U.S. books, whereas it was portrayed in 26% of the Belgian children's books, which is again in line with the relatively stronger Belgian concern for harmony and equality. Finally, Vander Wege and colleagues (2014), found a similar pattern of highlighting valued or normative emotions when comparing popular U.S. children's books against children's books from Romania and Turkey. Again, the American books emphasized negative powerful emotions (such as anger) in comparison to Romania and Turkey, both in terms of frequency and intensity of the emotions that characters displayed.

Cultural products are not limited to children's books. Tsai and colleagues found representations of ideal affect in advertisements in American and Chinese women's magazines (Chim, Moon, & Tsai, 2009) and in religious texts (Tsai, Miao, & Seppala, 2007). American advertisements had more excited (vs. calm) smiles than did Chinese advertisements (Chim et al., 2009). Consistently, contemporary Christian self-help books (the dominant religion in North America) endorsed more high-arousal positive states than Buddhist contemporary texts, which endorsed more low-arousal positive states (Tsai, Miao, & Seppala, 2007). In a related vein, Koopmann-Holm and Tsai (2014) found that German sympathy cards contained more negative and less positive content than American sympathy cards. A typical German card would encourage and acknowledge grief (e.g., "In deep sadness" or "Sharing your sadness"), whereas a typical American card would encourage and wish something positive (e.g., "The memories are yours" or "Hold on to hope"). Moreover, the degree to which individuals wanted to avoid negative emotions predicted which kind of sympathy card they selected. Therefore, the sympathy cards may in fact be seen as a means to regulate emotions in line with the cultural ideals. Together, the evidence suggests that ideal affect is not only in the head of people, it is also in their cultural worlds.

Emotion norms guide cultural *practices* as well. European Americans chose more profile photos with excited smiles for their Facebook pages than did Hong Kong Chinese, with Asian Americans falling in between the two groups (Moon, Chim, Tsai, Ho, & Fung, 2011). Similarly, North Americans and (Dutch-speaking) Belgians associated different words with the emotions of anger and shame, and the respective associations resonated with the cultural emotion norms. In a large-scale word association task, anger in the United States was associated with words that indicated yielding to the emotion (e.g., through hitting or shouting), whereas anger in Belgium was associated with words indicating containment of the emotion (e.g., through withdrawing or ignoring) (Boiger, De Deyne, et al., 2013, Study 3). Connotations for shame were the opposite of anger: Americans associated words of containment with shame, whereas Belgians associated words of yielding with shame. Thus, Americans and Belgians associate anger and shame with different connotations, and the respective connotations reflect the extent to which these emotions are valued in the two cultures.

Cultural Promotion of Situations

One reason for cultural differences in emotional experience may be that, across cultures, people seek out and encounter different types of situations. For example, it is possible that people in some cultures simply receive more compliments than in other cultures. To the extent the compliments elicit feelings of pride in all cultures, this means that there would be cross-cultural variation in the frequency and/or intensity of pride.

Several studies have suggested that situations that help to accomplish central cultural goals or tasks are relatively frequent. An example is the relatively high rate of compliments (or stickers, smiley faces, and awards in schools) in Northern American contexts (D'Andrade, 1987). Compliments fit—and help to achieve—the culturally central goals of enhancing a person's self-esteem and making him or her feel unique. In contrast, compliments are rare in cultures with less emphasis on self-esteem, such as Japan, where the focus is rather on fitting in. In Japanese schools, children are encouraged to be self-critical and reflect on ways to overcome their shortcomings in order to meet the group's standards (Lewis, 1995).

In a series of comparative survey studies from our own lab, we predicted the frequency of a set of emotion-eliciting situations from (1) their potential to elicit a given emotion, and (2) the value of that emotion within the particular culture (Boiger, De Deyne, et al., 2013, Study 1; Boiger, Güngör, Karasawa, & Mesquita, 2014; Boiger, Mesquita, Uchida, & Barrett, 2013). The research focused on shame and anger. In a first comparison between the United States and Japan, we expected that anger situations are afforded in the United States and avoided in Japan. In the United States, anger is a hallmark of autonomy and independence (Markus & Kitayama, 1994), but in Japan it violates the interdependent model of relatedness and harmony. Conversely, we predicted that shame situations are avoided in the United States but afforded in Japan. Shame violates the U.S. cultural model, because it undermines positive self-regard, but it is consistent with the Japanese ideal of self-reflection and self-improvement, as it increases an individual's awareness of his or her own shortcomings (Heine et al., 1999; Lebra, 1992; Oishi & Diener, 2003). Consistent with these expectations, we found that the higher the potency of a situation to elicit (high-intensity) anger, the higher its (perceived) frequency in the United States and the lower in Japan; conversely, the higher the potency of a situation to elicit (high-intensity) shame, the lower its rated frequency in the United States and the higher in Japan. In sum, situations that elicit culturally condoned emotions seem to be afforded, whereas situations that elicit culturally condemned emotions seem to be avoided.

When repeating this study with Turkish and Japanese situations and respondents, Boiger and colleagues (2014) replicated the pattern of results in Japan, but found that both anger and shame situations were perceived to occur frequently in Turkey. This concurrent "up-regulation" of anger and shame situations may be typical of an honor-based interdependent cultural context, such as Turkey. In honor cultures, "honor must be claimed, and honor must be paid by others" (Leung & Cohen, 2011, p. 509). The need to take a stand and uphold a reputation of toughness, while at the same time having to rely on others to confirm one's reputation may explain the concurrent promotion of anger (as an emotion that helps in claiming honor) and shame (as an emotion that protects honor by preventing others from losing respect) in Turkey. In comparison, in face cultures, such as Japan, face cannot be claimed but is obtained by social conferral only; this explains why only shame-promoting situations were perceived as frequent in Japan. Thus, cultural differences in the affordance of anger- and shame-eliciting situations may contribute to our understanding of the previously reported differences in emotional experience.

Consistently, research by Tsai, Knutson, and Rothman (2007) has found that people individually and culturally select situations that will lead to ideal emotions. When given a choice in an experimental setting, European Americans selected artifacts (e.g., CDs) that elicited high-arousal over those eliciting low-arousal activities, whereas the reverse was true for East Asians. Societal statistics corroborate these experimental results: North Americans prefer re-creative drugs, leisure activities, and music that elicit high-arousal positive emotions over their counterparts that elicit low-arousal positive emotions, whereas East Asian societies prefer low-arousal positive activities. Moreover, within a North American sample, individual differences in the preferential activities (leisure time, drugs, types of vacations) were predicted by ideal affect in ways that mirrored cultural differences between North Americans and East Asians (Tsai, Knutson, & Rothman, 2007). The more people valued excitement states, the more they preferred partying versus reading, running versus walking and stimulating versus calming drugs. Moreover, these differences in ideal affect accounted for cultural differences in these mood-producing behaviors, even after controlling for actual affect.

Culture-Specific Types of Interpersonal Emotion Regulation

Finally, emotional experience may come to differ across cultures because people help one another deal with emotional experience differently or because they structure one another's social contexts in different ways. For example, people may actively support and positively reward certain emotions in others, while ignoring or even punishing other kinds of emotions. The combined evidence suggests that interpersonal regulation is often geared to aligning emotions with the respective cultural models. Relatedly, emotions are often used to align people, children and adults alike, to the social order.

Emotions as Socialization Practices

Parents' socialization practices are examples of interpersonal emotion regulation that are conducive to the culturally valued emotions. For example, Cole and colleagues investigated how parents respond to their children's emotions in a series of studies with the Tamang and Brahman—two Nepali ethnic groups (Cole & Tamang, 1998; Cole, Tamang, & Shresta, 2006). On the one hand, the Tamang value harmony and self-effacement, and therefore, discourage anger but encourage shame. On the other hand, the Brahman associated their high-caste status with social dominance and self-control, encouraging anger but discouraging shame. In the case of anger, both Tamang and Brahman mothers were equally likely to ignore their children's anger (25%), yet the mother's active responses to anger (the other 75% of the cases) differed: Whereas Tamang mothers actively discouraged anger by rebuking, scolding, or teasing their angry children, Brahman mothers actively supported their children's anger in the form of teaching (i.e., calmly reasoning with the child), and to a lesser degree in the form of nurturance (i.e., hugged, kissed, spoke endearingly, or gave a treat that was not requested by the child), thereby communicating that anger is a justified experience of an individual with high status, such as they were. Tamang mothers were equally likely to respond by ignoring, teaching, and nurturing (each about 30%) when their child displayed shame, whereas Brahman mothers largely ignored their child's shame (about 75% of all responses), thereby communicating that shame is not a justified experienced for a high-status individual.

Similar cultural differences have been observed with Japanese and German mother–child dyads. Friedlmeier and Trommsdorff (1999) studied how mothers and their 2-year-old daughters work together in regulating the daughters' distress after being confronted with a playmate who felt sad about a broken toy. German mothers communicated that while it is important to know what other people feel, this should not affect your own feelings. They did so by emphasizing the distress of the playmate, while simultaneously ignoring that their daughters themselves were distressed. In contrast, Japanese mothers communicated that the emotions of ingroup members are ultimately to some extent your own emotions as well. They emphasized and acknowledged their daughters' empathy and feeling of what the playmate was feeling. The differential emotion regulation left the Japanese children more tense than the German children; however, each child was also socialized to be culturally attuned in this way.

Parents also strategically deploy emotions in interactions with their children to socialize cultural norms. The strongest evidence probably comes from developmental psychology and anthropology, where a number of studies have shown that parents use emotions strategically to modulate their children's behavior, and ultimately their acquisition of cultural norms. Trommsdorff and Kornadt (2003) have shown that German and Japanese mothers engage in particular emotion strategies in order to socialize the receptive cultural norms for autonomy (in Germany) and relatedness (in Japan). During conflicts with their children, German mothers tend to engage in escalating interactions of reciprocal anger and frustration, during which both the mother and the child communicate and enforce their own, autonomous perspective. In comparison, Japanese mothers tend show disappointment, yet make concessions by comforting their child and appeal to their empathy in order to maintain harmony and the desired feeling of "oneness" (*ittaikan*). These different strategies of German and Japanese mothers had long-term effects on children's emotional development: Escalation of interactions in early childhood predicted the level of empathy-based altruism and aggression 9 years later (Kornadt & Tachibana, 1999, as cited in Trommsdorff & Kornadt, 2003). Importantly, the emphasis on self-assertive or domineering emotions (e.g., anger) in the German dyads can be seen as a means of fostering the German cultural norm for autonomy, while the focus on submissive emotions (e.g., sadness, shame) in the Japanese dyads appears to foster the Japanese cultural norm for relatedness.

Parents use emotions as socialization tools not only during conflict, but also in the way they highlight certain emotional events over others. By highlighting those emotional experiences that match their cultural goals, parents pull attention to emotional states that support their socialization goals. For example, Taiwanese parents frequently instill shame in their children to mark transgressions of social rules (Wang, 1992; Fung, 1999; Fung & Chen, 2002). Fung (1999) reports how Taiwanese mothers frequently shamed their youngsters of 2½–3 years. Remarkably, most of the shaming was conducted in a rather playful format, teaching the children to distinguish right from wrong as the transgressions were unfolding. Shaming was not intended to harm or ostracize the child, but rather to "transmit the cultural values of discretion shame [. . .] teaching children how to be part of society, to include them rather than to set them apart" (pp. 202–203). The emotions that Taiwanese parents instilled in their children stand in stark contrast to the behavior of American, lower-class parents of Baltimore (Miller, Fung, & Mintz, 1996; Miller, Wiley, Fung, & Liang, 1997). In the Baltimore context, parents actively avoided turning their children's norm transgressions into shameful experiences by paying little attention to norm-inconsistent behavior. In the rare cases that parents did bring up their children's transgressions, they framed them as nonserious wrongdoings in order to "toughen" their children for their daily realities.

One of the most vivid examples of how parents strategically use specific emotions to socialize culturally desirable behavior comes from anthropological research with the Bara in Madagascar and the Minangkabau in Indonesia. Röttger-Rössler, Scheidecker, Jung, and Holodynski (2013) argue for the role of different, so-called socializing emotions in these two cultural contexts. Based on evidence that parenting practices need to be emotionally arousing to be memorable and effective across cultures (Quinn, 2005), Röttger-Rössler and colleagues propose that socializing emotions are those emotions that parents instill in their children in response to norm-inconsistent behavior in order to "support and mediate the transmission and education of social norms in a culturally adaptive way" (p. 263). Socializing emotions, in part, are assumed to work through the associated action tendencies that are used to override other, less desirable, emotions and behaviors. As children repeatedly experience these emotions in situations in which they do not comply with the social norms, they eventually become internalized responses. The Bara use beating to instill strong experiences of fear (*tahotsy*) and a strong aggressive action tendency; the Mingangkabau use social exclusion strategies to instill shame-like emotions (*malu*). While both fear of pain/aggression and shame provide the function of warning children about norm violations, they aim to socialize different cultural norms and support local social structures. Fearful emotions (felt toward the sanctioning authorities such as elders) as well as the aggressive action tendencies (which are channeled at outgroup members and younger members) are functional for the Bara context, where society is segmented, competition between patrilineages is high, and hierarchies within patrilineages are clear-cut. In contrast, shameful emotions are more suitable for maintaining smooth relations in the more stratified Mingangkabau society, where social harmony rather than conflict is the goal.

Interestingly, the predominant Taiwanese, Bara, and Mingangkabau socializing emotions stand in stark contrast to Western ideas about socialization, according to which shaming or physical punishment/fear induction are seen as extremely harmful for norm internalization (e.g., Dix & Grusec, 1983; Tangney, Stuewig, & Mashek, 2007). We discussed the tendency to ignore shameful emotions among Baltimore parents; this leaves open the question of what emotions U.S. parents use to instill cultural norms in their children. Pride is a likely candidate (see also Quinn, 2005; Holodynski & Friedlmeier, 2006): By emphasizing personal achievements rather than failures, pride instills the much-valued feelings of self-esteem and uniqueness that are at the core of American culture. This is also in line with the observation that U.S. socialization contexts instill pride and other positive emotions by frequent mutual praise (Kitayama & Markus, 2000) and with awards and medals (D'Andrade, 1987).

Co-Regulation in Adults

Co-regulation of emotion is not restricted to mother–child dyads. There are many examples of adults co-regulating each other's emotions in ways that align them with the cultural models. For example, the Toraja (Indonesia) have elaborate interpersonal scripts for controlling anger and aggression in order to maintain the culturally central values of social harmony and cohesion (Hollan, 1988). Anger is socially controlled in two different ways: On the one hand, the Toraja cultivate a social etiquette that is geared toward maximizing predictability of social behavior and thus limiting frustration—for example, through "mandatory offerings of food, drink, and shelter; deferential, sometimes obsequious, behavior toward social betters; and dissimulation, including the use of indirect, allusive speech to "disguise" remarks that could be interpreted as critical or negative" (p. 56). On the other hand, the Toraja help each other stay "cool" when a person is perceived as potentially being angry. The typical strategy is to avoid direct contact with presumably angry persons in order not to further enrage them and thus to allow their anger to cool down; if contact is unavoidable, one is not to make direct eye contact with the angry person. A more radical way of dealing with emotions that may potentially disrupt group cohesion has been reported for the Ilongot (Rosaldo, 1980). In this small Philippine community, ingroup cohesion is central for the survival of the group. *Liget*, a powerful emotion that among others denotes energy, passion, and anger, holds the potential to threaten ingroup harmony. When an Ilongot experienced *liget*, a headhunting raid on an enemy tribe was initiated. Having beheaded a member of the enemy tribe, the beheader cast the head on the ground, thereby ridding himself of all powerful emotions such as *liget*.

The specific relationship arrangements in which people engage in a culture also affect how they disclose and retell their experiences or, in other words, share their emotions with others. Sharing emotions plays an important role in how diffuse emotional episodes are turned into accessible and coherent narratives and helps people take a more distanced view on the event (yet not necessarily providing relief; Rimé, 2009). One would expect that in cultures that emphasize social group cohesion, emotional experiences of any one group member are relevant to the others of the group. This appears to be the case. Mesquita (1993) found that in the interdependent cultures of Turkey and Surinam, participants report more active sharing of their emotional experiences with others while at the same time experiencing more active support from others than in the independent Dutch context. It appears that in these interdependent cultures, emotions take on a more "collective" narrative and are consequently dealt with as a common responsibility.

That emotions are socially regulated in ways that are adaptive to the specific cultural context also becomes visible during ritualistic events, which temporarily set established cultural models out of action and thus function in what has been coined a "liminal" space (Turner, 1969). Burning Man, a yearly temporary community festival in the Black Rock desert of Nevada that celebrates art and radical self-expression, is an interesting case in point. Burning Man provides its 70,000 participants with a space that is set outside the boundaries of U.S. mainstream culture, both spatially and in terms of its cultural practices. Among the shared practices, which are held up as the "10 principles," are radical reliance on one's own inner resources, radical expression of personality, and immediacy of (social) interactions, but also radical inclusion of every participant and a gifting rather than exchange economy. Structuring community and social interactions in this way appears to have a marked impact on how individuals regulate their emotions and, consequently, how they feel. Research by McRae and colleagues found that participants at Burning Man use less emotion suppression and more reappraisal during the festival than at home (McRae, Heller, John, &

Gross, 2011). The decrease in emotion suppression was surprising, seen that this regulatory strategy is usually associated with negative outcomes. In a set of follow-up studies, Snyder and colleagues found that the tendency to suppress emotions less was mainly driven by decreased suppression of positive emotions (Snyder, Heller, Lumian, & McRae, 2013). Suppressing positive emotions to a lesser extent may be functional in a

> cultural environment that supports joyful experimentation among adults. . . . The increased expression of positive emotion might encourage adults to play, by experimenting with new identities, emotional repertoires, senses of self, and cultural tools more than they would in other situations. (p. 9)

Conclusion

Emotional experience differs across cultural contexts. Cultural differences, for the most part, can be understood from culture-specific moralities (see Shweder et al., 2008): What constitutes a good person, good relationships, or moral behavior? Emotions that foster or highlight cultural norms and ideals are prevalent and intense, whereas emotions that violate or undermine these norms and ideals are rare. Anger experiences are frequent and intense in cultures that value independence and assertiveness, but not in cultures that center on interpersonal harmony. Similarly, certain aspects of emotional experience fit the cultural morality and they occur frequently, but aspects that are considered immoral or irrelevant are rare; personal agency resonates with cultural ideals of independence, but not with those of relatedness. The most typical emotional experiences thus differ across cultures.

We have gone beyond descriptive data of frequency and intensity, suggesting different approaches to describing emotional differences. These approaches have in common that they abandon essentialist ways of describing "emotions" (the word has one referent) in favor of process approaches. A first approach that we have described compares the relative frequency of different varieties of emotions in different cultures. In this case, it is assumed that across cultures, people use a particular emotion word for a variety of experiences or meanings (in terms of appraisal and action readiness), and the experiences most typically referred to may differ across cultures. This type of research preselects the types of experiences compared. For example, one study found that "shame" cross-culturally comprises two varieties (defined by particular sets of appraisals and action tendencies), but that cultures differ with respect to the variety of shame that most frequently occurs. The most prevalent variety of experience appears to follow naturally from the cultural norms and ideals. Shame always describes a larger collection of experiences, but which subset is salient depends on the culture.

A second approach challenges the essentialist notion of emotions even more: It suggests that cultures differ in the very phenomena they define as emotional, with some cultures focusing on subjective contents, and others on aspects of the emotional interaction; with some cultures focusing on "mentalistic," and others on "somatic" phenomena. These differences in "spotlight" or "collective intentionality" can be understood from morality issues as well. In cultures that focus on relatedness, interactive aspects of emotions come to the foreground, but in cultures emphasizing individuality, the subjective feeling is what counts.

The reviewed literature challenges the notion that emotional experiences are fixed—if cross-culturally different—patterns of responses, and calls instead for a view of emotions as action. The combined research on cultural differences suggests that the question should be *how people do emotions* across cultures, rather than *what emotions people have* (Mesquita, 2010). Adopting a perspective of action means that the research naturally shifts to the different factors that influence how people do emotions. Culture, then, becomes a framework within which people jointly and collectively do emotions, rather than a one-time determinant of emotion.

Our review of the literature suggests several ways in which people jointly or collectively do emotions. Cultural products, practices, rituals, socialization strategies, and interpersonal regulation behaviors all help to do emotions in ways consistent with cultural morality. These joint and collective processes are geared toward the cultural alignment of individuals' emotional experiences. In all these different ways, cultures afford and promote ideal and normative emotions, while simultaneously steering individuals away from condemned emotions; cultures help define if emotions are within or between people, primarily physical or cognitive, desirable or dangerous, and healthy or unhealthy.

This view on emotions as joint and collective actions has implications for our study designs. The focus should be on the cultural differences and similarities in the way people make emotions interactively and in context (Boiger & Mesquita, 2012; Mesquita & Boiger, 2014; Saarni, 2008), and away from cross-cultural comparisons of the emotions people have. Currently, very few cross-cultural studies take this perspective: The bulk of cross-cultural studies compare the modal or average individual responses to decontextualized stimuli. A more ecologically valid approach would consist of studying the interactions and cultural practices in which emotions are made. It is in these contexts that we will be able to see what the processes are that lead to cultural alignment of emotional experience.

It is worth mentioning that this approach challenges the traditional approach to the study of emotions that "control" for context effects. Given the intricate relationships between emotions and the specific socio-cultural contexts in which they occur, it is time to start considering contexts as part of the phenomenon to be understood. As Richard Shweder (1991) eloquently put it: "the so-called 'noise' is not really noise at all; it is the message" (p. 99).

References

Abu-Lughod, L. (1986). *Veiled sentiments.* Berkeley: University of California Press.

Barrett, L. F. (2012). Emotions are real. *Emotion, 12*(3), 413–429.

Barrett, L. F., & Russell, J. A. (Eds.). (2015). *The psychological construction of emotion.* New York: Guilford Press.

Benedict, R. (1946). *The chrysanthemum and the sword: Patterns of Japanese culture.* Boston: Houghton Mifflin.

Boiger, M., De Deyne, S., & Mesquita, B. (2013). Emotions in "the world": Cultural practices, products, and meanings of anger and shame in two individualist cultures. *Frontiers in Psychology, 4*, 867.

Boiger, M., De Leersnyder, J., Uchida, Y., Norasakkunkit, V., Ceulemans, E., & Mesquita, B. (2013). *Cultural variation is real (and in the data): Experiencing anger and shame in the United States, Japan, and Belgium.* Manuscript in preparation.

Boiger, M., Güngör, D., Karasawa, M., & Mesquita, B. (2014). Defending honour, keeping face: Interpersonal affordances of anger and shame in Turkey and Japan. *Cognition and Emotion, 28*(7), 1255–1269.

Boiger, M., & Mesquita, B. (2012). The construction of emotion in interactions, relationships, and cultures. *Emotion Review, 4*, 221–229.

Boiger, M., Mesquita, B., Tsai, A., & Markus, H. (2012). Influencing and adjusting in daily emotional situations: A comparison of European and Asian American action styles. *Cognition and Emotion, 26*(2), 332–340.

Boiger, M., Mesquita, B., Uchida, Y., & Barrett, L. F. (2013). Condoned or condemned: The situational affordance of anger and shame in the United States and Japan. *Personality and Social Psychology Bulletin, 39*(4), 540–553.

Briggs, J. L. (1970). *Never in anger: Portrait of an Eskimo family.* Cambridge, MA: Harvard University Press.

Ceulemans, E., & Van Mechelen, I. (2008). CLASSI: A classification model for the study of sequential processes and individual differences therein. *Psychometrika, 73*(1), 107–124.

Chentsova-Dutton, Y. E., & Tsai, J. L. (2010). Self-focused attention and emotional reactivity: The role of culture. *Journal of Personality and Social Psychology,* 98(3), 507–519.

Chim, L., Moon, A., & Tsai, J. L. (2009*). Beauty is in the culture of the beholden: The occurrence and perception of American and Chinese smiles in magazines.* Poster presented at the 10th annual meeting of the Society of Personality Psychology, Tampa, FL.

Cole, P. M., & Tamang, B. L. (1998). Nepali children's ideas about emotional displays in hypothetical challenges. *Developmental Psychology, 34*(4), 640–646.

Cole, P. M., Tamang, B. L., & Shrestha, S. (2006). Cultural variations in the socialization of young children's anger and shame. *Child Development, 77*(5), 1237–1251.

Consedine, N. S., Chentsova-Dutton, Y. E., & Krivoshekova, Y. S. (2014). Emotional acculturation predicts better somatic health: Experiential and expressive acculturation among immigrant women from four ethnic groups. *Journal of Social and Clinical Psychology, 33*(10), 867–889.

D'Andrade, R. G. (1987). Modal responses and cultural expertise. *American Behavioral Scientist, 31*(2), 194–202.

De Leersnyder, J., Kim, H., & Mesquita, B. (2015). *My emotions belong here and there: Extending the phenomenon of emotional acculturation to heritage cultural contexts.* Manuscript submitted for publication.

De Leersnyder, J., Mesquita, B., & Kim, H. (2011). Where do my emotions belong?: A study of immigrants' emotional acculturation. *Personality and Social Psychology Bulletin, 37*, 451–463.

Dix, T., & Grusec, J. E. (1983). Parental influence techniques: An attributional analysis. *Child Development, 54*(3), 645–652.

Eid, M., & Diener, E. (2001). Norms for experiencing emotions in different cultures: Inter- and intranational differences. *Journal of Personality and Social Psychology, 81*(5), 869–885.

Fiske, A. P., Kitayama, S., Markus, H. R., & Nisbett, R. E. (1998). The cultural matrix of social psychology. In D. Gilbert, S. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology* (4th ed., pp. 915–981). New York: McGraw-Hill.

Friedlmeier, W., & Trommsdorff, G. (1999). Emotion regulation in early childhood: A cross-cultural comparison between German and Japanese toddlers. *Journal of Cross-Cultural Psychology, 30*(6), 684–711.

Frijda, N. H. (1986). *The emotions.* Cambridge, UK: Cambridge University Press.

Frijda, N. H. (2007). *The laws of emotion*. Mahwah, NJ: Erlbaum.

Fung, H. (1999). Becoming a moral child: The socialization of shame among young Chinese children. *Ethos, 27*(2), 180–209.

Fung, H., & Chen, E. C. H. (2002). Affect, culture, and moral socialization: Shame as an example. In T. L. Hu, M. T. Hsu, & K. H. Yeh (Eds.), *Emotion, affect, and culture* (pp. 17–48). Taipei, Taiwan: Institute of Ethnology, Academia Sinica. (in Chinese)

Heelas, P. (1986). Emotion talk across cultures. In M. Harré (Ed.), *The social construction of emotions* (pp. 234–265). New York: Blackwell.

Heider. K. G. (1984). *Emotion: Inner state versus interaction*. Paper presented at the meeting of the American Anthropological Association, Denver, CO.

Heine, S. J., Lehman, D. R., Markus, H. R., & Kitayama, S. (1999). Is there a universal need for positive self-regard? *Psychological Review, 106*(4), 766–794.

Hollan, D. (1988). Staying "cool" in Toraja: Informal strategies for the management of anger and hostility in a nonviolent society. *Ethos, 16*(1), 52–72.

Holodynski, M., & Friedlmeier, W. (2006). *Development of emotions and emotion regulation* (Vol. 8). New York: Springer.

Imada, T., & Ellsworth, P. C. (2011). Proud Americans and lucky Japanese: Cultural differences in appraisal and corresponding emotion. *Emotion, 11*(2), 329–345.

Immordino-Yang, M. H. (2010). Toward a microdevelopmental, interdisciplinary approach to social emotion. *Emotion Review, 2*(3), 217–220.

Immordino-Yang, M. H., Yang, X. F., & Damasio, H. (2014). Correlations between social-emotional feelings and anterior insula activity are independent from visceral states but influenced by culture. *Frontiers in Human Neuroscience, 8*, 728.

Jasini, A., De Leersnyder, J., & Mesquita, B. (2015). *Cultural exposure and emotional acculturation in minority youth*. Manuscript in preparation.

Kim, H., & Markus, H. R. (1999). Deviance or uniqueness, harmony or conformity?: A cultural analysis. *Journal of Personality and Social Psychology, 77*(4), 785–800.

Kitayama, S., & Markus, H. (1990, August). *Culture and emotion: The role of other-focused emotions*. Paper presented at the 98th annual convention of the American Psychological Association, Boston.

Kitayama, S., & Markus, H. R. (2000) The pursuit of happiness and the realization of sympathy: Cultural patterns of self, social relations, and well-being. In E. Diener, & E. M. Suh (Eds), *Culture and subjective well-being* (pp. 113–161). Cambridge, MA: MIT Press.

Kitayama, S., Markus, H. R., & Kurokawa, M. (2000). Culture, emotion, and well-being: Good feelings in Japan and the United States. *Cognition and Emotion, 14*, 93–124.

Kitayama, S., Mesquita, B., & Karasawa, M. (2006). The emotional basis of independent and interdependent selves: Socially disengaging and engaging emotions in the U.S. and Japan. *Journal of Personality and Social Psychology, 91*(5), 890–903.

Koopmann-Holm, B., & Tsai, J. L. (2014). Focusing on the negative: Cultural differences in expressions of sympathy. *Journal of Personality and Social Psychology, 107*(6), 1092–1115.

Kornadt, H. J., & Tachibana, Y. (1999). Early child-rearing and social motives after nine years: A cross-cultural longitudinal study. In *Merging past, present, and future in cross-cultural psychology: Selected papers from the Fourteenth International Congress of the International Association for Cross-Cultural Psychology* (pp. 429–441). Lisse, The Netherlands: Swets & Zeitlinger

Kuppens, P., Van Mechelen, I., Smits, D. J., De Boeck, P., & Ceulemans, E. (2007). Individual differences in patterns of appraisal and anger experience. *Cognition and Emotion, 21*(4), 689–713.

Laham, S. M., Chopra, S., Lalljee, M., & Parkinson, B. (2010). Emotional and behavioural reactions to moral transgressions: Cross-cultural and individual variations in India and Britain. *International Journal of Psychology, 45*(1), 64–71.

Lebra, T. S. (1983). Shame and guilt: A psycho cultural view of the Japanese self. *Ethos, 11*(3), 192–210.

Lebra, T. S. (1992). Self in Japanese culture. In N. E. Rosenberger (Ed.), *Japanese sense of self* (pp. 105–120). New York: Oxford University Press.

Leung, A. K. Y., & Cohen, D. (2011). Within- and between-culture variation: Individual differences and the cultural logics of honor, face, and dignity cultures. *Journal of Personality and Social Psychology, 100*(3), 507–526.

Levenson, R. W., Ekman, P., Heider, K., & Friesen, W. V. (1992). Emotion and autonomic nervous system activity in the Minangkabau of West Sumatra. *Journal of Personality and Social Psychology, 62*(6), 972–988.

Levy, R. I. (1973). *Tahitians*. Chicago: University of Chicago Press.

Lewis, C. C. (1995). *Educating hearts and minds*. New York: Cambridge University Press.

Lutz, C. (1982). The domain of emotion words on Ifaluk. *American Ethnologist, 9*(1), 113–128.

Lutz, C. (1983). Parental goals, ethnopsychology and the development of emotional meaning. *Ethos, 11*(4), 246–262.

Markus, H. R., & Kitayama, S. (1991a). Cultural variation of the self. In G. R. Goethals & J. Strauss (Eds.), *Multidisciplinary perspectives on the self* (pp. 18–48). New York: Springer-Verlag.

Markus, H. R., & Kitayama, S. (1991b). Culture and self: Implications for cognition, emotion, and motivation. *Psychological Review, 98*(2), 224–253.

Markus, H. R., & Kitayama, S. (1994). The cultural construction of self and emotion: Implications for social behavior. In S. Kitayama & H. R. Markus (Eds.), *Emotion and culture: Empirical studies of mutual influence* (pp. 89–130). Washington: APA.

Markus, H. R., & Kitayama, S. (2004). Models of agency: Sociocultural diversity in the construction of action. In V. Murphy-Berman & J. J. Berman (Eds.), *Cross-cultural differences in perspectives on the self: Nebraska Symposium on Motivation* (Vol. 49, pp. 1–57). Lincoln: University of Nebraska Press.

Masuda, T., Ellsworth, P. C., Mesquita, B., Leu, J., Tanida, S., & Van de Veerdonk, E. (2008). Placing the face in context: Cultural differences in the perception of facial emotion. *Journal of Personality and Social Psychology, 94*(3), 365–381.

Masuda, T., Wang, H., Ishii, K., & Ito, K. (2012). Do surrounding figures' emotions affect judgment of the target figure's emotion?: Comparing the eye-movement patterns of European Canadians, Asian Canadians, Asian international students, and Japanese. *Frontiers in Integrative Neuroscience, 6*(72).

Matsumoto, D., Kudoh, T., Scherer, K., & Wallbott, H. (1988). Antecedents of and reactions to emotions in the United States and Japan. *Journal of Cross-Cultural Psychology, 19*(3), 267–286.

Mauro, M. C., Strefeler, M., Weeden, N. F., & Reisch, B. I. (1992). Genetic analysis of restriction fragment length polymorphisms in vitis. *Journal of Heredity, 83*(1), 18–21.

McRae, K., Heller, S. M., John, O. P., & Gross, J. J. (2011). Context-dependent emotion regulation: Suppression and reappraisal at the Burning Man festival. *Basic and Applied Social Psychology, 33*(4), 346–350.

Mesquita, B. (1993). *Cultural variations in emotions. A comparative study of Dutch, Surainamese, and Turkish people in the Netherlands.* Unpublished doctoral dissertation, University of Amsterdam, Amsterdam, the Netherlands.

Mesquita, B. (2003). Emotions as dynamic cultural phenomena. In R. Davidson, H. Goldsmith, & K. R. Scherer (Eds.), *The handbook of the affective sciences* (pp. 871–890). New York: Oxford University Press.

Mesquita, B. (2010). Emoting: A contextualized process. In B. Mesquita, L. F. Barrett, & E. R. Smith (Eds.), *The mind in context* (pp. 83–104). New York: Guilford Press.

Mesquita, B., & Boiger, M. (2014). Emotions in context: A socio-dynamic model of emotions. *Emotion Review, 6*(4), 298–302.

Mesquita, B., De Leersnyder, J., & Albert, D. (2014). The cultural regulation of emotions. In J. J. Gross (Ed.), *The handbook of emotion regulation* (2nd ed., pp. 284–301). New York: Guilford Press.

Mesquita, B., & Ellsworth, P. C. (2001). The role of culture in appraisal. In K. R. Scherer & A. Schorr (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 233–248). New York: Oxford University Press.

Mesquita, B., & Frijda, N. H. (1992). Cultural variations in emotions: A review. *Psychological Bulletin, 112*(2), 179–204.

Mesquita, B., Frijda, N. H., & Scherer, K. R. (1997). Culture and emotion. In P. Dasen & T. S. Saraswathi (Eds.), *Handbook of cross-cultural psychology* (Vol. 2, pp. 255–297). Boston: Allyn & Bacon.

Mesquita, B., & Leu, J. (2007). The cultural psychology of emotions. In S. Kitayama & D. Cohen (Eds.), *Handbook for cultural psychology* (pp. 734–759). New York: Guilford Press.

Miller, P. J., Fung, H., & Mintz, J. (1996). Self-construction through narrative practices: A Chinese and American comparison of early socialization. *Ethos, 24*, 237–280.

Miller, P. J., Wiley, A., Fung, H., & Liang, C. (1997). Personal story-telling as a medium of socialization in Chinese and American families. *Child Development, 68*, 557–568.

Moon, A., Chim, L., Tsai, J., Ho, Y. W., & Fung, H. (2011). *The influence of cultural differences in ideal affect on self-presentation and other-perception of Facebook profiles.* Poster presented at the 12th annual meeting of the Society for Personality and Social Psychology, San Antonio, TX.

Morling, B., Kitayama, S., & Miyamoto, Y. (2002). Cultural practices emphasize influence in the United States and adjustment in Japan. *Personality and Social Psychology Bulletin, 28*(3), 311–323.

Niiya, Y., Ellsworth, P. C., & Yamaguchi, S. (2006). Amae in Japan and the United States: An exploration of a "culturally unique" emotion. *Emotion, 6*(2), 279–295.

Nisbett, R. E., Peng, K., Choi, I., & Norenzayan, A. (2001). Culture and systems of thought: Holistic versus analytic cognition. *Psychological Review, 108*(2), 291–310.

Oishi, S., & Diener, E. (2003). Culture and well-being: The cycle of action, evaluation, and decision. *Personality and Social Psychology Bulletin, 29*(8), 939–949.

Parkinson, B., Fischer, A. H., & Manstead, A. S. (2005). *Emotion in social relations: Cultural, group, and interpersonal processes.* New York: Psychology Press.

Quinn, P. O. (2005). Treating adolescent girls and women with ADHD: Gender-specific issues. *Journal of Clinical Psychology, 61*(5), 579–587.

Rimé, B. (2009). Emotion elicits the social sharing of emotion: Theory and empirical review. *Emotion Review, 1*(1), 60–85.

Rosaldo, R. (1980). Doing oral history. *Social Analysis, 4*, 89–99.

Roseman, I. J., Dhawan, N., Rettek, S. I., Naidu, R. K., & Thapa, K. (1995). Cultural differences and cross-cultural similarities in appraisals and emotional responses. *Journal of Cross-Cultural Psychology, 26*(1), 23–48.

Röttger-Rössler, B., Scheidecker, G., Jung, S., & Holodynski, M. (2013). Socializing emotions in childhood: A cross-cultural comparison between the Bara in Madagascar and the Minangkabau in Indonesia. *Mind, Culture, and Activity, 20*(3), 260–287.

Rozin, P., Lowery, L., Imada, S., & Haidt, J. (1999). The CAD triad hypothesis: A mapping between three moral emotions (contempt, anger, disgust) and three moral codes (community, autonomy, divinity). *Journal of Personality and Social Psychology, 76*(4), 574–586.

Ryder, A. G., & Chentsova-Dutton, Y. E. (2012). Depression in cultural context: "Chinese somatization," revisited. *Psychiatric Clinics of North America, 35*(1), 15–36.

Saarni, C. (2008). The interface of emotional development with social context. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (pp. 332–347). New York: Guilford Press.

Savani, K., Markus, H. R., Naidu, N. V. R., Kumar, S., & Berlia, N. (2010). What counts as a choice?: U.S. Americans are more likely than Indians to construe actions as choices. *Psychological Science, 21*(3), 391–398.

Scherer, K. R. (1997a). Profiles of emotion–antecedent appraisal: Testing theoretical predictions across cultures. *Cognition and Emotion, 11*, 113–150.

Scherer, K. R. (1997b). The role of culture in emotion–antecedent appraisal. *Journal of Personality and Social Psychology, 73*(5), 902–922.

Scherer, K. R., & Wallbott, H. G. (1994). Evidence for universality and cultural variation of differential emotion response patterning. *Journal of Personality and Social Psychology, 66*(2), 310–328.

Shweder, R. (1991). *Thinking through cultures: Expeditions in cultural psychology*. Cambridge, MA: Harvard University Press.

Shweder, R. A., & Bourne, E. J. (1982). Does the concept of the person vary cross-culturally? In A. J. Marsalla & G. M. White (Eds.), *Cultural conceptions of mental health and therapy* (pp. 97–137). London: Reidel.

Shweder, R. A., Haidt, J., Horton, R., & Joseph, C. (2008). The cultural psychology of the emotions: Ancient and renewed. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 409–427). New York: Guilford Press.

Shweder, R. A., Much, N. C., Mahapatra, M., & Park, L. (1997). The "big three" of morality (autonomy, community, divinity), and the "big three" explanations of suffering. In P. Rozin & A. Brandt (Eds.), *Morality and health* (pp. 119–172). New York: Routledge.

Snyder, S. A., Heller, S. M., Lumian, D. S., & McRae, K. (2013). Regulation of positive and negative emotion: Effects of sociocultural context. *Frontiers in Psychology, 4*, 259.

Solomon, R. C. (2003). *Not passion's slave: Emotions and choice*. New York: Oxford University Press.

Tangney, J. P., Stuewig, J., & Mashek, D. J. (2007). Moral emotions and moral behavior. *Annual Review of Psychology, 58*, 345–372.

Trommsdorff, G., & Kornadt, H. (2003). Parent–child relations in cross-cultural perspective. In L. Kuczynski (Ed.), *Handbook of dynamics in parent–child relations* (pp. 271–305). Thousand Oaks, CA: Sage.

Tsai, J. L., Knutson, B., & Fung, H. H. (2006). Cultural variation in affect valuation. *Journal of Personality and Social Psychology, 90*(2), 288–307.

Tsai, J. L., Knutson, B., & Rothman, A. (2007). *The pursuit of ideal affect: Variation in mood-producing behavior*. Unpublished manuscript.

Tsai, J. L., Louie, J. Y., Chen, E. E., & Uchida, Y. (2007). Learning what feelings to desire: Socialization of ideal affect through children's storybooks. *Personality and Social Psychology Bulletin, 33*(1), 17–30.

Tsai, J. L., Miao, F., Seppala, E., Fung, H., & Yeung, D. (2007). Influence and adjustment goals: Sources of cultural differences in ideal affect. *Journal of Personality and Social Psychology, 92*, 1102–1117.

Tsai, J. L., Miao, F. F., & Seppala, E. (2007). Good feelings in Christianity and Buddhism: Religious differences in ideal affect. *Personality and Social Psychology Bulletin, 33*, 409–421.

Turner, V. (1969). *The ritual process: Structure and anti-structure*. Ithaca, NY: Cornell University Press.

Uchida, Y., Townsend, S. S., Markus, H. R., & Bergsieker, H. B. (2009). Emotions as within or between people?: Cultural variation in lay theories of emotion expression and inference. *Personality and Social Psychology Bulletin, 35*(11), 1427–1439.

Vander Wege, B., González, M. L. S., Friedlmeier, W., Mihalca, L. M., Goodrich, E., & Corapci, F. (2014). Emotion displays in media: A comparison between American, Romanian, and Turkish children's storybooks. *Frontiers in Psychology, 5*(600).

Wang, X. (1992). *Resilience and fragility in language acquisition: A comparative study of the gestural communication systems of Chinese and American deaf children*. Unpublished doctoral dissertation, University of Chicago, Chicago, IL.

Weisz, J. R., Rothbaum, F. M., & Blackburn, T. C. (1984). Standing out and standing in: The psychology of control in America and Japan. *American Psychologist, 39*(9), 955–969.

CHAPTER 23

Intergroup Emotions

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Current emotion research and theory generally assume that emotions are adaptive and functional, with a strong focus on their functionality at the biological or individual level. This focus has often involved the use of nonsocial "prototype" emotion situations (such as encountering a bear while walking in the woods) as conceptual touchstones. However, social aspects of emotions are increasingly being investigated, following from the recognition that (in humans) emotions involve socially constructed meanings and most often occur in a social context.

In this chapter, we describe a specific class of social emotions, which we have called "intergroup emotions"—emotions that arise when people identify with a social group and respond emotionally to events or objects that impinge on the group. After introducing the concept of intergroup emotions, we describe its relationship to theoretical models of emotions that usually are applied to individuals. We review evidence (from our own work and that of others) regarding the key properties of intergroup emotions, and conclude by summarizing the implications of this conceptualization, both for emotion theory in general and for intergroup relations. As we show, this model shares the assumption that emotions are generally functional, but at the level of social groups and not solely at the level of the individual.

What Are Intergroup Emotions?

Group Identification and Depersonalization

The fundamental insight underlying the concept of intergroup emotions derives from a major line of social-psychological theory and research inspired by social identity theory (Tajfel, 1978) and self-categorization theory (Turner, Hogg, Oakes, Reicher, & Wetherell, 1987). This is the idea that important group memberships (those with which people psychologically identify) become a part of a person's identity, along with the person's unique, personal, individuating attributes. The "group" in this conceptualization can be a relatively small number of people who interact face to face (such as a committee or a sports team), or a larger social category of people who do not interact face to face (such as a national, ethnic, gender, or religious identity). Either type of group can serve as a vehicle for social identification and can constitute an important and meaningful aspect of someone's identity.

Under circumstances that make a particular group membership or social identity salient, people do not think of themselves as unique individuals, but rather as relatively interchangeable members of the group (a process known as "depersonalization"). This occurs primarily in what is termed an "intergroup situation," one in which social comparisons, competition, or conflict between groups are salient—hence the name of our theoretical model, "intergroup emotions theory" (IET). The consequences of depersonalization are many (see Oakes, Haslam, & Turner, 1994, for a review). People conform to the norms of the activated group in their beliefs, attitudes, and behaviors. They become motivationally aligned with the group, so they see actions that advance the group's interests as desirable and beneficial. They perceive other members of the same group (the "ingroup") as similar to themselves and as likable, and tend to treat them with justice and fairness, while withholding these benefits from members of outgroups.

Tajfel's (1978) original formulation of social identity theory included the idea that when group identification turns a group into an important social identity for an individual, the group takes on emotional significance. However, compared with the cognitive, motivational, and behavioral consequences of group identification, until recently, emotional consequences received little theoretical or empirical attention in the large literature inspired by social identity theory. This seems odd in view of the obvious fact that intergroup conflicts (whether labor–management disputes, ethnic or religious conflicts, clashes between street gangs and police, or international wars) are regularly characterized by extreme levels of emotion. Both direct participants and bystanders who identify with one of the groups involved but are not directly affected tend to experience strong negative feelings, including anger, fear, resentment, contempt, and so on.

Group Identification as a Basis for Intergroup Emotions

The core concepts underlying IET, introduced by Smith (1993), flow from this theoretical background. The fundamental idea is that when someone in an intergroup situation is thinking of him- or herself in terms of a social identity, objects or events that affect the ingroup will elicit emotional responses, because the group becomes in a real sense an aspect of the person's psychological self (Smith & Henry, 1996). Simply put, under these conditions depersonalization causes the person to react to the world as a group member rather than a unique individual, and thus objects and events have emotional consequences based on the way the objects or events relate to the group, not the individual. These group-based emotions can be understood and analyzed in the same way as any others—by using theories of emotions in general, such as appraisal theories. At the heart of IET, therefore, is the distinction between intergroup emotions and the more commonly studied individual-level emotions.

Let us clarify two important points. First, in our conceptualization, intergroup emotions are experienced by individuals (when they identify as members of a group), not by some kind of group mind. Whether intergroup emotions are actually shared across many members of a group is not definitional but is an empirical question, and we present relevant evidence later. This point is in line with Niedenthal and Brauer's (2012) useful distinction:

> Group emotions are the emotions that arise as a function of being in a collective such as a work team or a crowd; they occur in groups. Group-based emotions are emotions that are elicited in an individual because of his or her identification with a group and knowledge that the group has caused or been the target of an emotion-inducing event. (p. 269)

Group-based emotions by this second definition are our topic here. Second, we assume that intergroup emotions are generally similar to individual-level emotions in the ways they are experienced; the effects they have on cognitive, perceptual, and motor processes; and so forth (see Rydell et al., 2008). They differ in the ways they are elicited (i.e., by group-relevant rather than personally relevant events) and in their functions (i.e., in regulating group-related or collective behavior rather than purely individual behavior).

As background for IET, the broader idea that intergroup relations and especially intergroup conflict might trigger emotional responses has been investigated since the 1980s, with seminal work by Dijker (1987), Gaertner and Dovidio (1986), and Stephan and Stephan (1985). Their research examined the usually negative emotions that people can experience when encountering individual members of outgroups, triggered by cultural differences (e.g., the outgroup member may violate ingroup norms) or by an anxiety-toned desire to make the interaction go smoothly and not to give offense. Research has amply demonstrated that these emotional reactions can occur and can motivate avoidance of outgroup members—demonstrating that avoidance need not necessarily be attributed to sheer antipathy for the outgroup.

From the standpoint of IET, an important question is whether these negative emotions experienced during intergroup contact are individual-level or intergroup emotions. They may often remain at the individual level, if the emotions are generated by perceptions of an outgroup member's *individual* annoying or offensive characteristics, or by one's perceived *personal* lack of knowledge about the outgroup and uncertainty about how to interact appropriately. Still, the definition of a situation as interpersonal or intergroup depends on the way the perceiver thinks about it. So a white person's concern about personally appearing prejudiced in an interracial interaction would be an individual emotion, but if he or she feels like a representative of the entire white group and is concerned about confirming the stereotype that whites are generally racist, this would be a group-level emotion. A woman's anger at being made to look stupid by a man's cutting comment might be individual, but if she feels that she was made to look stupid *because* she was a woman, the emotion might be group-based.

One test of whether an emotion is individual or group based is to ask this question: Would the emotional response be similar if the same event happened to some *other* ingroup member? For a group-based emotion, the answer is probably yes. For example, someone might be angered by perceiving that another ingroup member was "victimized" by an unfair affirmative action program, even if the perceiver was personally unaffected. In fact, the late U.S. senator Jesse Helms ran a TV ad in his 1990 campaign, showing a pair of white hands crumpling a letter (presumably a rejection letter) while a voice-over stated, "You needed that job, but they had to give it to a minority" (the ad can be viewed at *www.pbs.org/30secondcandidate/timeline/years/1990.html*). Evidently, the goal was to anger white viewers at the thought that other members of their ingroup were being treated unfairly.

Whether an emotion is individual or group based, if repeated encounters with members of a particular group consistently give rise to feelings of annoyance, anxiety, and the like, the emotion may become associated with the mental representation of the group in general (just as for some individuals feelings of anxiety may become associated with dentists in general). As a result, the perceiver might start to experience anxiety, irritation, and so forth, on any thought about or encounter with that particular outgroup.

Intergroup Emotions and the Regulation of Behavior

Just as any emotion motivates people to take specific sorts of action (Frijda, Kuipers, & ter Schure, 1989), intergroup emotions should do the same. Generally, intergroup emotions should lead to actions specifically related to the intergroup situation. Examples include desires to confront or attack an outgroup, to avoid an outgroup, to affiliate with ingroup members, or to support or oppose government policies that have an impact on entire social groups. In this way, intergroup emotions involve appraisals, feelings, and action tendencies that are all at the group level: The individual who identifies with an ingroup may feel that *they* are threatening *us*; *we* feel angry at *them*; *we* support policies designed to keep *them* from immigrating to our country, cut off *their* government benefits, and so on. The distinction between individual and intergroup emotions is parallel to that between individual and fraternal (i.e., group-based) relative deprivation (Runciman, 1966). The former is the perception that one is not doing as well as other individuals, and the latter is the perception that one's group is not doing as well as other groups; fraternal deprivation has more potent effects on political and social attitudes. Similarly, intergroup emotions are important causes of behavioral outcomes such as support or participation in collective action intended to improve a group's situation in society (van Zomeren, Leach, & Spears, 2012).

Two Foci of Intergroup Emotions

Individual-level emotions can be specifically targeted, or can be more general moods or feeling states. Individuals at times experience emotions targeted at specific other individuals or objects (e.g., anger at a threatening rival, sympathy for a person in distress), and also possess relatively stable profiles of emotional feelings (e.g., general tendencies to feel angry, anxious, or happy) that relate to their personality characteristics (Watson & Clark, 1992).

The same distinction applies to group-level emotional responses. First, emotions such as anger, fear, disgust, or envy targeted *specifically at an outgroup* may relate to perceptions, prejudiced attitudes, or discriminatory behaviors directed at the outgroup. This line of thinking leads to the important hypothesis that all negatively evaluated outgroups are not treated the same way. For example, outgroups that are targets of anger may be actively attacked or confronted, while outgroups that are targets of disgust may be avoided. Several studies have confirmed such hypotheses (Ray, Mackie, & Smith, 2012; Cottrell, Richards, & Nichols, 2010). Outgroup-directed emotions need not always be negative, for in some circumstances people who identify with one group may feel sympathy or pity toward an outgroup, leading to desires to offer help.

Second, people may experience more general emotional feelings when they are thinking of themselves in terms of a particular social identity. These may include not only emotions directed at outgroups, but also positive or negative ingroup-directed emotions (such as group-based pride or collective guilt) and general affective feelings (such as happiness, anxiety, or irritation) that are based on group membership. Thus each group may have a typical "profile" of emotional tendencies, such that when thinking of themselves in terms of that group membership, people often feel proud, irritated, anxious, and so on, in a pattern that systematically differs from what they would report when thinking of themselves as individuals (Smith, Seger, & Mackie, 2007; Seger, Smith, & Mackie, 2009).

Relation of IET to Emotion Theory in General

Appraisal Theories of Emotion

Our original outline of IET (Smith, 1993) and subsequent work (Mackie, Devos, & Smith, 2000; Mackie, Silver, & Smith, 2004; Smith, 1999) adopted the assumptions of appraisal theories of emotions, because they seemed to us to fit well with our general theoretical structure. Our sole modification to appraisal theory was the assumption that in an intergroup situation, events, objects, and groups are appraised in terms of their implications for the ingroup (not just the individual self). Intergroup emotions are generated by this appraisal process, just as individual-level emotions are generated by appraisals of objects or events that impinge on the individual self (Scherer, 1999). For example, a person who identifies with a group and sees the ingroup as threatened by a powerful outgroup's actions may experience intergroup anxiety or fear. One consequence may be a desire or impulse to avoid or escape from the outgroup. As we have discussed earlier, intergroup emotions may be directed at the ingroup as well. For example, in an intergroup situation that makes social comparisons between groups salient, people may feel collective pride if they believe that their group has succeeded in an important task. Or feelings of collective guilt may result if people appraise their group as having violated important moral principles (Doosje, Branscombe, Spears, & Manstead, 1998). Appraisals of the same situation may even differ depending on the specific group membership that is salient. In one study, participants who categorized themselves as students appraised a proposal to raise nonresident tuition at the University of Colorado as more unjust, compared with when they were categorized as Colorado residents (Gordijn, Yzerbyt, Wigboldus, & Dumont, 2006).

Although many appraisal theories (e.g., Roseman, 1984) suggest that appraisals cause emotional states, the causal direction is not one-way. Tiedens and Linton (2001) have demonstrated that emotional states influence people's judgments on appraisal-related dimensions—for example, because anxiety is related to the appraisal of uncertainty, people in an anxious state judge events as highly uncertain. This process operates in the same way with regard to intergroup emotions as it does with individual-level emotions (Rydell et al., 2008).

Finally, appraisal theories suggest that emotions lead to specific behavioral action tendencies (Frijda, 1986). Intergroup anger may lead to a desire to attack or confront the outgroup, disgust to a desire to avoid, or guilt to a desire to make reparations for the ingroup's actions. By adopting the assumptions of appraisal theories in this way, IET makes predictions about linkages of appraisals of the intergroup situation, specific emotional experiences that people report when they are thinking of themselves as group members, and motives or tendencies to engage in collective (group-level) actions. These predictions have been tested (e.g., Mackie et al., 2000).

Core Affect Model of Emotion

However, IET does not necessarily rest solely on appraisal theories. Its fundamental insight is the idea that group identification makes the ingroup part of the psychological self and hence makes group-relevant events or objects able to trigger emotions (as self-relevant events or objects always do). The process of "triggering" could be described by using the concepts of appraisal theories, as in our earlier presentations of the IET model, or can be described in alternative ways. As an illustration, we consider the "core affect" model (Russell & Barrett, 1999; Russell, 2003; Barrett, 2006). In this model, states of core affect, which are described in a two-dimensional space whose axes are pleasantness and arousal, are fundamental components of all experienced emotions (as well as moods). Core affect can change for many reasons: in response to external stimuli such as pleasant or unpleasant environmental states or positive or negative events, or in response to internal physiological processes such as diurnal rhythms. Core affect is assumed to be subjectively perceptible (as the sense of feeling good, bad, energized, tired, etc.).

An experienced episode of emotion begins with a change of core affect that is consciously noted and attributed to some cause. This attribution makes the difference between just feeling negatively aroused and feeling negatively aroused *because* of a specific event. Attributing affective states to external objects or events is often unproblematic, because of the frequent close co-occurrence in time of external events and the affective reactions that they cause. And these attributions are adaptive, for they allow the perceiver to direct attention and behavior appropriately with regard to the object that is responsible for the feeling. However, the true causes of affective states are not always obvious, so people may make misattributions. A feeling of negative arousal that is actually due to irrelevant reasons (such as unpleasantly hot temperatures) may be misattributed to another person's annoying behavior, leading to the experience of anger, and potentially to aggression (Berkowitz, 1998).

How is an emotional experience labeled as an instance of a specific emotion such as anger, fear, sadness, or guilt? The core affect model holds that various factors—including the core affect and its perceived cause, as well as the situational context, one's overt behaviors, and bodily experiences (such as physiological changes)—become input to a perceptual categorization process in which the experience is categorized as a discrete emotion. Russell (2003) holds that the episode is categorized on the basis of the resemblance between these factors and the person's mental representation of a given emotion's prototype. Barrett's (2006) model differs in postulating not a fixed prototype representation, but a situated reconstruction—an emotion representation that is created online and flexibly tuned to the constraints and goals of the situation. In either case, these mental representations (prototype or situated reconstruction) can and will vary between people because of individual experiences and cultural differences. As a result of the categorization, a person could say that he or she feels *afraid* of the specific object. This labeling process produces the conscious awareness of having an emotional episode.

The core affect model incorporates many substantive predictions of appraisal theories, by postulating that appraisals (the person's interpretations of various aspects of the situation) relate to the process of categorization and self-perception of a specific emotion, rather than seeing appraisals as initiating the emotional state with all its concomitants (subjective feelings, autonomic changes, instrumental actions, etc.). See Russell (2003) for further discussion of relations between the core affect model and appraisal theories.

IET is broadly consistent with the core affect model as well as with appraisal theories. How might the process differ if a group (rather than an individual) identity is at stake? First, assume that an event occurs with implications for a person's important group membership, such as a reminder of a nation's colonial past for a person who identifies strongly with the national group. The event may lead to changes in core affect—in this example, negative arousal. Next, the person may search for a cause of that change, perhaps making a misattribution or perhaps correctly attributing it to the event in question. The individual will then draw on his or her affective feelings and attributions, as well as other aspects of the situation, to label the emotion as an instance of guilt—in this case, collective guilt. Desires to take collective actions, such as to make reparations or to offer aid to the victims of the ingroup's actions, may ultimately result. The overall process is not greatly different from that postulated by the core affect model in general; the key differences are that the self-relevance that triggers affective changes in the first place is relevance to a collective (rather than an individual) self, and that the interpretive and categorization processes that follow identify the emotion as an intergroup rather than individual-level emotion. In our example, the perceiver will be readily able to categorize the experience as one of collective guilt, because he or she will have no reason to feel *individually* guilty about ingroup actions that occurred perhaps hundreds of years ago.

Another example illustrates how the process of making an attribution can switch a perceiver between an individual or intergroup emotion. Someone who learns that he or she was not chosen for a much-wanted promotion (and hence feels strong negative arousal) may decide that the reason was his or her boss's ignorance and failure to recognize talent—and may thus experience anger or disappointment at the individual level. Alternatively, the same event may be attributed to the boss's prejudice against a group to which the employee belongs—in which case the individual's anger may be at the intergroup level. The action tendencies will be quite different in this case than in the case of individual anger.

As this discussion indicates, each of the three main elements of the core affect model can be influenced by a person's group identifications. Core affect changes can arise from events that have an impact on the ingroup and not just the person as an individual (a common example is the way we feel great when our team wins). Attributions concerning the cause of a change in core affect may implicate social groups—for example, when we decide that an outgroup member is treating us unfairly because he or she is prejudiced against our group, not just for idiosyncratic personal reasons. And categorization processes may tell us that we are feeling an emotion as an individual (e.g., individual guilt for some personal action) or as a group member (e.g., collective guilt for an ingroup's historical acts).

Evidence Regarding Intergroup Emotions

In this section, we review evidence regarding the properties of intergroup emotions, especially those that distinguish them from individual emotions. We describe evidence on four fundamental questions: (1) Are intergroup emotions distinct from the same person's individual emotions?; (2) Are they related to group identification?; (3) Are they shared among members of the same group?; and (4) Do they functionally regulate intragroup and intergroup attitudes and behaviors? Our discussion also emphasizes studies that demonstrate roles for intergroup emotions in several specific phenomena relevant to prejudice and intergroup relations.

Differences from Individual-Level Emotions

One important distinction between intergroup and individual emotions is that a group-relevant event can cause people to experience emotions on behalf of a group or fellow group members even when the perceivers are not personally affected (e.g., Mackie et al., 2004). For example, in one study, people learned of an event that harmed students at a different university, but that had no conceivable implications for the perceivers as individuals (Yzerbyt, Dumont, Wigboldus, & Gordijn, 2003). They reported feeling more unhappy and angry when they self-categorized as students (making the victims fellow ingroup members), compared with when they self-categorized as members of their own university. Such results indicate that the self-categorization has emotional consequences above and beyond empathy or other individual-level types of emotion contagion.

In a more direct examination of relations between group- and individual-level emotions, Smith et al. (2007) had students report the extent to which they generally felt 12 specific emotions, as individuals and as members of several different ingroups (university, national, and political party groups). As might be expected, reports of emotions at the individual and group level were correlated at about the .3 level (e.g., people who reported feeling more angry as individuals also tended to report feeling more angry as group members). Despite this correlation, analyses showed that profiles of group emotions and individual emotions were meaningfully distinct—qualitatively different, not merely differing in the overall level or intensity of individual versus group emotions. For example, participants reported experiencing lower levels of irritation and guilt, but higher levels of pride and disgust as Americans, compared with their reports of individual-level emotions.

Relationship to Group Identification

For all groups, Smith et al. (2007) found a strong relation between positive group emotions and ingroup identification. This relation occurs for a wide range of groups and is present even when group identification is subtly induced by incidental exposure to ingroup symbols (Seger, Smith, Kinias, & Mackie, 2009; Seger, Smith, & Mackie, 2009). This pattern makes sense both because group identification is a condition that enables the experience of intergroup emotions, and because positive intergroup emotions such as pride and satisfaction are likely to reward and encourage strong identification with a particular group. The relation of anger at the outgroup to group identification was also positive, consistent with some other research (Kessler & Hollbach, 2005). Pennekamp, Doosje, Zebel, and Fischer (2007) found that among Surinamese immigrants in the Netherlands, Surinamese identification related positively, while Dutch identification related negatively, to group-based anger about past slavery.

In contrast, negative group emotions other than outgroup anger (such as guilt, anxiety, and irritation) relate more weakly and generally negatively to identification (Smith et al., 2007). The data patterns suggest that the negative correlation is largely due to a type of motivated cognition: Strong group identification leads people to reinterpret and reappraise group-related events to avoid negative feelings (Doosje et al., 1998). An additional process that may contribute to the negative correlation is that over time, negative emotions may motivate decreased identification with the particular group.

Social Sharing within an Ingroup

Our results (Smith et al., 2007) also demonstrate that people's group-level emotions are socially shared, and shared more strongly by people who identify more with the group—that is, each social group (Americans, Democrats, university students, etc.) has a specific profile of group-level emotions (e.g., high happiness, low anger, moderate guilt). When reporting their emotions for that particular group, members tend to converge toward the group profile, and those who identify more strongly with the group converge to a greater extent. Other studies similarly show that people's perceptions of typical emotions in their group as a whole (whether measured or experimentally manipulated) influence their self-reported emotions, appraisals, and collective action tendencies (Leonard, Moons, Mackie, & Smith, 2011).

Three distinct processes may contribute to this convergence. First, the convergence may be due to "emotional contagion" (Neumann & Strack, 2000), meaning that people tend to take on the emotions displayed by fellow ingroup members with whom they interact. However, the contagion mechanism may be more relevant to face-to-face interacting groups than to the social category groups used in this study. Still, members of larger groups may be affected by emotional contagion when leaders or prototypical members are portrayed in the media and other group members model their emotions (Pescosolido, 2002). Second, people could be regarded as conforming to ingroup norms with regard to their group-level emotions. It has long been known that when people strongly identify with a group, and their membership is made salient in a specific situation, their behaviors and attitudes tend to conform to group norms or move closer to the group prototype (Hogg & Turner, 1987; Simon & Hamilton, 1994). Recent research confirms that emotions are affected in the same way by group norms (Moons, Leonard, Mackie, & Smith, 2009; Leonard, Moons, et al., 2011). Finally, a third possibility is that group emotion convergence occurs because thinking about a group membership makes the same key group-relevant events and appraisals salient to different perceivers, so that emotional responses to such events are generally shared among group members. For example, when many individual Americans think of themselves as Americans, the same limited number of events and situations may be salient, such as attacks by militant anti-Americans. So these individuals may all report feeling angry as Americans because they are all responding to more or less the same salient events in more or less the same way. In general, all three of these processes (emotional contagion, conformity to emotion profiles that function as group norms, and shared reactions to salient group-relevant objects or events) may be important causes of group emotion convergence.

Regulation of Intergroup and Intragroup Attitudes and Behaviors

Smith et al. (2007) found that group emotions predicted both ingroup- and outgroup-directed action tendencies, above and beyond the relatively weak predictive power of individual-level emotions. These studies investigated a wide range of specific action tendencies involving ingroup support and solidarity, outgroup confrontation, and outgroup avoidance. The results suggested that anger at the outgroup (and, to a lesser extent, anger at the ingroup) was the most powerful predictor across all categories of action tendencies. The fact that anger at the outgroup predicts the desire to engage in confrontational behavior would be expected from standard theories relating emotion to action tendencies (Frijda et al., 1989; Mackie et al., 2000). The relation of anger at the outgroup to tendencies to support and affiliate with the ingroup is also consistent with previous research (Kessler & Hollbach, 2005) showing that this group emotion tends to increase ingroup identification.

The regulation of intergroup behavior by intergroup emotions has also been demonstrated in research examining the antecedents of collective action. A meta-analysis (van Zomeren, Postmes, & Spears, 2008) and proposed theoretical model (van Zomeren et al., 2012) both give group-based anger a central role in motivating people to support or participate in collective action on behalf of their group. Consistent with this idea, Leonard, Moons, et al. (2011) found that manipulations that increased women's group-based anger also led to increased support for collective action against a sexist act. Collective guilt as well as anger lead members of advantaged groups to support demands for justice made by disadvantaged groups (e.g., Iyer, Schmader, & Lickel, 2007).

Yet another aspect of behavioral regulation by intergroup emotions is that if intergroup emotions are functional, successfully implementing an emotion-linked behavioral tendency should allow the emotional feelings to dissipate, whereas impeding the behavioral tendency should intensify the emotion. Maitner, Mackie, and Smith (2006) investigated the emotional consequences of satisfying or thwarting behavioral intentions related to intergroup emotions. Study 1 showed that if an attack on the ingroup produced anger, retaliation increased satisfaction, but if an attack produced fear, retaliation increased fear and guilt. Study 2 showed that outgroup-directed anger instigated via group insult dissipated when the ingroup successfully responded, but was exacerbated by an unsuccessful response. Responding in an emotionally appropriate way was satisfying, but ingroup failure to respond elicited anger directed at the ingroup. Study 3 showed that intergroup guilt following aggression was diminished when the ingroup made reparations, but was exacerbated when the ingroup aggressed again. These findings demonstrate that satisfying behavioral intentions associated with intergroup emotions fulfills a regulatory function.

Many other studies show that intergroup emotions are related to desires to take actions relevant to group memberships. For example, the specific group-based emotions that Americans experienced in response to the attacks of September 11, 2001, predicted respondents' support for restrictions on civil liberties measured several months later, with fear increasing such support and anger decreasing it (Skitka, Bauman, & Mullen, 2004). A number of researchers have demonstrated potent effects of group-level guilt and ingroup-directed anger on action tendencies related to apologizing and making reparations for past group-based offenses (Branscombe & Doosje, 2004; Leach & Iyer, 2006; Iyer & Leach, 2010). And when intergroup apologies are made, their effects on forgiveness and desires for retribution are mediated by outgroup-directed emotions (Leonard, Mackie, & Smith, 2011). Finally, recent work shows that teaching emotion regulation strategies to people involved in an intractable conflict situation (the Israeli–Palestinian conflict) successfully reduces their support for policies aimed at harming those on the other side (Gross, Halperin, & Porat, 2013). These studies not only provide additional experimental support for the role of intergroup emotions in regulating intergroup behavior but also open up new possibilities for handling and perhaps defusing intractable conflicts.

Relations of Intergroup Emotions to Prejudice

The theme that intergroup emotions regulate and direct people's attitudes and behaviors toward an outgroup has specific implications for understanding prejudice—a topic that has been the focus of much of our research. Miller, Smith, and Mackie (2004) examined the role of intergroup emotions directed at a specific outgroup (African Americans) in predicting European Americans' prejudice against that group. The studies replicated large bodies of research showing that past intergroup contact reduces prejudice, and that "social dominance orientation" (SDO), a personality-like individual difference reflecting desires to maintain hierarchies of group inequality, is associated with increased prejudice. The studies also demonstrated that intergroup emotions (self-reports of different emotions experienced by European Americans when encountering or thinking about African Americans) played a major role in mediating both of those effects. We also examined stereotypes of the outgroup as an alternative potential mediator. Stereotypes had no significant role in mediating the effects of past intergroup contact, and mediated part of the effect of SDO in one of the two studies. These results fit with the existing empirical and conceptual evidence for the priority of affective (emotional) over cognitive (stereotype beliefs) mediators of effects on prejudice (e.g., Pettigrew, 1998). Other work shows that in a cross-categorization situation, different discrete emotions underlie prejudice toward others who may share one ingroup membership but differ on a second dimension (Ray et al., 2012). Such findings underline the importance of understanding group-level emotions as part of the entire picture of prejudice, as well as their important role in strategies (such as intergroup contact or cross-categorizations) for prejudice reduction.

Conceptualizing prejudice as often including an emotional component also helps understand why people's perceptions and desired actions toward different outgroups may differ. Cottrell et al. (2010) demonstrate that general prejudice (defined as a negative attitude toward an outgroup) failed to predict such distinctions, while the particular emotions (such as disgust, anger, or guilt) felt toward specific groups were much more powerful predictors of preferences regarding group-relevant policies, in ways that could be understood in terms of the specific emotions' action tendencies.

Summary and Implications

The perspective described in this chapter rests on the simple yet powerful idea that a social identity based on group identification—not just a biological/individual self—can have emotional implications. Many concrete research hypotheses can be generated by combining this fundamental idea with assumptions based on emotion theory in general, yielding the insight that appraisals of social situations, experienced emotions, and emotion-driven desires for action can all occur at the level of the social group as well as the individual.

Implications for the Study of Intergroup Relations

This set of ideas has several implications for our understanding of prejudice and intergroup relations. First, consider the relations of group-based emotions directed at a particular outgroup and the more traditional concept of stereotypes of the outgroup. IET holds that stereotypes are far from irrelevant, for they may feed into appraisals. For example, an outgroup may be seen as hardworking and achievement oriented, which could lead to its being appraised as a potent threat to the ingroup's economic status in society. Note that, as this example implies, there is no necessary direct relationship between the valence of stereotypes and the valence of people's emotional responses to groups. Positive traits ascribed to the outgroup can lead to negative responses, because emotional responses rest on relational appraisals (What does the outgroup mean for us?) rather than on the valence of the outgroup's characteristics in isolation.

Second, thinking about intergroup perceptions and behavior as being at least in part based on emotions leads to a whole new portfolio of approaches to reducing prejudice and discrimination. Group stereotypes are often deep-seated and resistant to change, as people employ various attributional and subtyping processes in their defense. Hence, changing stereotypes may not be broadly effective in reducing prejudice. However, emotion regulation approaches may have much promise. As mentioned earlier, Gross et al. (2013) found that teaching reappraisal techniques to members of a group enmeshed in an intractable conflict successfully improved their attitudes on policies related to the conflict. As the authors conclude,

> These results suggest that emotion regulation can affect not only emotional reactions but also political ones. Moreover, they indicate that reappraisal may be an efficient tool for regulating emotions even in the context of one of the most ideologically driven, intense, and highly emotional settings and in the face of an ongoing stream of negative information and events. (p. 427)

Finally, thinking about emotions as an important component of people's reactions to outgroups also leads to new conceptions regarding time. In traditional views, stereotypes and prejudiced attitudes toward an outgroup are typically regarded as highly stable (in fact, their resistance to change has been a core issue motivating much research). In contrast, emotions are labile, varying over seconds and minutes. This raises new research questions, such as whether someone's thoughts, evaluations, and behaviors toward an outgroup may differ specifically when the individual is in an emotional state from when he or she is not. At least one study suggests that the answer to this question may be yes (DeSteno, Dasgupta, Bartlett, & Cajdric, 2004).

Implications for Emotion Theory and Research

Just as IET encourages a rethinking of some issues related to prejudice and intergroup behavior, it also has implications for theory and research regarding emotion more generally. Perhaps the most fundamental implication is the idea that emotions pertain to an *identity* and not to a biological individual. An individual typically has multiple identities (including a personal self, many group memberships that may become salient in different circumstances, and possibly several important relational identities as well; Sedikides & Brewer, 2001). Each of these identities is an aspect of the self, so it remains true that, as emotion researchers assume, emotions always implicate the self. In addition, there will generally be a degree of continuity between emotions experienced in different identities (illustrated by the .3 correlations between group- and individual-level emotions; Smith et al., 2007), perhaps partly due to biologically based differences in emotional reactivity. Still, each identity may have a distinctive emotion profile, both short term and chronically. This idea has many as-yet-unexplored implications—for example, in regard to emotional vulnerability.

The idea that emotions are rooted in identities also has implications for emotion regulation: Because people can shift rapidly between identities (e.g., between one group membership and another, or between a group- and an individual-level identity), such shifts can be part of an emotion regulation process (Smith & Mackie, 2006). People may be expected to adopt identities associated with positive group emotions or disidentify from groups associated with negative group emotions, and there is evidence consistent with this idea (Kessler & Hollbach, 2005). Research might productively examine more details of this identity-based emotion regulation strategy, and compare its effectiveness against other strategies on which the literature has focused (Gross, 1998).

IET encourages theorists and researchers to look into social influences (especially influences of the intergroup context) on all aspects of emotional responding. Whereas a number of theorists (e.g., Smith & Lazarus, 1991; Mesquita, 2003) have argued that emotions are inherently relational or interpersonal in nature, our argument is slightly different: that emotions arise from group memberships or collective (not only relational) aspects of the self (Sedikides & Brewer, 2001). Group memberships may influence all aspects of emotional responding: changes in core affect, the causal attributions people make for such changes, the way they categorize their emotional experiences, and the types of actions that they may seek to perform when in emotional states. Investigations of these issues may clarify the ways emotions are functional at the level of groups and not solely individuals. Indeed, such group-level functionality is to be expected, for group living is evolutionarily ancient in humans as well as related primate species, and it would be surprising indeed if emotions did not play a role in shaping our feelings about and reactions to other ingroup members as well as outgroup members (Cottrell & Neuberg, 2005; Caporael, 1997).

We close with one obvious point. For emotion researchers, intergroup relations offer a powerful venue in which to investigate emotions and their effects. This is a domain of social life in which emotions are often intense, compelling—and highly consequential (with effects including persecutions, pogroms, and genocides). It is also a domain in which, as we argue, emotions are often driven by people's self-identification with important social groups, rather than by their individual selves. Increases in our understanding of emotions themselves, as well as understanding of the social phenomena to which they contribute, may result from an increased focus on social group memberships as bases for emotions.

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References

Barrett, L. F. (2006). Solving the emotion paradox: Categorization and the experience of emotion. *Personality and Social Psychology Review, 10*(1), 20–46.

Berkowitz, L. (1998). Affective aggression: The role of stress, pain, and negative affect. In R. G. Geen & E. Donnerstein (Eds.), *Human aggression: Theories, research, and implications for social policy* (pp. 49–72). San Diego, CA: Academic Press.

Branscombe, N. R., & Doosje, B. (Eds.). (2004). *Collective guilt: International perspectives*. Cambridge, UK: Cambridge University Press.

Caporael, L. R. (1997). The evolution of truly social cognition: The core configurations model. *Personality and Social Psychology Review, 1*, 276–298.

Cottrell, C. A., & Neuberg, S. L. (2005). Different emotional reactions to different groups: A sociofunctional-threat-based approach to "prejudice." *Journal of Personality and Social Psychology, 88*, 770–789.

Cottrell, C. A., Richards, D. A. R., & Nichols, A. L. (2010). Predicting policy attitudes from general prejudice versus specific intergroup emotions. *Journal of Experimental Social Psychology, 46*(2), 247–254.

DeSteno, D., Dasgupta, N., Bartlett, M. Y., & Cajdric, A. (2004). Prejudice from thin air: The effect of emotion on automatic intergroup attitudes. *Psychological Science, 15*, 319–324.

Dijker, A. J. (1987). Emotional reactions to ethnic minorities. *European Journal of Social Psychology, 17*, 305–325.

Doosje, B., Branscombe, N. R., Spears, R., & Manstead, A. S. R. (1998). Guilty by association: When one's group has a negative history. *Journal of Personality and Social Psychology, 75*, 872–886.

Frijda, N. H. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.

Frijda, N. H., Kuipers, P., & ter Schure, E. (1989). Relations among emotion, appraisal, and emotional action readiness. *Journal of Personality and Social Psychology, 57*, 212–228.

Gaertner, S. L., & Dovidio, J. F. (1986). The aversive form of racism. In J. F. Dovidio & S. L. Gaertner (Eds.), *Prejudice, discrimination, and racism* (pp. 61–90). Orlando, FL: Academic Press.

Gordijn, E. H., Yzerbyt, V., Wigboldus, D., & Dumont, M. (2006). Emotional reactions to harmful intergroup behavior. *European Journal of Social Psychology, 36*, 15–30.

Gross, J. J. (1998). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology, 74*, 224–237.

Gross, J. J., Halperin, E., & Porat, R. (2013). Emotion regulation in intractable conflicts. *Current Directions in Psychological Science, 22*(6), 423–429.

Hogg, M. A., & Turner, J. C. (1987). Intergroup behavior, self-stereotyping and the salience of social categories. *British Journal of Social Psychology, 26*, 325–340.

Iyer, A., & Leach, C. W. (2010). Helping disadvantaged outgroups challenge unjust inequality: The role of group-based emotions. In S. Stürmer & M. Snyder (Eds.), *The psychology of prosocial behavior: Group processes, intergroup relations, and helping* (pp. 337–353). Hoboken, NJ: Wiley-Blackwell.

Iyer, A., Schmader, T., & Lickel, B. (2007). Why individuals protest the perceived transgressions of their country: The role of anger, shame, and guilt. *Personality and Social Psychology Bulletin, 33*, 572–587.

Kessler, T., & Hollbach, S. (2005). Group-based emotions as determinants of ingroup identification. *Journal of Experimental Social Psychology, 41*, 677–685.

Leach, C. W., & Iyer, A. (2006). Anger and guilt about in-group advantage explain the willingness for political action. *Personality and Social Psychology Bulletin, 32*, 1232–1245.

Leonard, D. J., Mackie, D. M., & Smith, E. R. (2011). Emotional responses to intergroup apology mediate intergroup forgiveness and retribution. *Journal of Experimental Social Psychology, 47*, 1198–1206.

Leonard, D. J., Moons, W. G., Mackie, D. M., & Smith, E. R. (2011). We're mad as hell and we're not going to take it anymore: Anger self-stereotyping and collective action. *Group Processes and Intergroup Relations, 14*, 99–111.

Mackie, D. M., Devos, T., & Smith, E. R. (2000). Intergroup emotions: Explaining offensive action tendencies in an intergroup context. *Journal of Personality and Social Psychology, 79*, 602–616.

Mackie, D. M., Silver, L. A., & Smith, E. R. (2004). Intergroup emotions: Emotion as an intergroup phenomenon. In L. Z. Tiedens & C. W. Leach (Eds.), *The social life of emotions* (pp. 227–245). Cambridge, UK: Cambridge University Press.

Maitner, A. T., Mackie, D. M., & Smith, E. R. (2006). Evidence for the regulatory function of intergroup emotion: Emotional consequences of implemented or impeded intergroup action tendencies. *Journal of Experimental Social Psychology, 42*, 720–726.

Mesquita, B. (2003). Emotions as dynamic cultural phenomena. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 871–890). New York: Oxford University Press.

Miller, D. A., Smith, E. R., & Mackie, D. M. (2004). Effects of intergroup contact and political predispositions on prejudice: Role of intergroup emotions. *Group Processes and Intergroup Relations, 7*, 221–237.

Moons, W. G., Leonard, D. J., Mackie, D. M., & Smith, E. R. (2009). I feel our pain: Antecedents and consequences of emotional self-stereotyping. *Journal of Experimental Social Psychology, 45*, 760–769.

Neumann, R., & Strack, F. (2000). "Mood contagion": The automatic transfer of mood between persons. *Journal of Personality and Social Psychology, 79*, 211–223.

Niedenthal, P. M., & Brauer, M. (2012). Social functionality of human emotion. *Annual Review of Psychology, 63*(1), 259–285.

Oakes, P., Haslam, S. A., & Turner, J. C. (1994). *Stereotyping and social reality*. Oxford, UK: Blackwell.

Pennekamp, S. F., Doosje, B., Zebel, S., & Fischer, A. H. (2007). The past and the pending: The antecedents and consequences of group-based anger in historically and currently disadvantaged groups. *Group Processes and Intergroup Relations, 10*, 41–55.

Pescosolido, A. T. (2002). Emergent leaders as managers of group emotion. *Leadership Quarterly, 13*, 583–599.

Pettigrew, T. F. (1998). Intergroup contact theory. *Annual Review of Psychology, 49*, 65–85.

Ray, D. G., Mackie, D. M., & Smith, E. R. (2012). Discrete emotions elucidate the effects of crossed-categorization on prejudice. *Journal of Experimental Social Psychology, 48*, 55–69.

Roseman, I. J. (1984). Cognitive determinants of emotion: A structural theory. *Review of Personality and Social Psychology, 5*, 11–36.

Runciman, W. G. (1966). *Relative deprivation and social justice*. Berkeley: University of California Press.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*, 145–172.

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology, 76*, 805–819.

Rydell, R. J., Mackie, D. M., Maitner, A. T., Claypool, H. M., Ryan, M. J., & Smith, E. R. (2008). Arousal, processing, and risk taking: Consequences of intergroup anger. *Personality and Social Psychology Bulletin, 34*, 1141–1152.

Scherer, K. R. (1999). Appraisal theory. In T. Dalgliesh & M. J. Power (Eds.), *Handbook of cognition and emotion* (pp. 637–663). New York: Wiley.

Sedikides, C., & Brewer, M. B. (Eds.). (2001). *Individual self, relational self, collective self.* Philadelphia: Psychology Press.

Seger, C. R., Smith, E. R., Kinias, Z., & Mackie, D. M. (2009). Knowing how they feel: Perceiving emotions felt by outgroups. *Journal of Experimental Social Psychology, 45*, 80–89.

Seger, C. R., Smith, E. R., & Mackie, D. M. (2009). Subtle activation of a social categorization triggers group-level emotions. *Journal of Experimental Social Psychology, 45*, 460–467.

Simon, B., & Hamilton, D. L. (1994). Self-stereotyping and social context: The effects of relative in-group size and in-group status. *Journal of Personality and Social Psychology, 66*, 699–711.

Skitka, L. J., Bauman, C. W., & Mullen, E. (2004). Political tolerance and coming to psychological closure following the September 11, 2001 terrorist attacks: An integrative approach. *Personality and Social Psychology Bulletin, 30*, 743–756.

Smith, C. A., & Lazarus, R. S. (1991). Appraisal components, core relational themes, and the emotions. *Cognition and Emotion, 7*, 233–269.

Smith, E. R. (1993). Social identity and social emotions: Toward new conceptualizations of prejudice. In D. M. Mackie & D. L. Hamilton (Eds.), *Affect, cognition, and stereotyping: Interactive processes in group perception* (pp. 297–315). San Diego, CA: Academic Press.

Smith, E. R. (1999). Affective and cognitive implications of a group becoming part of the self: New models of prejudice and of the self-concept. In D. Abrams & M. A. Hogg (Eds.), *Social identity and social cognition* (pp. 183–196). Oxford, UK: Blackwell.

Smith, E. R., & Henry, S. (1996). An in-group becomes part of the self: Response time evidence. *Personality and Social Psychology Bulletin, 22*, 635–642.

Smith, E. R., & Mackie, D. M. (2006). It's about time: Intergroup emotions as time-dependent phenomena. In R. Brown & D. Capozza (Eds.), *Social identities: Motivational, emotional, cultural influences* (pp. 173–187). New York: Psychology Press.

Smith, E. R., Seger, C., & Mackie, D. M. (2007). Can emotions be truly group-level? Evidence regarding four conceptual criteria. *Journal of Personality and Social Psychology, 93*, 431–446.

Stephan, W. G., & Stephan, C. W. (1985). Intergroup anxiety. *Journal of Social Issues, 41*, 157–175.

Tajfel, H. (1978). *Differentiation between social groups: Studies in the social psychology of intergroup relations*. London: Academic Press.

Tiedens, L. Z., & Linton, S. (2001). Judgment under emotional certainty and uncertainty: The effects of specific emotions on information processing. *Journal of Personality and Social Psychology, 81*, 973–988.

Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D., & Wetherell, M. S. (1987). *Rediscovering the social group: A self-categorization theory*. Oxford, UK: Blackwell.

van Zomeren, M., Leach, C. W., & Spears, R. (2012). Protesters as "passionate economists": A dynamic dual pathway model of approach coping with collective disadvantage. *Personality and Social Psychology Review, 16*(2), 180–199.

van Zomeren, M., Postmes, T., & Spears, R. (2008). Toward an integrative social identity model of collective action: A quantitative research synthesis of three socio-psychological perspectives. *Psychological Bulletin, 134*, 504–535.

Watson, D., & Clark, L. A. (1992). On traits and temperament: General and specific factors of emotional experience and their relation to the five-factor model. *Journal of Personality, 60*, 441–476.

Yzerbyt, V. Y., Dumont, M., Wigboldus, D., & Gordijn, E. (2003). I feel for us: The impact of categorization and identification on emotions and action tendencies. *British Journal of Social Psychology, 42*, 533–549.

CHAPTER 24

SOCIAL FUNCTIONS OF EMOTION AND EMOTION REGULATION

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The classic perspective on the functionality of emotions is that they increase the probability of an individual's survival and/or reproductive success. The general argument is that emotions are functional in the sense that they help the individual to address or overcome problems (e.g., Frijda, 1986; Lazarus, 1991; Levenson, 1999; Cosmides & Tooby, 2000). Fear of predators or enemies, for example, is adaptive in the sense that individuals who have the capacity to experience such fear are more likely to be vigilant and avoidant, and thereby to escape the threat of predation or attack (Cosmides & Tooby, 2000; Öhman, 2000).

In this chapter, we shift the attentional focus to functional analyses of emotion that emphasize "social survival"—that is, our human capacity to build social bonds and address and overcome social problems such as social exclusion or loss of power (see, e.g., Barrett, 1995; Fridlund, 1994; Griffiths & Scarantino, 2009; Keltner & Haidt, 1999). The central argument we advance is that emotions are important to social well-being because the emotions we experience and express help us to (1) form and maintain positive social relationships (affiliation function); and (2) establish or maintain a social position relative to others, and to preserve our self-esteem, identity, or power, sometimes at the expense of others (distancing function). Both functions point to the importance of a precarious balance between maintaining close and harmonious relations without sacrificing a secure and healthy sense of self. We summarize evidence for the affiliation and distancing functions of positive and negative emotions first at the interpersonal level and then at the group level. Because these functions cannot be served without social regulation, we also discuss the social function of emotion regulation, and the issue of how other people play a role in regulating our emotions.

The Nature of Social Functions

Some social functions of emotions may have an evolutionary origin, because humans compete and cooperate in order to meet survival and reproduction goals. Cultural and social norms, however, have become increasingly important in our complex, industrialized societies, where social well-being is based on how well we adjust to the challenges of different social goals. Living a socially successful life has become a complex endeavor that requires knowledge of norms, sensitivity to one's own and others' needs, and the ability to regulate one's emotions in a socially appropriate way. This entails striking a balance between competing social goals, which can be described as social connectedness and cooperation, on the one hand, and autonomy and competition, on the other. Humans are social creatures who need social bonds in order to thrive (Baumeister & Leary, 1995): We affiliate with others, work together with others, and seek harmony, closeness, and love. The importance of social bonds is illustrated by research on social isolation, showing that this leads not only to poorer health and well-being, but also to inhibited development of various social, emotional, and cognitive skills (Williams, 2001). On the other hand, we also have goals that set us apart from others: We are keen to avoid others who might pose a threat to us, excel above others and win when competing with others, exert control over others, or enhance our social power or social standing. These latter social goals cannot simply be achieved through cooperation and affiliation; they typically require distancing ourselves from others, or even being ready to compete with other persons or groups.

Emotions play an important role in realizing these two types of goals, and we therefore draw a broad distinction between two general social functions of emotion. The "affiliation function" of emotion refers to the idea that emotions help an individual or group to establish or maintain cooperative and harmonious relations with other individuals or other social groups. The "distancing" function of emotion serves to differentiate or distance the self or group from others (see also Brewer, 1991) and even to compete with these others for social status or power. Each of these general social functions of emotion operates at both the interpersonal and group level.

Any analysis of the social functions of emotion is likely to encounter the same conceptual and empirical issues as those encountered by analyses of its nonsocial functions (Gross & John, 2002; Oatley & Jenkins, 1992; Parrott, 2001, 2002). Emotion expressions typically have social effects (e.g., Algoe, Fredrickson, & Gable, 2013; Fischer & Roseman, 2007; Giner-Sorolla, 2012; Hess & Fischer, 2013; Hutcherson & Gross, 2011; Tiedens & Leach, 2004; Van Kleef, De Dreu & Manstead, 2010; Van Kleef, van Doorn, Heerdink, & Koning, 2011), whether or not these effects are intended. However, social effects are not the same as social functions.

Social effects of emotions depend on the way in which the emotion is expressed, and also on the specific features of the social and cultural context (e.g., Fischer, Manstead, & Zaalberg, 2003; Mesquita, 2003; Parkinson, 2005; Parkinson, Fischer, & Manstead, 2005; Van Kleef et al., 2011). For example, anger can be expressed by ignoring, criticizing, or shouting at someone. These behaviors are likely to have different effects, and these effects are also likely to vary as a function of the identity of the target and the appropriateness of the expression. Scolding a friend because he or she forgot an appointment might elicit an apology on the part of the friend, but the same expression of anger toward a superior who forgot an appointment might evoke a contemptuous response (e.g., Van Kleef & Côté, 2007). In the same vein, the effects of emotion are likely to vary across cultural contexts, depending on what is considered a typical or desirable expression in a specific situation (see also Kitayama, Mesquita, & Karasawa, 2006; Tsai, Knutson, & Fung, 2006). Thus, the social effects of emotion expressions are quite concrete and also context specific (see also Philippot, Feldman, & Coats, 1999).

Social functions are defined at a more abstract level and are inferred from the social-relational goals inherent in the appraisals and action tendencies that are typical of a given emotion (e.g., Roseman, Wiest, & Swartz, 1994; see Table 24.1). The social distancing function is typical of contempt (wanting to exclude another person), anger (wanting to confront, attack, or criticize), disgust (wanting to move away, isolate oneself from), social fear (wanting to flee from someone), or *schadenfreude* (being pleased about or amused by another's misfortune). The affiliation function, on the other hand, is typical of happiness and other positive emotions, such as gratitude, love, or admiration (sharing positive experiences with or communicating positive experiences to others), but is also characteristic of certain negative emotions, such as guilt (acknowledging that you have harmed someone), shame (acknowledging one's faults), or sadness (seeking help and support from others).

We therefore propose that each emotion has a prevalent social function, based on the individual's

TABLE 24.1. Illustrative Social Functions of Some Emotions

Affiliation function	Distancing function
Happiness	Anger
Love	Hate
Gratitude	Contempt
Admiration	Disgust
Sadness	Social fear
Guilt	Schadenfreude
Shame	Pride about self
Regret	Disappointment in others

goals in a social situation (affiliating with another or distancing from another). It is possible, however, that a single emotion can serve both social functions, depending on the context and taking the time frame into account. This is a point we return to below.

The idea that emotions have social functions does not imply that emotions are always socially functional—that is, that they always have the social effects that would be predicted on the basis of their relational goals. Anger, contempt, and even hate can be socially functional if they help to protect the self from destructive relations with others. However, these emotions can be and frequently are socially dysfunctional when expressions of anger or contempt are targeted either at others who pose no threat to the self or at others who have the power to inflict even greater damage. In the case of others who pose no threat to the self, expression of these emotions may irreparably damage relationships with them, without achieving anything in terms of social control or social standing. In the case of others who have the power to inflict greater damage, expression of these emotions clearly runs the risk of eliciting such damage.

The same applies to positive emotions such as pride, happiness, or love: Rather than strengthening social bonds, they may cause others to take exception to what they regard as inappropriate in the circumstances. Social dysfunctionality is especially likely to occur if the social impact of one's emotions is not taken into account or if inappropriate appraisals of the social context are made (e.g., Evers, Fischer, Rodriguez Mosquera, & Manstead, 2004; Manstead & Fischer, 2001; Parrott, 2001). According to Giner-Sorolla's (2012) functional conflict theory, dysfunctionality may also be a consequence of emotions having different functions at different levels, at least some of which can be contradictory. Thus, the social functionality of emotion in a particular set of circumstances is not a given, but rather depends on the way in which the person assesses his or her concerns or goals in relation to others' concerns or goals, and regulates his or her emotions accordingly. Becoming "too" jealous, getting angry "too often," or feeling contempt for many people is unlikely to be socially functional, although it can sometimes be functional at an individual level (e.g., by allowing the individual to vent negative feelings). Below we further explore the social functions of emotion, starting with emotions in interpersonal relationships.

The Affiliation Function of Emotions at the Interpersonal Level

Social relations between individuals vary in emotional tone from love affairs to work relations, but any relationship between two persons involves some degree of emotion. The amount of emotion that is experienced and expressed, however, is closely related to the nature of the relationship, reflecting an important function of emotions at the interpersonal level: Emotions enable us to form and maintain long-term and intimate relationships by promoting closeness and harmony, by providing comfort and avoiding social isolation. This function can be inferred from research on the social effects of emotions on others or on the relationships with others.

There is evidence that the frequency and intensity of emotion experience and expression increase with the intimacy of the relationship. For example, research by Clark, Fitness, and Brissette (2004) has shown that emotions are more often experienced and expressed in communal or intimate relations than in other types of relationships. Barrett, Robin, Pietromonaco, and Eyssell (1998) also found that the degree of expression of specific emotions, as reported in diary entries, was highly correlated with the closeness of the interaction partner. Research on social sharing has also repeatedly shown that people share their emotions mainly with family and friends (Rimé, Philippot, Boca, & Mesquita, 1992). A related point is that an absence of emotions in relationships casts doubt on the strength of the social bond between the relationship partners (Laurenceau, Barrett, & Pietromonaco, 1998). In their analysis of marital conflicts, Gottman and Levenson (2002) found that an absence of affect during such conflicts was a predictor of subsequent divorce. Studies of anger and aggression have shown that people, especially women, are most often angry with intimates (Fischer, Rodriguez Mosquera, van Vianen, & Manstead, 2004; Kring, 2000), and that physical aggression, especially on the part of women, also occurs more often within intimate relationships (Archer, 2000).

These various lines of research provide support for the idea that intimate and communal relationships are characterized by strong mutual concerns and therefore give rise to emotions (e.g., Frijda, 1986), whether positive or negative. In addition, intimate relations also allow the expression of emotions, especially emotions that may expose weak or vulnerable facets of the self (such as jealousy, powerlessness), which may then further strengthen the emotional involvement. Indeed, suppression of emotional expressions in such relationships may be dysfunctional, because it may reflect a lack of trust or support. The suppression of emotional expressions in relations between strangers may also be dysfunctional, however. Research on the social effects of emotion suppression (Butler et al., 2003), for example, has shown that if one individual is instructed to suppress his or her emotions, the other person feels less emotional rapport, and exhibits heightened cardiovascular responding. Van Kleef, Oveis, Van Der Löwe, LuoKogan, Goetz, and Keltner (2008) further showed that a higher sense of power leads to being less emotionally responsive to a conversation partner's distress, which then resulted in partners' feeling less understood and less keen on befriending the other. In addition, a study of the long-term social relationship effects of emotion suppression showed that suppression as measured in freshmen prior to entering college led to poorer social relations 4 years later (English, John, Srivastava, & Gross, 2012). In other words, suppressing emotions may not only be detrimental in intimate relationships but also limit the formation of new relationships.

Previous research also shows that the expression of virtually all positive emotions promotes the development of stable and close relationships. This applies not only to romantic relationships but also to relations between strangers. Smiling people, for example, are more likely to be ascribed positive traits, such as kindness, humor, intelligence, or honesty, than are their nonsmiling counterparts (Hess, Beaupré, & Cheung, 2002; Reis et al., 1990). Krumhuber and colleagues (Krumhuber & Kappas, 2005; Krumhuber, Manstead, & Kappas, 2007) showed that these positive effects of smiling are moderated by the perceived genuineness of the smile. The more we believe that a stranger's smile reflects sincere positive feelings, the more cooperative we are likely to be toward that person (Krumhuber, Manstead, Cosker, et al., 2007).

The reciprocal expression of gratitude has also been shown to be very functional in close relationships. Showing that one is grateful for what one's partner has done leads not only to positive and appreciative feelings in the partner, but also to the recognition that one's relationship is valuable and that one feels secure and appreciated by the other (Algoe, Gable, & Maisel, 2010; Gordon, Impett, Kogan, Oveis, & Keltner, 2012). Expressions of gratitude also benefit relations between strangers and result in prosocial behavior, even if such behavior is effortful and unpleasant to carry out (Bartlett & DeSteno, 2006). One of the few positive emotions that does not necessarily result in closeness and affiliation is pride because (along with positive affect) this emotion signals high relative social status (Shariff & Tracy, 2009), and this is more likely to serve the social distancing function than the affiliation function. However, this only applies when the pride is expressed in relation to one's own attributes or achievements; in cases where one expresses pride in relation to the attributes or achievements of others, as is quite common in collectivistic cultures (Fischer, Manstead, & Rodriguez, 1999), such expressions can clearly serve the affiliation function.

Negative emotions play a different role in the development and maintenance of interpersonal relationships. The evidence suggests that negative emotions serve three specific social functions that all promote the more general affiliation function, namely *signaling*, *support*, and *social change*. These functions are not mutually exhaustive but refer to different processes. Signaling refers only to providing information about the state of the expresser, which can then result in different behaviors from the recipient. Support refers to a specific type of behavior that is elicited in the recipient, namely psychological (consoling, offering solutions) or material (e.g., financial) support. Social change also refers to the elicitation of a specific range of behaviors, namely those that evoke a change in the other person's behavior that may in turn improve the relationship with another person.

A classic example of the signaling function (also referred to as the alerting function; see Parkinson, 2011; Parkinson & Simons, 2012) is provided by research on social referencing (e.g., Sorce, Emde, Campos, & Klinnert, 1985), showing that 12-month-olds are less likely to proceed in an uncertain and possibly unsafe situation when their mothers display a negative expression. Thus, negative emotions potentially have informational value for others because they communicate concerns and appraisals of the current situation. The use of others' nonverbal expressions as a signal has been referred to as social appraisal and has been seen as one of the mechanisms in how others' emotions affect one's own (Manstead & Fischer, 2001). Mumenthaler and Sander (2012) demonstrated this idea at a very basic level by showing that the recognition of a facial expression on a computer screen is facilitated by another facial expression that gazes at the target face, but not by a facial expression that gazes away. More specifically, when a target face shows anger, the presence of a fear face gazing at the target face leads to a stronger rating of the anger face. This phenomenon also occurs in daily life, as illustrated in a diary study by Parkinson and Simons (2009). They found that anxiety and excitement about decisions involving another person are predicted by the (perceived) anxiety and excitement of the other person, even after controlling for one's own appraisals. Although the nature of the relationship was not examined in these studies, we know from other lines of research that the extent to which emotion signals are sent and the extent to which they are acted upon by receivers is also a function of relational closeness (e.g., Bruder, Fischer, & Manstead, 2013; Erber, Wegner, & Therriault, 1996; Hess & Fischer, 2013). The fact that a key outcome of emotional signaling is the strengthening of trust and social connection between signaler and receiver (Campellone & Kring, 2013) suggests that this process is bidirectional.

Second, expressing negative emotions may not only signal that a person is in danger or helpless, but may also evoke help or support. Studies on social sharing of emotions (see Rimé, 2009) have shown that we are inclined to share nearly all of our negative emotions, with the possible exception of shame, after an emotional event. Research on crying also provides evidence of this support function, because individuals are more likely to cry in the company of partners or intimates than in the company of strangers (Vingerhoets & Becht, 1997). Independently of the motive of seeking support, perceivers also actually tend to provide help when someone cries or shows signs of distress (e.g., Coke, Batson, & McDavis, 1978).

A third way in which the expression of negative emotions can directly serve an affiliative function is because it acknowledges one's own wrongdoing and is thereby intended to rescue or reaffirm the relationship with the other person. This is clearly the case in episodes of regret, guilt, or shame. Research on regret, for example, shows that it motivates efforts to undo the harm done in relationship contexts (Zeelenberg, Van der Pligt, & Manstead, 1998). Studies of guilt (Baumeister, Stillwell, & Heatherton, 1994; Tangney, Miller, Flicker, & Barlow, 1996) have shown that this emotion is typically expressed in the context of valued relationships and where people have high respect for the other. Embarrassment displays have also shown to be beneficial for one's relations with others, because they evoke sympathy, positive evaluations, or helpful behavior in others (Feinberg, Willer, & Keltner, 2012; Keltner & Buswell, 1976, 1997; Ketelaar & Au, 2002; Miller, 2004), as well as increased perceptions of trustworthiness and conscientiousness—as, for example, in studies on blushing, a typical signal of embarrassment (de Jong, 1999; Dijk, Koenig, Ketelaar, & de Jong, 2011). Interestingly, embarrassment displays tend to elicit more positive evaluations on a "warmth" dimension, but not on a "competence" dimension (Semin & Manstead, 1981), consistent with the notion that this emotion serves an affiliation function. The expression of these emotions thus promotes harmonious relationships.

Although there is abundant evidence of the affiliation function served by both positive and negative emotions, we argued above that social functionality does not necessarily mean that these emotions serve this social function regardless of context. An important boundary condition for social functionality is that the emotion display should be perceived as appropriate by targets or observers of the display. For example, individuals who are regarded as *too* happy, or who display smiles for self-interested reasons (see Maringer, Krumhuber, Fischer, & Niedenthal, 2011), are likely to be regarded as inauthentic. Clearly, smiles can be interpreted in different ways, depending on culture and context (Hess et al., 2002). The expression of negative emotions, such as shame or guilt, may also fail to serve an affiliation function if they are seen as ambiguous or unjustified. For example, individuals who blush when there is no reason to blush may be regarded as being guilty of something they have not done. In such situations, blushing may backfire and have negative effects on the blusher (de Jong & Dijk, 2013). In other words, social functions of emotions are at least partly related to the perceived appropriateness of the emotion expression in the situation (see also Parrott, 2001; van Kleef et al., 2011), and whether the expresser is regarded as sincere and as willing and able to change his or her behavior.

The Social Distancing Function of Emotion at the Interpersonal Level

Emotional expressions in interpersonal contexts do not always serve to increase relational closeness. Indeed, emotions such as anger, contempt, disgust, or fear of another person do the reverse, increasing the social distance between self and other (e.g., Fridlund, 1994; Oatley & Jenkins, 1992). Markus and Kitayama (1991) alluded to a similar notion when they distinguished between "socially engaging" and "socially disengaging" emotions. The latter are more socially acceptable or even desirable in cultures in which an independent rather than an interdependent self is promoted. The emotions of anger, contempt, socio-moral disgust, *schadenfreude*, and pride are assumed to serve this function. We now consider examples of these emotions, and the ways in which they increase social distance.

Although anger is generally categorized as belonging to the "approach" family of emotions, the nature of the approach is confrontational, which is likely, at least in the short term, to increase the distance between self and other. If directly expressed to the object of the anger, this emotion confronts the other person with the fact that the angry person wants to change the target's behavior and exert some control over the target (e.g., Fischer & Roseman, 2007; Fischer & Evers, 2011; van Dijk, van Kleef, Steinel, & Van Beest, 2008). This implies that the target of the anger should apologize, yield, show submissiveness, or simply stop doing whatever he or she was doing. Studies by Van Kleef and colleagues have shown that the verbal expression of anger in a negotiation context does indeed result in greater concessions by the other party (e.g., Van Kleef, De Dreu, & Manstead, 2004). Indeed, even when others do not visibly and immediately react to the expresser's anger, they may covertly retaliate against the angry person (e.g., Wang, Northcraft, & Van Kleef, 2012).

In keeping with the idea that direct anger expression is an attempt to regain or maintain status or power, or simply to control the other, research by Tiedens (2001) confirms that high-status persons are expected to respond to negative outcomes with anger (rather than sadness or guilt), and to positive outcomes with pride (rather than appreciation; see also Kuppens, Van Mechelen, & Meulders, 2004). Moreover, when people express anger or pride they are regarded as high in status, but when they express sadness, guilt, or appreciation they are regarded as low in status. The underlying explanation for these differences, according to Tiedens (2001), lies in the appraisals of agency that are inferred from the expression of each of these emotions (see also Hareli & Hess, 2009). An expression of anger is seen as reflecting an appraisal of other-blame, implying not only greater social distance but also self-elevation; by contrast, an expression of guilt or sadness reflects an appraisal of self-blame. On the other hand, actual social status, power, or dominance increases the likelihood that one expresses one's anger (Fischer & Evers, 2011; Van Kleef & Côté, 2007).

Schadenfreude is another example of an emotion that serves a social distancing function, as is clear from evidence that one feels greater *schadenfreude* following others' misfortune if these others pose a threat to one's self-esteem (Van Dijk, Ouwerkerk, Wesseling, & van Koningsbruggen, 2011). A more extreme example is provided by contempt. The expression of this emotion, typically in the form of derogation and rejection, often results in social exclusion of the object of the contempt (Fischer & Roseman, 2007; Fischer & Giner-Sorolla, 2014; Gottman, 1994). The aim is to make it clear that the other person is inferior or even worthless, which is a way of boosting one's own social position or status, either as an individual or as a group member. Contempt as well as anger may be elicited if alternative ways of changing others' behavior are expected to fail. Disappointment *in* another person is less extreme than contempt but nevertheless serves a similar function, because it implies that the target of these emotions has not met one's expectations, and one therefore feels distance from or even abandonment of the person who is the object of the emotion (van Dijk & Zeelenberg, 2002).

Thus anger, disappointment, hate, and contempt all serve a social distancing function because they imply that the target is responsible for a negative outcome. The social distance results from the negative appraisals of the actions or character of the other person and can be further reinforced by tendencies to attack the other (in the case of anger and hate) or to treat the other as an inferior being (in the case of contempt). Although these emotions all serve a social distancing function, they differ in the extent to which they are also able to serve an affiliation function: Whereas contempt is highly unlikely to give rise to any improvement in a social relationship (see Fischer & Giner-Sorolla, 2015), anger can do so, especially in the longer term (Fischer & Roseman, 2007). This suggests that whereas the primary social function of anger is to criticize the other person, and thereby to increase distance, it can also serve an affiliation function, but at a later point in time.

To summarize, we have considered evidence that certain emotions have the effect of creating social distance between self and others in a way that may enhance one's social standing or self-evaluation. Expression of these emotions implies movement away from, and sometimes above, the other person(s). Confronting and constraining the antisocial or dysfunctional behaviors of others by expressing anger and contempt toward them thus serves the function of protecting the individual or group from the harmful or disruptive behavior of others. Likewise, it is sometimes functional for individuals and groups to set themselves apart from or to cut themselves off from other individuals or groups. For example, anger felt toward an ex-partner can be helpful not only in detaching oneself from that relationship but also in creating the possibility for a new one. Likewise, contempt expressed toward others who fail to endorse or live up to key norms and values can be beneficial in protecting those norms and values.

Affiliation Functions of Emotions at the Group Level

Affiliation and social distancing functions can also be identified at the group level. In line with social identity theory (Tajfel & Turner, 1979), which argues that self-esteem derives in part from the status and achievements of the groups with which we identify, we can safely assume that emotions serve the function of strengthening ingroup bonds as well as creating distance from outgroups. The strength of these group-based emotions is related to one's categorization as a group member (e.g., Smith, 1993). For example, Dumont, Yzerbyt, Wigboldus, and Gordjin (2003) showed that mere social categorization could increase or decrease the intensity of group-based emotions. When Dutch or Belgian participants categorized themselves as Westerners, a social identity that includes Americans, they reported experiencing more fear after being reminded of the terrorist attacks on the World Trade Center in 2001 than when they categorized themselves as Europeans, an identity that excludes Americans.

Typically, the more one identifies with a group, the stronger the positive group-based emotions one experiences (Smith, Seger, & Mackie, 2007). However, strong identification with a group can also lead to weaker group emotions if such emotions could be harmful to one's social identity and/or beneficial for an outgroup. This is the case with group-based guilt (Branscombe, Doosje, & McGarty, 2002; Doosje, Branscombe, Spears, & Manstead, 1998). Doosje et al. (1998) found that strength of identification with Dutch identity among Dutch participants was inversely related to guilt about the way that Indonesians were treated during the colonial era. High identifiers appeared to engage in defensive denial that wrongdoing had been perpetrated. In a study on European Americans' "White guilt" with respect to African Americans, Iyer, Leach, and Crosby (2003) further suggested that group-based guilt may involve a focus on the ingroup with a view to alleviating ingroup distress, rather than a more outgroup-focused desire to help members of the disadvantaged group. The aversive nature of group-based emotions such as guilt and—especially—shame is also functional in preventing group members from engaging in actions that might give rise to these emotions. Shepherd, Spears, and Manstead (2013a, 2013b, 2013c) have shown that *anticipated* group-based shame results in less ingroup favoritism and motivates group members to engage in collective action to stop the shame-evoking behavior.

The affiliative, group-bonding function of positive group emotions is shown more directly in a study where group-based emotions resulted in stronger identification with a group (Kessler & Hollbach, 2005). Shared positive emotion is likely to play a role in the "basking in reflected glory" phenomenon (Cialdini et al., 1976). The shared positive affect that supporters experience as a result of their team's success on the football field presumably serves to strengthen their ingroup identification. Likewise, it seems plausible that shared negative emotions provide an emotion-based account for the related phenomenon of "cutting off reflected failure" (Snyder, Lassegard, & Ford, 1986), in which group failure leads individuals to distance themselves from the ingroup in question. Livingstone, Spears, Manstead, Bruder, and Shepherd (2011) have gone a step further by showing that similarity between own and others' emotional reactions to an event led participants to be more inclined to see themselves as having a shared identity. Just as shared identity strengthens group-based emotions, shared emotions in a group strengthen social identity.

One way in which emotions serve an affiliative, group-bonding function is because the communication of emotion within a group provides group members with rapid information about group structure and the environment (Spoor & Kelly, 2004). Furthermore, if others share one's emotional reactions to an event, one is more likely to regard oneself as sharing group membership with them (Livingstone et al., 2011) and to feel emotions on behalf of that group (Kuppens, Yzerbyt, Dandache, Fischer & van der Schalk, 2013). Moreover, emotions within one's group also seem useful when distinctions from other groups are relevant. This is nicely illustrated by research on sports teams, where individual team members' moods are correlated with their own team's aggregate mood, and not with that of a competing team (Totterdell, 2000). Work teams also experience "group moods," and the extent to which group members have similar moods has an influence on levels of cooperation and conflict in the group (Barsade, 2002; Bartel & Saavedra, 2000). In particular, the collective display of positive emotion leads to greater cooperation and reduces conflict in the group, whereas the display of negative emotion is associated with the opposite outcomes. George and her colleagues have also shown that group affective tone is related to prosocial behavior (see George, 1990).

Group emotions may also serve an affiliation function in cases where groups are less cohesive and when group members do not agree or have different opinions. For example, Heerdink, Van Kleef, Homan, and Fischer (2013) examined expressions of anger or happiness toward a group member's deviant opinion and found that happy expressions by other group members led to stronger feelings of being accepted, whereas angry expressions led to stronger feelings of being rejected. In other words, as well as strengthening group bonds, emotions can also maintain cohesiveness in less cohesive groups by excluding deviant members. This has also been illustrated in research by Sani and colleagues (e.g., Sani, 2005; Sani & Reicher, 1999), who showed that schisms develop from perceptions that positions taken by other ingroup members threaten the shared identity of the group. Shared identity is a core attribute of the group, so any threat to it is likely to evoke negative emotions such as dejection and agitation, resulting in decreased identification with the group and lower perceived cohesiveness. In a field study of the secession of a subgroup from the Church of England, Sani (2005) showed that strong negative emotion aroused by a perceived threat to group identity was a positive predictor of intentions to secede from the group.

A third way in which group emotions may have an affiliative function is at the level of intergroup relations: By eliciting and expressing (social distancing) emotions toward outgroups, one can strengthen relations within one's own group. The stereotype content model (Cuddy, Fiske, & Glick, 2008) proposes that group-based emotions are a key feature of stereotypes and prejudice, reinforcing not only differences between groups but also a social hierarchy. Fiske, Cuddy, Glick, and Xu (2002) argued that stereotypes are based on two dimensions, warmth and competence, and depend on social structural features of intergroup relations in a society. A group's status predicts the degree to which a group is seen as competent, whereas its cooperativeness predicts the degree to which it is seen as warm or cold. These dimensions also predict how people emotionally react to members of specific outgroups. Envy is felt toward groups seen as cold but competent; in the North American context such groups include Asians, Jews, and rich people. Contempt or disgust are felt toward social groups that are seen as both cold and incompetent, such as welfare recipients, homeless people, or drug addicts. Pity and sympathy are felt toward those seen as warm but incompetent, such as the elderly. By contrast, groups seen as warm and competent elicit admiration (Sweetman, Spears, Livingstone, & Manstead, 2013).

Although much research has been conducted on anger, other emotions also help to sharpen group boundaries by stressing dissimilarities with the outgroup, or by promoting prejudice. For example, studies on intergroup *schadenfreude* (Leach, Spears, Branscombe, & Doosje, 2003; Spears & Leach, 2004) have shown that its intensity is, among other things, associated with feelings of inferiority with respect to the outgroup, suggesting that intergroup *schadenfreude* can be seen as a way of coping with the lower social status of one's own group.

Distancing Functions of Emotions at the Group Level

Clearly, group-level emotions can also serve a social distancing function when they are targeted at outgroups. In particular, anger challenges existing social hierarchies. Indeed, anger has been considered to be the basis of intractable intergroup conflicts, such as the one between Israelis and Palestinians (Bar-Tal, Halperin, & Rivera, 2007). These group-based distancing emotions are also strengthened by identification with one's group. The more strongly people identify with a group or take the perspective of a group, the more group-based anger they feel toward an outgroup that threatens the well-being of the group—even if they are not personally affected by any injustice (Mackie, Devos, & Smith, 2000; van Zomeren, Spears, Fischer, & Leach, 2004). Gordijn, Yzerbyt, Wigboldus, and Dumont (2006) found that a perceiver's degree of identification with the victims of an injustice affected not only the perceiver's level of group-based anger, but also his or her willingness to engage in collective action or protest to redress the wrong. Van Zomeren and colleagues (2004) sought to understand why collective disadvantage sometimes does and sometimes does not lead to collective action, and hypothesized that this was due to different expectations about the type of support that members would receive from their group. These researchers drew a distinction between "instrumental support" (support for action) and "emotional support" (sharing opinions). They found that the anticipation of instrumental support was sufficient to predict collective action in the absence of anger; however, if group members anticipated emotional support, this led to more group-based anger and thereby to collective action. In the latter case, anger served the function of motivating group members to engage in collective action.

Group-based anger therefore has the effect of mobilizing people who are not themselves directly affected by the perceived injustice. Research by DeSteno, Dasgupta, Bartlett, and Cajdric (2004) has shown that even the memory of a personal anger incident can automatically evoke negative evaluations of outgroups in an intergroup context, supposedly because of its functional relevance to intergroup conflict and competition.

It should be noted that whereas anger has often been thought of as providing the basis for strong intergroup conflict, there is recent evidence suggesting that its social function is more complex, in keeping with our reasoning about the possibly beneficial effects of anger in interpersonal relations in the longer term. Anger appears to have a distancing and even destructive effect if it is accompanied by hatred or contempt, associated with appraisals of the other group as evil, or expresses a long-term negative sentiment (Fischer & Roseman, 2007; Halperin & Gross, 2011). If, however, anger is simply based on appraisals of a group's negative behavior, and is expressed to communicate an injustice and to change the outgroup's attitude, it may ultimately decrease the social distance between groups. For example, the communication of pure group-based anger (without contempt) toward an outgroup can evoke empathy in the outgroup and decrease the intention to engage in a conflict (De Vos, van Zomeren, Gordijn, & Postmes, 2013).

Consistent with this reasoning, Halperin, Russell, Dweck, and Gross (2011) showed that it was the level of hatred that determined whether anger toward an outgroup was destructive or constructive. Inducing anger toward Palestinians in Israeli respondents who had low levels of hate toward Palestinians resulted in stronger support for compromise in an upcoming peace negotiation, whereas it decreased support for compromise among Israelis who had high levels of hatred. Another way in which group-based anger can bring groups closer together is when group members express moral outrage at the actions of other ingroup members who have adversely affected members of a disadvantaged outgroup (Leach, Iyer, & Pedersen, 2006). Such outrage motivates political action aimed at reducing the outgroup's disadvantage. In sum, anger serves a distancing function in intergroup relations when it is based in long-term negative sentiments, such as hatred and contempt, but it can serve a constructive role when it signals unjust treatment that may be acknowledged by the perpetrating group.

In summary, there are different ways in which group emotions help to promote emotional bonding within groups (affiliative function) and to delineate the boundaries between groups (social distancing function; see also Keltner & Haidt, 1999). First, positive group-based emotions, such as happiness or admiration, promote group cohesiveness, ingroup identification, and ingroup cooperation. Second, ingroup bonds can also be strengthened by emotions that serve a distancing function when these are expressed toward deviant group members, thereby promoting cohesion within the group. Third, certain negative group-based affiliative emotions, such as guilt and shame, may strengthen bonds within groups because they are collectively experienced as aversive and/or threatening to the group's social identity; group members may then become motivated to defend their group identity by engaging in reparation or collective action. Fourth, group bonds can also be strengthened by differentiating one's group from other groups and/or challenging the social hierarchy by expressing anger, hate, or contempt toward outgroups that are seen as threatening the ingroup's interests or values. At the same time, positive emotions, such as admiration for another group, may also help to maintain social hierarchies. Finally, positive intergroup relations can be promoted by group-based anger, but only if the anger is focused on the outgroup's behavior, rather than being based on appraisals of the outgroup's negative nature.

Interpersonal Regulation of Emotions

If emotions serve social functions, a natural place to look for the origin of these functions is the reactions of others to expressions of emotion. The fact that others respond to our emotions—and because we often care about the way in which they respond—means that emotions are subject to regulation, both by the person experiencing the emotion and by others. Interpersonal emotion regulation is defined as the explicit or implicit attempt to change someone else's emotions. The related concept of co-regulation refers to a process of reciprocal regulation of each other's emotions. Both types of emotion regulation are often preceded by the perception and appraisal of anticipated, imagined, or actual emotional reactions by others (i.e., social appraisal; Manstead & Fischer, 2001). The functions that emotions serve in interactions and relationships with others are therefore intertwined with the interpersonal regulation of emotion (e.g., Lopes, Salovey, Côté, & Beers, 2005; Niven, Macdonald, & Holman, 2012; see Emotion Regulation, Chapter 26, this volume).

It has been argued that the concept of emotion regulation is difficult to define, because it is unclear where emotion ends, where emotion regulation begins, and who is regulating what (Kappas, 2013). We might shout a little harder at a friend than at a superior, or we might cry more overtly in the company of a friend than in the company of strangers, without even noticing that we are regulating our emotion. Thus it can be argued that emotion regulation, like emotions themselves, serves the same two social functions that we have described in this chapter (see also Keltner & Haidt, 1999). Emotions are typically regulated in such a way that they are socially functional, helping us to establish or maintain closeness and cooperation with some but separation and distance from others (see also Emotion Regulation, Chapter 26, this volume).

Interpersonal regulation starts already early in life (Trevarthen, 1984): Parents adjust their own facial and vocal expressions of emotion in order to soothe, interest, or bring pleasure to a baby. When children are older, caregivers try to calm agitated or angry children by encouraging them to reappraise the situation, count to 10, or go to their room. Children who are unhappy are stimulated to smile; children who appear to be ungrateful are encouraged to express their gratitude (Eisenberg, Cumberland, & Spinrad, 1998). Parents' regulation of their children's emotions is later supplemented or superseded by peers (Helsen, Vollebergh, & Meeus, 2000) and still later by partners, who tell one to calm down, give disapproving looks, offer verbal comfort or criticism, or laugh with someone or at someone when expressing or sharing an emotion (Rimé, 2009). In communal relationships, partners are both targets of emotional expression and regulators of such expression (see also Clark et al., 2004). Interpersonal regulation thereby serves an affiliative function, because it is essentially cooperative.

Co-regulation involves not only telling others how to modify unwanted feelings, but also expressing one's own emotions in a way that regulates others' emotions. By expressing anger when one's partner is jealous, displaying shame when one's child has a temper tantrum in public, or expressing empathy when one's friend is in distress, we also attempt to help others to regulate their emotions. In the context of cooperative relationships, co-regulation is likely to involve encouraging affiliative emotions, and discouraging social distancing emotions.

Sharing the experience of affiliative emotions in interpersonal relations or groups is likely to enhance the closeness (see also Laurenceau, Barrett, & Pietromonaco, 1998), intimacy, or positivity of a relationship, and may result in emotional transference, convergence, or contagion (Hatfield, Cacioppo, & Rapson, 1992; Parkinson & Simons, 2012). Indirect evidence for such co-regulation of affiliative emotions can be found in a study by Anderson, Keltner, and John (2003), who found that dating partners and college roommates became emotionally more similar over the course of a year. This emotional convergence effect applied to both positive and negative emotional reactions to events and could not be explained by increased similarity in personality variables. More direct evidence for co-regulation comes from research by Bruder, Dosmukhambetova, Nerb, and Manstead (2012), who found that dyads jointly exposed to emotional films converged in their appraisals, emotions, and nonverbal behavior.

Regulating others' emotions can also operate via emotional mimicry (e.g., Dimberg, 1982; Dimberg & Lundquist, 1990). Research has shown that we mimic intimates more than strangers (Fischer, Becker, & Veenstra, 2012), ingroup members more than outgroup members (Bourgeois & Hess, 2008, Study 2; Van der Schalk et al., 2011), and people whom we like more than people whom we do not like (Likowski, Mühlberger, Seibt, Pauli, & Weyers, 2008). Instructions to mimic another person also lead to more affective bonding with this person, in comparison with conditions in which people are instructed not to mimic (Stel & Vonk, 2010). In short, interacting with others involves regulating our tendencies to mimic the other's emotional expressions, which is likely to serve an affiliative function.

The social consequences of interpersonal emotion regulation are also apparent when emotions are socially shared (Rimé, 2009). Sharing any emotion is likely to involve some degree of co-regulation, and to the extent that the emotion is not only communicated but also shared, the effect is likely to be one of strengthening social bonds. Indeed, a study by Kuppens and colleagues (2013) showed that talking about an emotionally relevant topic in a group resulted in stronger indignation than did discussing an emotional topic that was irrelevant to the group, suggesting that sharing emotions within a group can lead to the up-regulation of group-based emotions and thereby serve an affiliative function. In general, we assume that the expression of anger, rage, antipathy, and other negative emotions may serve a social distancing function with respect to the outgroup (moving away from the threatening group), whereas sharing these emotions with ingroup members serves an affiliation function (see also Hess & Fischer, 2013).

Conclusion

Emotions are experienced and expressed in social contexts, and they help us to deal with the challenges posed by the social environment. We have distinguished two general social functions of emotion: affiliation and social distancing. Emotions can reduce or increase the social and psychological distance between self and others, or between one group and another. However, it should be evident from our review of the literature that the social functions of emotion cannot be equated with the social effects of expressing that emotion in any given setting. The social functions of emotion are relatively independent of specific context, but rather are intrinsic to the social-relational goals and prototypical features of the emotional reaction, whereas the social effects of an emotion are contingent on both the way in which the emotion is expressed and the specifics of the social context. Social functionality thus depends on the typical social action tendencies intrinsic to an emotion, such as wanting to hide, avoid, run away, promote the self, attack, stay as close as possible to another, or make up with another. These goals are met only when an appropriate balance is struck between affiliation and cooperation, on the one hand, and social distancing and competition, on the other (see also Salovey & Mayer, 1990). Social survival and social well-being involve a compromise between these fundamental social goals.

We have argued that each emotion can be seen as having a primary social function, either affiliation or social distancing. Most positive emotions—but also some negative emotions like regret, embarrassment, sadness, shame, or guilt—serve an affiliation function. By contrast, anger, contempt, and (social) disgust serve an individual's or group's need for social distance and increased social standing. However, when we take into account the way in which an emotion is expressed, or the target of the emotion, or the time frame of the emotion, other effects may become apparent. For example, anger generally increases social distance in the short term, but may ultimately be constructive in a relationship. Whether or not this latter effect takes place depends primarily on the perceived appropriateness of the anger.

A final point that bears repetition is that although we firmly believe that emotions serve social functions, this does not mean that emotions are always socially functional. The potential social functionality of emotions can be inferred from their social-relational goals and typical features. In practice, this functionality depends on how the individuals or social groups involved appraise the social context, and the extent to which they regulate their emotions and expressions in ways that are consistent with those appraisals. Perhaps the ultimate social function of emotions is to persuade others to acknowledge the validity of one's own or one's group's appraisals (see Parkinson, 1995).

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References

Algoe, S. B., Fredrickson, B. L., & Gable, S. L. (2013). The social functions of the emotion of gratitude via expression. *Emotion, 13*, 605–609.

Algoe, S. B., Gable, S. L., & Maisel, N. C. (2010). It's the little things: Everyday gratitude as a booster shot for romantic relationships. *Personal Relationships, 17*, 217–233.

Anderson, C., Keltner, D., & John, O. P. (2003). Emotional convergence between people over time. *Journal of Personality and Social Psychology, 84*, 1054–1068.

Archer, J. (2000). Sex differences in aggression between heterosexual partners: A meta-analytic review. *Psychological Bulletin, 126*, 651–680.

Bar-Tal, D., Halperin, E., & Rivera, J. (2007). Collective emotions in conflict situations: Societal implications. *Journal of Social Issues, 63*, 441–460.

Barrett, K. C. (1995). A functionalist approach to shame and guilt. In J. P. Tangney & K. W. Fischer (Eds.), *Self-conscious emotions: The psychology of shame, guilt, embarrassment, and pride* (pp. 25–64). New York: Guilford Press.

Barrett, L. F., Robin, L., Pietromonaco, P. R., & Eyssell, K. (1998). Are women the more emotional sex?: Evidence from emotional experiences in social interactions. *Cognition and Emotion, 12*, 555–578.

Barsade, S. G. (2002). The ripple effect: Emotional contagion in groups. *Administrative Science Quarterly, 47*, 644–677.

Bartel, C. A., & Saavedra, R. (2000). The collective construction of work group moods. *Administrative Science Quarterly, 45*, 197–231.

Bartlett, M. Y., & DeSteno, D. (2006). Gratitude and prosocial behavior: Helping when it costs you. *Psychological Science, 17*, 319–325.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*, 497–529.

Baumeister, R. F., Stillwell, A. M., & Heatherton, T. F. (1994). Guilt: An interpersonal approach. *Psychological Bulletin, 115*, 243–267.

Bourgeois, P., & Hess, U. (2008). The impact of social context on mimicry. *Biological Psychology, 77*, 343–352.

Branscombe, N. R., Doosje, B., & McGarty, C. (2002). Antecedents and consequences of collective guilt. In D. M. Mackie & E. R. Smith (Eds.), *From prejudice to intergroup emotions: Differentiated reactions to social groups* (pp. 49–66). New York: Psychology Press.

Brewer, M. B. (1991). The social self: On being the same and different on the same time. *Personality and Social Psychology Bulletin,* 86, 307–324.

Bruder, M., Dosmukhambetova, D., Nerb, J., & Manstead, A. S. R. (2012). Emotional signals in nonverbal interaction: Dyadic facilitation and convergence in expressions, appraisals, and feelings. *Cognition and Emotion, 26*, 480–502.

Bruder, M., Fischer, A. H., & Manstead, A. S. R. (2013). Social appraisal as a cause of collective emotions. In C. von Scheve & M. Salmela (Eds.), *Collective emotions*. Oxford, UK: Oxford University Press.

Butler, E. A., Egloff, B., Wilhelm, F. H., Smith, N. C., Erickson, E. A., & Gross, J. J. (2003). The social consequences of expressive suppression. *Emotion, 3*, 48–67.

Campellone, T., & Kring, A. M. (2013). Who do you trust?: The impact of facial emotion and behavior on decision making. *Cognition and Emotion, 27*, 603–620.

Cialdini, R. B., Borden, R. J., Thorne, A., Walker, M. R., Freeman, S., & Sloan, L. R. (1976). Basking in reflected glory: Three (football) field studies. *Journal of Personality and Social Psychology, 34*, 366–375.

Clark, M. S., Fitness, J., & Brissette, I. (2004). Understanding people's perceptions of relationships is crucial to understanding their emotional lives. In M. B. Brewer & M. Hewstone (Eds.), *Emotion and motivation* (pp. 21–47). Malden, MA: Blackwell.

Coke, J. S., Batson, C. D., & McDavis, K. (1978). Empathic mediation of helping: A two-stage model. *Journal of Personality and Social Psychology, 36*, 752–766.

Cosmides, L., & Tooby, J. (2000). Evolutionary psychology and the emotions. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed., pp. 91–116). New York: Guilford Press.

Cuddy, A. J. C., Fiske, S. T., & Glick, P. (2008). Warmth and competence as universal dimensions of social perception: The stereotype content model and the BIAS map. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 40, pp. 61–149). San Diego, CA: Academic Press.

De Jong, P. J. (1999). Communicative and remedial effects of social blushing. *Journal of Nonverbal Behavior, 23*, 197–217.

De Jong, P. J., & Dijk, C. (2013). Social effects of facial blushing: Influence of context and actor versus observer perspective. *Social and Personality Psychology Compass, 7*(1), 13–26.

De Vos, B., van Zomeren, M., Gordijn, E. H., & Postmes, T. (2013). The communication of "pure" group-based anger reduces tendencies towards intergroup conflict, because it increases out-group empathy. *Personality and Social Psychology Bulletin, 39*, 1043–1052.

DeSteno, D., Dasgupta, N., Bartlett, M. Y., & Cajdric, A. (2004). Prejudice from thin air: The effect of emotion on automatic intergroup attitudes. *Psychological Science, 15*, 319–324.

Dijk, C., Koenig, B., Ketelaar, T., & de Jong, J. (2011). Saved by the blush: Being trusted despite defecting. *Emotion, 2*, 313–319.

Dimberg, U. (1982). Facial reactions to facial expressions. *Psychophysiology, 19*, 643–647.

Dimberg, U., & Lunquist, L.-O. (1990). Gender differences in facial reactions to facial expressions. *Biological Psychology, 30*, 151–159.

Doosje, B., Branscombe, N. R., Spears, R., & Manstead, A. S. R. (1998). Guilty by association: When one's group has a negative history. *Journal of Personality and Social Psychology, 75*, 872–886.

Dumont, M., Yzerbyt, V. Y., Wigboldus, D., & Gordijn, E. H. (2003). Social categorization and fear reactions to the September 11th terrorist attacks. *Personality and Social Psychology Bulletin, 29*, 1509–1520.

Eisenberg, N., Cumberland, A., & Spinrad, T. L. (1998). Parental socialization of emotion. *Psychological Inquiry, 9*, 241–273.

English, T., John, O. P., Srivastava, S., & Gross, J. J. (2012). Emotion regulation and peer-rated social functioning: A 4-year longitudinal study. *Journal of Research in Personality, 46*, 780–784.

Erber, R., Wegner, D. M., & Therriault, N. (1996). On being cool and collected: Mood regulation in anticipation of social interaction. *Journal of Personality and Social Psychology, 70*, 757–766.

Evers, C., Fischer, A. H., Rodriguez Mosquera, P. M., & Manstead, A. S. R. (2004). Anger and social appraisal: A "spicy" sex difference? *Emotion, 5*, 258–266.

Feinberg, M., Willer, R., & Keltner, D. (2012). Flustered and faithful: Embarrassment as a signal of prosociality. *Journal of Personality and Social Psychology, 102*, 81–97.

Fischer, A., Manstead, A. S. R., & Rodriguez, P. M. (1999). The role of honor-based versus individualistic values in conceptualizing pride, shame, and anger: Spanish and Dutch cultural prototypes. *Cognition and Emotion, 13*, 149–179.

Fischer, A. H., Becker, D., & Veenstra, L. (2012). The social regulation of mimicry: The case of disgust and pride. *Frontiers in Emotion Science, 3*, 475.

Fischer, A. H., & Evers, C. (2011). The social costs and benefits of anger as a function of gender and relationship context. *Sex Roles, 65*, 23–34.

Fischer, A. H., & Giner-Sorolla, R. (2015). Contempt: Derogating others while keeping calm. *Emotion Review.*

Fischer, A. H., Manstead, A. S. R., & Zaalberg, R. (2003). Social influences on the emotion process. In W. Stroebe & M. Hewstone (Eds.), *European review of social psychology* (Vol. 14, pp. 171–203). Hove, UK: Psychology Press.

Fischer, A. H., Rodriguez Mosquera, P. M., van Vianen, A. E. M., & Manstead, A. S. R. (2004). Gender and culture differences in emotion. *Emotion, 4*, 87–94.

Fischer, A. H., & Roseman, I. J. (2007). Beat them or ban them: The characteristics and social functions of anger and concept. *Journal of Personality and Social Psychology, 93*, 103–115.

Fiske, S. T., Cuddy, A. J., Glick, P., & Xu, J. (2002). A model of (often mixed) stereotype content: Competence and warmth respectively follow from perceived status and competition. *Journal of Personality and Social Psychology, 82*, 878–902.

Fridlund, A. J. (1994). *Human facial expression: An evolutionary view.* San Diego, CA: Academic Press.

Frijda, N. H. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.

George, J. M. (1990). Personality, affect, and behavior in groups. *Journal of Applied Psychology, 75*, 107–116.

Giner-Sorolla, R. (2012). *Judging passions: Moral emotions in persons and groups*. Hove, UK: Psychology Press.

Gordijn, E., Yzerbyt, V. Y., Wigboldus, D., & Dumont, M. (2006). Emotional reactions to harmful intergroup behavior: The impact of being associated with the victims or the perpetrators. *European Journal of Social Psychology, 36*, 15–30.

Gordon, A. M., Impett, E. A., Kogan, A., Oveis, C., & Keltner, D. (2012). To have and to hold: Gratitude promotes relationship maintenance in intimate bonds. *Journal of Personality and Social Psychology, 103*, 257–274.

Gottman, J. M. (1994). *What predicts divorce?: The relationship between marital processes and marital outcomes*. New York: Psychology Press.

Gottman, J. M., & Levenson, R. W. (2002). A two-factor model for predicting when a couple will divorce: Exploratory analyses using 14-year longitudinal data. *Family Process, 41*, 83–96.

Griffiths, P., & Scarantino, A. (2009). Emotions in the wild: The situated perspective on emotion. In P. Robbins & Murat Aydede (Eds.), *The Cambridge handbook of situated cognition* (pp. 437–453). New York: Cambridge University Press.

Gross, J., & John, O. P. (2002). Wise emotion regulation. In L. F. Barrett & P. Salovey (Eds.), *The wisdom in feeling: Psychological processes in emotional intelligence* (pp. 297–319). New York: Guilford Press.

Halperin, E. (2011). The emotional roots of intergroup aggression: The distinct roles of anger and hatred. In P. R. Shaver & M. Mikulincer (Eds.), *Human aggression and violence: Causes, manifestations, and consequences* (pp. 315–331). Washington, DC: American Psychological Association.

Halperin, E., & Gross, J. J. (2011). Intergroup anger in intractable conflict: Long-term sentiments predict anger responses during the Gaza war. *Group Processes and Intergroup Relations, 14*, 477–488.

Halperin, E., Russell, A. G., Dweck, C. S., & Gross, J. J. (2011). Anger, hatred, and the quest for peace: Anger can be constructive in the absence of hatred. *Journal of Conflict Resolution, 55*, 274–291.

Hareli, S., & Hess, U. (2009). What emotional reactions can tell us about the nature of others?: An appraisal perspective. *Cognition and Emotion, 24*(1), 128–140.

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1992). Primitive emotional contagion. In M. S. Clark (Ed.), *Review of personality and social psychology: Emotion and social behavior* (Vol. 14, pp. 151–177). Thousand Oaks, CA: Sage.

Heerdink, M. W., Van Kleef, G. A., Homan, A. C., & Fischer, A. H. (2013). On the social influence of emotions in groups: Interpersonal effects of anger and happiness on conformity and deviance. *Journal of Personality and Social Psychology, 105*, 262–284.

Helsen, M., Vollebergh, W., & Meeus, W. (2000). Social support from parents and friends and emotional problems in adolescence. *Journal of Youth and Adolescence, 29*, 319–335.

Hess, U., Beaupré, M. G., & Cheung, N. (2002). Who, to whom, and why: Cultural differences and similarities in the function of smiles. In M. H. Abel (Ed.), *An empirical reflection on the smile* (pp. 187–216). Lewiston, NY: Mellen Press.

Hess, U., & Fischer, A. H. (2013). Emotional mimicry as social regulation. *Personality and Social Psychology Review, 17*, 142–157.

Hutcherson, C. A., & Gross, J. J. (2011). The moral emotions: A social–functional account of anger, disgust and contempt. *Journal of Personality and Social Psychology, 100*, 719–737.

Iyer, A., Leach, C. W., & Crosby, F. J. (2003). White guilt and racial compensation: The benefits and limits of self-focus. *Personality and Social Psychology Bulletin, 29*, 117–129.

Kappas, A. (2011). Emotion and emotion regulation are one! *Emotion Review, 1*, 17–25.

Keltner, D., & Buswell, B. N. (1976). Evidence for the distinctness of embarrassment, shame, and guilt: A study of recalled antecedents and facial expressions of emotion. *Cognition and Emotion, 10*, 155–171.

Keltner, D., & Buswell, B. N. (1997). Embarrassment: Its distinct form and appeasement function. *Psychological Bulletin, 122*, 250–270.

Keltner, D., & Haidt, J. (1999). Social functions of emotions at four levels of analysis. *Cognition and Emotion, 13*, 505–521.

Kessler, T., & Hollbach, S. (2005). Group based emotion as determinants of ingroup identification. *Journal of Experimental Social Psychology, 41*, 677–685.

Ketelaar, T., & Au, W. T. (2002). The effects of feelings of guilt on the behavior of uncooperative individuals in repeated social bargaining games: An affect-as-information interpretation of the role of emotion in social interaction. *Cognition and Emotion, 17*, 429–455.

Kitayama, S., Mesquita, B., & Karasawa, M. (2006). Cultural affordances and emotion experience: Socially engaging versus disengaging emotions in Japan and the United States. *Journal of Personality and Social Psychology, 91*, 890–903.

Kring, A. M. (2000). Gender and anger. In A. H. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 211–232). Cambridge, UK: Cambridge University Press.

Krumhuber, E., & Kappas, A. (2005). Moving smiles: The role of dynamic components for the perception of the genuineness of smiles. *Journal of Nonverbal Behavior, 29*, 3–24.

Krumhuber, E., Manstead, A. S. R., Cosker, D., Marshall, D., Rosin, P. L., & Kappas, A. (2007). Facial dynamics as indicators of trustworthiness and cooperative behavior. *Emotion, 7*, 730–735.

Krumhuber, E., Manstead, A. S. R., & Kappas, A. (2007). Temporal aspects of facial displays in person and expression perception: The effects of smile dynamics, head-tilt, and gender. *Journal of Nonverbal Behavior, 31*, 39–56.

Kuppens, P., Van Mechelen, I., & Meulders, M. (2004). Every cloud has a silver lining: Interpersonal and individual differences determinants of anger-related behavior. *Personality and Social Psychology Bulletin, 30*, 1550–1564.

Kuppens, T., Yzerbyt, V., Dandache, S., Fischer, A. H., & van der Schalk, J. (2013). Social identity salience shapes group-based emotions through group-based appraisals. *Cognition and Emotion, 29*, 1359–1377.

Laurenceau, J. P., Barrett, L. F., & Pietromonaco, P. R. (1998). Intimacy as an interpersonal process: The importance of self-disclosure, partner disclosure, and perceived partner responsiveness in interpersonal exchanges. *Journal of Personality and Social Psychology, 74*, 1238–1251.

Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

Leach, C. W., Iyer, A., & Pedersen, A. (2006). Anger and guilt about ingroup advantage explain the willingness for political action. *Personality and Social Psychology Bulletin, 32*, 1232–1245.

Leach, C. W., Spears, R., Branscombe, N., & Doosje, B. (2003). Malicious pleasure: Schadenfreude at the suffering of another group. *Journal of Personality and Social Psychology, 84*, 932–943.

Levenson, R. W. (1999). Intrapersonal functions of emotion. *Cognition and Emotion, 13*, 481–504.

Likowski, K., Mühlberger, A., Seibt, B., Pauli, P., & Weyers, P. (2008). Modulation of facial mimicry by attitudes. *Journal of Experimental Social Psychology, 44*, 1065–1072.

Livingstone, A. G., Spears, R., Manstead, A. S. R., Bruder, M., & Shepherd, L. (2011). We feel, therefore we are: Emotion as a basis for self-categorization and social action. *Emotion, 11*, 754–767.

Lopes, P. N., Salovey, P., Côté, S., & Beers, M. (2005). Emotion regulation abilities and the quality of social interaction. *Emotion, 5*, 113–118.

Mackie, D. M., Devos, T., & Smith, E. R. (2000). Intergroup emotions: Explaining offensive action tendencies in an intergroup context. *Journal of Personality and Social Psychology, 79*, 602–616.

Manstead, A. S. R., & Fischer, A. H. (2001). Social appraisal: The social world as object of and influence on appraisal processes. In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 221–232). New York: Oxford University Press.

Maringer, M., Krumhuber, E. G., Fischer, A. H., & Niedenthal, P. M. (2011). Beyond smile dynamics: Mimicry and beliefs in judgments of smiles. *Emotion, 11*, 181–187.

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review, 98*, 224–253.

Mesquita, B. (2003). Emotions as dynamic cultural phenomena. In R. J. Davidson, K. R. Scherer, H. Goldsmith, & H. Hill (Eds.), *Handbook of affective sciences. Series in affective science* (pp. 871–890). New York: Oxford University Press,

Miller, R. S. (2004). Emotion as adaptive interpersonal communication: The case of embarrassment. In L. Z. Tiedens & C. W. Leach (Eds.), *The social life of emotions* (pp. 87–105). Cambridge, UK: Cambridge University Press.

Mumenthaler, C., & Sander, D. (2012). Social appraisal influences recognition of emotions. *Journal of Personality and Social Psychology, 102*, 1118–1135.

Niven, K., Macdonald, I., & Holman, D. (2012). You spin me right round: Cross-relationship variability in interpersonal emotion regulation. *Frontiers in Psychology, 3, 394.*

Oatley, K., & Jenkins, J. M. (1992). Human emotions: Function and dysfunction. *Annual Review of Psychology, 43*, 55–85.

Öhman, A. (2000). Fear and anxiety: Evolutionary, cognitive and clinical perspectives. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed., pp. 573–593). New York: Guilford Press.

Parkinson, B. (1995). *Ideas and realities of emotion*. London: Routledge.

Parkinson, B. (2005). Do facial movements express emotions or communicate motives? *Personality and Social Psychology Review, 9*, 278–311.

Parkinson, B. (2011). Interpersonal emotion transfer: Contagion and social appraisal. *Social and Personality Psychology Compass, 5*, 428–439.

Parkinson, B., Fischer, A. H., & Manstead, A. S. R. (2005). *Emotions in social relations: Cultural, group, and interpersonal processes*. New York: Psychology Press.

Parkinson, B., & Simons, G. (2009). Affecting others: Social appraisal and emotion contagion in everyday decision making. *Personality and Social Psychology Bulletin, 35*, 1071–1084.

Parkinson, B., & Simons, G. (2012). Worry spreads: Interpersonal transfer of problem-related anxiety. *Cognition and Emotion, 26*, 462–479.

Parrott, W. G. (2001). Implications of dysfunctional emotions for understanding how emotions function. *Review of General Psychology, 5*, 180–186.

Parrott, W. G. (2002). The functional utility of negative emotions. In L. F. Barrett & P. Salovey (Eds.), *The wisdom in feeling: Psychological processes in emotional intelligence* (pp. 341–362). New York: Guilford Press.

Philippot, P., Feldman, R. S., & Coats, E. J. (Eds.). (1999). *The social context of nonverbal behavior.* New York: Cambridge University Press.

Reis, H. T., McDougal Wilson, I., Monestere, C., Bernstein, S., Clark, K., Seidl, E., et al. (1990). What is smiling is beautiful and good. *European Journal of Social Psychology, 20*, 259–267.

Rimé, B. (2009). Emotion elicits the social sharing of emotion: Theory and empirical review. *Emotion Review, 1*, 60–85.

Rimé, B., Philippot, P., Boca, S., & Mesquita, B. (1992). Long-lasting cognitive and social consequences of emotion: Social sharing and rumination. In W. Stroebe & M. Hewstone (Eds.), *European review of social psychology* (Vol. 3, pp. 225–258). Chichester, UK: Wiley.

Roseman, I. J., Wiest, C., & Swartz, T. S. (1994). Phenomenology, behaviors and goals differentiate discrete emotions. *Journal of Personality and Social Psychology, 67*, 206–221.

Salovey, P., & Mayer, J. D. (1990). Emotional intelligence. *Imagination, Cognition, and Personality, 9*, 185–211.

Sani, F. (2005). When subgroups secede: Extending and refining the social psychological model of schisms in groups. *Personality and Social Psychology Bulletin, 31*, 1074–1086.

Sani, F., & Reicher, S. (1999). Identity, argument and schism: Two longitudinal studies of the split in the Church of England over the ordination of women to the priesthood. *Group Processes and Intergroup Relations, 2*, 279–300.

Semin, G. R., & Manstead, A. S. R. (1981). The social implications of embarrassment displays and restitution behaviour. *European Journal of Social Psychology, 12*, 367–377.

Shariff, A. F., & Tracy, J. L. (2009). Knowing who's boss: Implicit perceptions of status from the nonverbal expression of pride. *Emotion, 9*, 631–639.

Shepherd, L., Spears, R., & Manstead, A. S. R. (2013a). The self-regulatory role of anticipated group-based shame and guilt in inhibiting in-group favoritism. *European Journal of Social Psychology, 43*, 493–504.

Shepherd, L., Spears, R., & Manstead, A. S. R. (2013b). "This will bring shame on our nation": The role of anticipated group-based emotions on collective action. *Journal of Experimental Social Psychology, 49*(1), 42–57.

Shepherd, L., Spears, R., & Manstead, A. S. R. (2013c). When does anticipating group-based shame lead to lower ingroup favoritism?: The role of status and status stability. *Journal of Experimental Social Psychology, 49*(3), 334–343.

Smith, E. R. (1993). Social identity and social emotions: Toward new conceptualizations of prejudice. In D. M. Mackie, D. Hamilton, & D. Lewis (Eds.), *Affect, cognition, and stereotyping: Interactive processes in group perception* (pp. 297–315). San Diego, CA: Academic Press.

Smith, E. R., Seger, C. R., & Mackie, D. M. (2007). Can emotions be truly group level?: Evidence regarding four conceptual criteria. *Journal of Personality and Social Psychology, 93*, 431–446.

Snyder, C. R., Lassegard, M., & Ford, C. E. (1986). Distancing after group success and failure: Basking in reflected glory and cutting off reflected failure. *Journal of Personality and Social Psychology, 51*, 382–388.

Sorce, J. F., Emde, R. N., Campos, J. J., & Klinnert, M. D. (1985). Maternal emotional signaling: Its effect on the visual cliff behavior of 1-year-olds. *Developmental Psychology, 21*, 195–200.

Spears, R., & Leach, C. W. (2004). Intergroup schadenfreude: Conditions and consequences. In L. Z. Tiedens & C. W. Leach (Eds.), *The social life of emotions* (pp. 336–355). New York: Cambridge University Press.

Spoor, J. R., & Kelly, J. R. (2004). The evolutionary significance of affect in groups: Communication and group bonding. *Group Processes and Intergroup Relations, 7*, 401–415.

Stel, M. & Vonk, R. (2010). Mimicry in social interaction: Benefits for mimickers, mimickees and their interaction. *British Journal of Psychology, 101*, 311–323.

Sweetman, J., Spears, R., Livingstone, A. G., & Manstead, A. S. R. (2013). Admiration regulates social hierarchy: Antecedents, dispositions, and effects on intergroup behavior. *Journal of Experimental Social Psychology, 49*, 534–542.

Tangney, J. P., Miller, R. S., Flicker, L., & Barlow, D. H. (1996). Are shame, guilt, and embarrassment distinct emotions? *Journal of Personality and Social Psychology, 70*, 1256–1264.

Tajfel, H., & Turner, J. C. (1979). An integrative theory of intergroup conflict. In W. G. Austin & S. Worchel (Eds.), *The social psychology of intergroup relations* (pp. 33–47). Chicago: Nelson Hall.

Tiedens, L. Z. (2001). Anger and advancement versus sadness and subjugation: The effect of negative emotion expressions on social status conferral. *Journal of Personality and Social Psychology, 80*, 86–94.

Tiedens, L. Z., & Leach, C. W. (Eds.). (2004). *The social life of emotions.* New York: Cambridge University Press.

Totterdell, P. (2000). Catching moods and hitting runs:

Mood linkage and subjective performance in professional sports teams. *Journal of Applied Psychology, 85*, 848–859.

Trevarthen, C. (1984). Emotions in infancy: Regulators of contact and relationships with persons. In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 129–157). Hillsdale, NJ: Erlbaum.

Tsai, J. L., Knutson, B., & Fung, H. H. (2006). Cultural variation in affect valuation. *Journal of Personality and Social Psychology, 90*, 288–307.

Van der Schalk, J., Fischer, A. H., Doosje, B. J., Wigboldus, D., Hawk, S. T., Hess, U., et al. (2011). Congruent and incongruent responses to emotional displays of ingroup and outgroup. *Emotion, 11*, 286–298.

Van Dijk, E., Van Kleef, G. A., Steinel, W., & Van Beest, I. (2008). A social functional approach to emotions in bargaining: When communicating anger pays and when it backfires. *Journal of Personality and Social Psychology, 94*, 600–614.

Van Dijk, W. W., & Zeelenberg, M. (2002). What do we talk about when we talk about disappointment?: Distinguishing outcome-related disappointment from person-related disappointment. *Cognition and Emotion, 16*, 787–807.

Van Dijk, W. W., Ouwerkerk, J. W., Wesseling, Y. M., & van Koningsbruggen, G. M. (2011). Towards understanding pleasure at the misfortunes of others: The impact of self-evaluation threat on schadenfreude. *Cognition and Emotion, 25*, 360–368.

Van Kleef, G. A., & Côté, S. (2007). Expressing anger in social conflict: When it helps and when it hurts. *Journal of Applied Psychology, 92*, 1557–1569.

Van Kleef, G. A., De Dreu, C. K. W., & Manstead, A. S. R. (2004). The interpersonal effects of anger and happiness in negotiations. *Journal of Personality and Social Psychology, 86*, 57–76.

Van Kleef, G. A., De Dreu, C. K. W., & Manstead, A. S. R. (2010). An interpersonal approach to emotion in social decision making: The emotions as social information model. *Advances in Experimental Social Psychology, 42*, 45–96.

Van Kleef, G. A., Oveis, C., Van Der Löwe, I., LuoKogan, A., Goetz, J., & Keltner, D. (2008). Power, distress and compassion: Turning a blind eye to the suffering of others. *Psychological Science, 19*, 1315–1322.

Van Kleef, G. A., van Doorn, E. A., Heerdink, M., & Koning, L. F. (2011). Emotion is for influence. *European Review of Social Psychology, 22*, 114–163.

Van Zomeren, M., Spears, R., Fischer, A. H., & Leach, C. W. (2004). Put your money where your mouth is!: Explaining collective action tendencies through group-based anger and group efficacy. *Journal of Personality and Social Psychology, 87*, 649–664.

Vingerhoets, A. J. J. M., & Becht, M. C. (1997). *The ISAC study: Some preliminary findings.* Poster presented at the annual meeting of the American Psychosomatic Society, Santa Fe, NM.

Wang, L., Northcraft, G. B., & Van Kleef, G. A. (2012). Beyond negotiated outcomes: The hidden costs of anger expression in dyadic negotiation. *Organizational Behavior and Human Decision Processes, 119*(1), 54–63.

Williams, K. D. (2001). *Ostracism: The power of silence*. New York: Guilford Press.

Zeelenberg, M., Van der Pligt, J., & Manstead, A. S. R. (1998). Undoing regret on Dutch television: Apologizing for interpersonal regrets involving actions or inactions. *Personality and Social Psychology Bulletin, 24*, 1113–1119.

CHAPTER 25

Social Pain and Social Pleasure

Two Overlooked but Fundamental Mammalian Emotions?

Naomi I. Eisenberger

> A sense of separation is a condition that makes being a mammal so painful.
>
> —Paul MacLean (1993)

> There is something in staying close to men and women and looking on them, and in the contact and odor of them, that pleases the soul well. . . .
>
> —Walt Whitman (1855)

Paul MacLean, a 20th-century neuroscientist, and Walt Whitman, a 19th-century poet, each highlighted one of the fundamental truths about human nature: that our social relationships can have profound effects on our emotional experience. Indeed, it is hard to imagine an experience more pleasurable than the formation of a loving relationship or one more painful than the loss of those closest to us. In fact, when asked to list the single most positive and the single most negative emotional event of their lives, approximately three out of four individuals listed events that involved close social relationships (Jaremka, Gabriel, & Carvallo, 2011). The creation and dissolution of social bonds has a significant impact on our emotional lives. Yet, even though these intense feelings of pleasure and pain that stem from social relationships are one of the most basic building blocks of human emotional experience, these experiences have typically not been included, by scientists, as fundamental emotional states. Why is this? Why have these experiences been largely overlooked in the study of emotion?

In this chapter, I argue that experiences of "social pain" (the painful feelings following social rejection, exclusion, or loss) and "social pleasure" (the pleasurable feelings associated with feeling connected to others) should be considered fundamental emotional states. These emotional states (like others) stem from an inherent mammalian survival need (LeDoux, 2012)—the need for social connection. Given that most mammalian infants are born relatively immature and completely dependent on a caregiver for nourishment and protection, there may be multiple systems in place that promote social connection by eliciting painful, distressing feelings in response to social separation and pleasurable, warm feelings in response to social connection (Eisenberger, 2012; Inagaki & Eisenberger, 2013; MacDonald & Leary, 2005; Panksepp, 1998).

Indeed, the need to stay connected may be so essential that these experiences of social pain and pleasure may have co-opted other basic regulatory systems to ensure social connection. Specifically, experiences of social pain may have co-opted the physical pain system, that is, borrowing the pain signal to highlight and prevent experiences of social separation (Eisenberger, 2012; MacDonald & Leary, 2005; Panksepp, 1998). Likewise, one type of socially pleasurable experience, "social warmth"—the warm feelings associated with feeling connected to and loved by others—may have borrowed the temperature regulation mechanisms involved in detecting and approaching physical warmth in order to promote and maintain the warm experience associated with feeling loved and connected (Inagaki & Eisenberger, 2013; Panksepp, 1998).

In this chapter, I first review evidence supporting the idea that these emotional experiences of social pain and social warmth are so critical to mammalian survival that they rely on the more basic systems involved in physical pain and temperature regulation mechanisms. I then review several possible reasons for why these emotional states may have been overlooked in the study of emotion. These include the possibility that (1) early emotion research categorized emotions based on external (rather than internal) manifestations of emotional states (expressions, behaviors) and social pain/warmth may not have uniform expressions or behavioral outputs; (2) pain and temperature, the hypothesized substrate of social pain and social warmth, have typically been classified as sensory processes rather than emotional states; and (3) pain and temperature are different from emotions in that pain and temperature convey information about how the environment affects the body, whereas emotions convey information about how the environment affects the self.

Social Pain and Physical Pain

If we examine the way that individuals describe experiences in which they have been rejected, excluded, or have lost a loved one, we notice an interesting pattern. People use physical pain words to describe these negative social events—complaining of "*hurt* feelings" and "*broken* hearts." In fact, these physical pain words are often considered better and more accurate descriptors of the feelings that follow these negative social events than more standard emotion words, such as "angry," "sad," or "upset." Moreover, this pattern of using physical pain words to describe socially painful experiences is observed across many different languages and is not exclusive to the English language (MacDonald & Leary, 2005). Yet, does this observation provide meaningful insight into the way people process these negative social events or is the pain associated with social rejection or loss more metaphorical than real?

Over the past several decades, accumulating research has started to indicate that the painful feelings associated with social rejection or loss may be more than just metaphorical. Research across multiple species has shown that experiences of social pain rely on some of the same neural and neurochemical substrates that are involved in the distressing experience of physical pain (Eisenberger, Lieberman, & Williams, 2003; Eisenberger & Lieberman, 2004; Eisenberger, 2012; MacDonald & Leary, 2005; Panksepp, 1998). Indeed, such a physical–social pain overlap makes sense from an evolutionary perspective. Compared with other species, mammals are unique in that they are born relatively immature without the capacity to feed or fend for themselves. Given this innate dependency, it is critical for mammalian infants to stay close to a caregiver in order to obtain the appropriate nourishment and protection. To the extent that being separated from a caregiver is such a threat to the survival of young mammals, feeling hurt by separation may be an adaptive way to prevent it. In fact, it has been hypothesized that, over the course of our evolutionary history, the social attachment system may have piggybacked onto the physical pain system, borrowing the pain signal to prevent social separation (Eisenberger et al., 2003; Eisenberger & Lieberman, 2004; Eisenberger, 2012; MacDonald & Leary, 2005; Panksepp, 1998).

Shared Neurochemical Substrates

Evidence for a physical–social pain overlap comes from several different lines of research. The earliest research in this area focused on the shared neurochemical substrates underlying physical and social pain in animals and demonstrated that mu-opioids, known for their powerful pain-relieving effects, also reduced separation distress behaviors, such as distress vocalizations—characteristic calls made by infant mammals following mother–infant separation. For example, low, nonsedating doses of morphine, a mu-opioid agonist, can decrease distress vocalizations when pups are separated from their mothers, whereas naloxone, a mu-opioid antagonist, can increase distress vocalizations (Herman & Panksepp, 1978; Kalin, Shelton, & Barksdale, 1988; Panksepp, Herman, Conner, Bichop, & Scott, 1978). Interestingly, blocking opioids in humans has also been shown to reduce feelings of social connection (Inagaki, Ray, Irwin, Way, & Eisenberger, in press).

Similarly, genes that regulate mu-opioid processes also affect attachment-related behaviors. Mice lacking the mu-opioid receptor gene produce fewer distress vocalizations following maternal–infant separation (Moles, Kieffer, & D'Amato, 2004), perhaps because there is no longer distress at separation. Likewise, infant rhesus monkeys carrying a version of the mu-opioid receptor gene that is linked with increased physical pain sensitivity (Chou et al., 2006; Sia et al., 2008) also show increased distress behaviors upon separation from their mothers (Barr et al., 2008), and mothers who carry this same version of the gene are more likely to prevent their infants from separating from them (Higham et al., 2011), possibly because of the increased distress associated with separation. Together, these studies support the physical–social pain overlap by showing that opioids have similar effects on both physical and social pain.

Shared Neural Substrates

In addition to sharing neurochemical substrates, physical and social pain are also known to share neural substrates. As a bit of background, pain research has shown that physical pain can be subdivided into two components: (1) a sensory component, which codes for the localization, quality, and intensity of the nociceptive stimulus; and (2) an affective component, which is associated with the distressing experience of pain and the drive to terminate the painful stimulus (Price, Harkins, & Baker, 1987). Neuroimaging research has shown that these two components of pain map fairly well onto different cortical regions: the sensory component tends to be associated with activity in the primary and secondary somatosensory cortices (S1, S2) and the posterior insula (PI), whereas the affective component of pain tends to be associated with activity in the dorsal anterior cingulate cortex (dACC) and anterior insula (AI; Treede, Kenshalo, Gracely, & Jones, 1999; Apkarian, Bushnell, Treede, & Zubieta, 2005). Given that social pain does not have the same kind of nociceptive input as does physical pain, we have hypothesized that social pain shares the affective component with physical pain.

As evidence for this, lesioning certain regions known to play a role in the affective component of pain (dACC, AI) not only reduces the suffering component of pain (Foltz & White, 1962; Berthier, Starkstein, & Leiguarda, 1988), it also reduces social pain-related behaviors and experience. In animals, lesioning the anterior cingulate cortex (ACC; dorsal and/or ventral to the genu) in infant mammals reduces distress vocalizations upon mother–infant separation (Hadland, Rushworth, Gaffan, & Passingham, 2003; MacLean & Newman, 1988), whereas stimulating this region leads to the spontaneous production of these vocalizations (Robinson, 1967; Smith, 1945). Similarly, in humans, lesioning the dACC (through a surgical procedure known as a cingulotomy) can reduce shyness and lead to a reduced concern about the opinions or judgments of others (Tow & Whitty, 1953). Hence, across animals and humans, lesions to the ACC, known to play a role in the affective component of physical pain, reduce separation-distress behaviors in animals and concerns about social rejection in humans.

Neuroimaging research has also provided evidence that experiences of social pain rely on affective pain-related neural regions. Thus, various types of socially painful experiences (reviewed in Eisenberger, 2012) including social exclusion (Eisenberger et al., 2003), negative social evaluation (Eisenberger, Inagaki, Muscatell, Haltom, & Leary, 2011; Takahashi et al., 2009; Wager et al., 2009), viewing rejection-themed images (Kross, Egner, Ochsner, Hirsch, & Downey, 2007), reliving a romantic rejection (Fisher, Brown, Aron, Strong, & Mashek, 2010; Kross, Berman, Mischel, Smith, & Wager, 2011), and being reminded of a lost loved one (Gündel, O'Connor, Littrell, Fort, & Richard, 2003; Kersting et al., 2009; O'Connor et al., 2008) all activate the dACC and AI. In fact, one study demonstrated that subjects showed overlapping neural activity in the dACC and AI in response to both a physical pain task and a social pain task in which they relived a recent relationship breakup (Kross et al., 2011).

However, recent research has also suggested that there may be computational differences in the processing of social and physical pain, when looking at the level of multivariate patterns of neural activity (Woo et al., 2014; Wager et al., 2013). Thus, although physical and social pain activate overlapping neural regions (Kross et al., 2011), findings from multivariate pattern analysis (MVPA) show that physical and social pain rely on dissociable representations in these same regions. While it is possible that this is the case, these studies are hindered by the fact that they compare neural representations of live experiences of physical pain (e.g., subjects receive multiple trials of heat pain during the experiment) with memories of social pain (e.g., subjects are asked to think back to a prior experience of rejection multiple times). Hence, the differences observed in the multivariate patterns of neural activity could be due to real differences between physical and social pain or they could be due to more mundane differences inherent in the eliciting stimuli (real experiences vs. memories, etc.). Future studies are needed to address this confound and further examine the representational overlap between physical and social pain. Thus, though not conclusive, considerable research has shown that experiences of social pain activate neural regions often associated with the affective component of physical pain.

Functional Consequences

As further evidence that physical and social pain processes overlap, research has also confirmed some of the expected consequences of such an overlap. For example, one corollary of the physical–social pain overlap hypothesis is that individuals who are more sensitive to one type of pain should also be more sensitive to the other. Indeed, studies have shown that individuals who tend to be more sensitive to physical pain stimuli also go on to report greater social distress following social exclusion (Eisenberger, Jarcho, Lieberman, & Naliboff, 2006). Likewise, individuals who carry a variant of the mu-opioid receptor gene linked to increased physical pain sensitivity also report higher levels of rejection sensitivity and show greater activity in the dACC and AI in response to social exclusion (Way, Taylor, & Eisenberger, 2009).

A second corollary of the physical–social pain overlap hypothesis is that altering one kind of pain should alter the other in a similar manner, and studies have shown evidence for this as well. Factors that increase social pain, such as social exclusion or failure, tend to increase sensitivity to physical pain (Bernstein & Claypool, 2012; Levine, Krass, & Padawer, 1993; van den Hout, Vlaeyen, Peters, Engelhard, & van den Hout, 2000; cf. DeWall & Baumeister, 2006), whereas factors that decrease social pain, such as social support, reduce physical pain experience and pain-related neural activity in response to physically painful stimuli (dACC, AI; Eisenberger, Master, Inagaki, Taylor, Shirinyan, et al., 2011; Master et al., 2009; Younger, Aron, Parke, Chatterjee, & Mackey, 2010). Likewise, factors that increase physical pain, such as inflammatory processes, increase feelings of social disconnection (Eisenberger, Inagaki, Mashal, & Irwin, 2010) and are associated with greater dACC and AI activity to social exclusion (Eisenberger, Inagaki, Rameson, Mashal, & Irwin, 2009), whereas factors that decrease physical pain, such as the physical pain-reliever Tylenol, have been shown to reduce daily hurt feelings as well as pain-related neural activity (dACC, AI) to social exclusion (DeWall et al., 2010).

Summary

Together, this research provides solid evidence for the hypothesis that experiences of social pain may rely on the same neural mechanisms as those that process the distressing experience of physical pain. Given the importance of social connection for survival as well as the profound emotional impact that experiences of social pain have, it seems plausible that social pain represents a fundamental type of mammalian emotional experience.

Social Warmth and Physical Warmth

Similar to the insights we gain from examining the language of social pain, listening to the language of social pleasures, or the feelings that arise in response to feeling socially connected, may provide important information about these feeling states as well. Although there are many ways that people describe feelings of social connection, one common way is with words that reflect physical warmth, such as when individuals speak of "having *warm* feelings for someone" or of someone's actions "*warming* their hearts." (Another category of words used to describe social connection are those that indicate physical proximity—such as closeness: "I felt *close* to her." However, this category of linguistic processing is not reviewed here. See Parkinson, Liu, & Wheatley, 2014, for an insightful treatment of this topic.) Indeed, it has been suggested that the mechanisms involved in temperature perception and regulation may be involved in detecting and reinforcing social connection (Inagaki & Eisenberger, 2013; Panksepp, 1998). Specifically, the mechanisms underlying thermoregulation, the processes associated with maintaining our relatively warm core body temperature (including the motivation to seek out warm stimuli and the perceived pleasantness of physical warmth; Rolls, Grabenhorst, & Parris, 2008) may have been co-opted to maintain "social warmth"—the experience of feeling connected to and loved by others.

Physical and Social Warmth Are Associated Early On

In a very tangible way, physical and social warmth are associated from birth. Being close and (literally) connected to the mother before birth is associated with the physical warmth of the mother's womb. After birth, being held, rocked, or soothed by a caregiver is associated with increased physical warmth due to the close proximity of the caregiver. Hence, an early association is formed between physical and social warmth, the experience of being connected to and cared for by someone. Whether the association between physical and social warmth has been selected for over the course of evolutionary history or is learned within an individual's lifespan is not yet known.

This association between physical and social warmth appears to play out in multiple species. For example, in Harlow's (1958) early studies of infant rhesus monkeys' preference for cloth or wire monkey mothers, he found that infant rhesus monkeys preferred cloth mothers, which in addition to being soft, were also warmed by a 100-watt lightbulb. Moreover, monkeys paired with these warm, cloth mothers went on to show fewer emotional problems later on than those paired exclusively with wire monkey mothers (Harlow, 1958; Harlow & Zimmerman, 1959). Similarly, rat pups deprived of maternal care continued to develop normally if placed in a warm rather than a cold environment (Stone, Bonnet, & Hofer, 1976), suggesting that physical warmth may be substituting for the care or social warmth provided by the mother. Likewise, pups removed from their mothers evidenced less distress if placed in warm rather than cold or hot cages (Blumberg, Efimova, & Alberts, 1992).

Although the interaction between physical and social warmth has been less studied in humans, research has highlighted the importance of physical and social warmth (separately) for human infant development. Highlighting the critical need for physical warmth, premature infants placed in warmer, rather than cooler, incubators for the first 5 days of life were more likely to survive (Silverman, Fertig, & Berger, 1958). Highlighting the critical need for social warmth, children raised in institutional settings without a warm, nurturing caregiver show lifelong problems with physical, cognitive, and socioemotional development (Gunnar, Bruce, & Grotevant, 2000).

Behavioral Evidence for a Physical–Social Warmth Overlap

Emerging evidence stemming largely from the embodied cognition literature suggests that physical and social warmth rely on shared underlying mechanisms. One way that this has been demonstrated is by showing that altering one kind of warmth process can alter the other in a similar manner. For example, several studies have shown that increasing feelings of physical warmth can lead to corresponding increases in feelings of social warmth. Thus, holding a warm (vs. a cold) beverage increased self-reported feelings of social connection with a close other (IJzerman & Semin, 2009) as well as the tendency to act in socially warm ways (giving to close others vs. oneself; Williams & Bargh, 2008). Likewise, holding a warm (vs. cold or neutral) pack led to greater feelings of social connection (Inagaki & Eisenberger, 2013) and trust in others (Kang, Williams, Clark, Gray, & Bargh, 2011). Finally, being in a warm (vs. cool) room led to increased feelings of closeness with an experimenter (IJzerman & Semin, 2009). Conversely, reducing physical warmth can reduce social warmth; individuals who held a cold (vs. a warm or neutral) pack reported greater feelings of loneliness (Bargh & Shalev, 2012).

Reversing the causal direction of these effects, other studies have shown that altering social warmth can alter perceived physical warmth in a similar manner. Reading loving, socially warm (vs. neutral) messages from close others increased self-reported feelings of warmth (Inagaki & Eisenberger, 2013), and feeling more similar to interaction partners increased the perceived warmth of a room (IJzerman & Semin, 2010). Conversely, reducing feelings of social warmth have been shown to reduce feelings of physical warmth. Individuals who relived or faced an episode of social exclusion estimated the temperature of the room to be colder than those who relived or experienced social inclusion (Zhong & Leonardelli, 2008). Additionally, thinking about the many (vs. few) ways in which one is dissimilar from someone else led individuals to estimate the room temperature as colder (IJzerman & Semin, 2010).

Finally, as further evidence for this physical–social warmth overlap, human research has also shown that individuals may regulate their feelings of social warmth by substituting physical warmth. Thus, greater loneliness, or a lack of social warmth, is associated with taking more frequent warm baths/showers, taking longer warm baths/showers, and preferring the temperature of the water to be warmer (Bargh & Shalev, 2012). Similarly, after reliving a past rejection experience, holding a warm (vs. cold) pack reduced the need for affiliation or emotion regulation that typically follows rejection experiences (Bargh & Shalev, 2012).

Neural and Neurochemical Evidence for an Overlap

More recently, research has examined whether common neural structures underlie physical and social warmth. The few studies that have examined neural responses to warm thermal stimuli have highlighted a role for regions like the insula and ventral striatum (VS). Warm stimuli increase insula activity, a region associated with processing interoceptive cues (Becerra et al., 1999; Olausson et al., 2005; Rolls et al., 2008; Verhagen, Kadohisa, & Rolls, 2004), and lesions to the insula can result in the selective loss of nonpainful thermal sensation (Cattaneo, Chierici, Cucurachi, Gobelli, & Pavesi, 2007). Additionally, regions like the VS, pregenual anterior cingulate cortex (pACC), and orbitofrontal cortex correlate with the perceived pleasantness of warm stimuli (Rolls et al., 2008), suggesting that these regions may play a role in the pleasurable experience associated with warmth. Interestingly, similar regions have been implicated in viewing loved ones (Acevedo, Aron, Fisher, & Brown, 2012; Aron et al., 2005; Bartels & Zeki, 2000, 2004).

To examine whether experiences of physical and social warmth rely on similar regions, we examined neural activity as subjects completed physical and social warmth tasks (Inagaki & Eisenberger, 2013). During the physical warmth task, subjects held a warm pack on some trials (physical warmth) and a squeeze ball on other trials (control). During the social warmth task, subjects read loving messages written to them by their close family members and friends (seen for the first time in the scanner) on some trials (social warmth) and read neutral messages written by these same individuals on other trials (control). In addition to showing that the warm packs (vs. squeeze ball) made people feel more connected and that reading the loving (vs. neutral) messages made people feel warmer, results also showed that there was overlapping neural activity in the middle insula and the VS in response to both tasks. Hence, physical and social warmth may rely on common neural substrates.

Finally, physical and social warmth may also rely on some of the same neurochemical substrates. The regions that showed overlapping neural activity to physical and social warmth—the insula and VS—are known to have a high density of mu-opioid receptors, and thus opioids may serve, in part, to regulate physical and social warmth. Though complicated, mu-opioids have been shown to play a role in temperature regulation such that mu-opioid agonists, which enhance opioid processes, can increase body temperature (Clark, Murphy, Lipton, & Clark, 1983), whereas mu-opioid antagonists, which block opioid processes, can decrease body temperature (Handler, Geller, & Adler, 1992; Spencer, Hruby, & Burks, 1988). Interestingly, blocking mu-opioid processes in humans (through naltrexone) has been shown to reduce feelings of social connection in response to reading loving messages from close others (Inagaki, Ray, Irwin, Way, & Eisenberger, in press) and to reduce feelings of social connection in response to holding a warm pack (Inagaki, Irwin, & Eisenberger, 2015). In fact, Panksepp (1998) hypothesized that mu-opioids play a critical role in both the positive and negative socioemotional feelings that underlie social attachments, with increasing levels of opioids underlying the positive feelings associated with social connection and decreasing levels of opioids underlying the painful feelings associated with social separation.

Summary

In addition to a physical–social pain overlap, emerging evidence also highlights the shared mechanisms underlying physical and social warmth. Hence, mammalian species may have developed multiple insurance policies for maintaining social connection—relying on pain mechanisms to detect and avoid social separation as well as temperature regulation mechanisms to detect and reinforce social connection. Based on this, social pain and warmth may represent two fundamental emotional states—each associated with maintaining the critical mammalian goal of attaining social connection.

Why Have Social Pain and Social Warmth Been Overlooked as Fundamental Emotional States?

Given that emotions have been conceptualized as affective-motivational processes that reflect the function of circuits related to survival (LeDoux, 2012), social pain and social warmth, which are affective-motivational states stemming from the mammalian need for social connection, seem like shoe-ins for fundamental emotional states. However, typically, social pain and warmth—or even related terms that are more commonly used such as "hurt feelings" or "love"—have typically not been studied as fundamental emotions by the scientific community. Why is this? What might differentiate these emotional states from others and are these valid differences or faulty assumptions? Here, I review three possible reasons for why social pain and warmth may have been overlooked in the study of emotion.

- *Possibility 1: Early, influential models of emotion focused more on external cues of emotion.* Perhaps the main reason that social pain and warmth have been overlooked as fundamental emotions is that some of the early emotion research, which was influential in initially determining "what counts" as an emotion, focused more heavily on external cues of emotion. Thus, some early emotion research, inspired in part by Darwin's (1872) observations of emotional expressions in animals, focused on observable expressions of emotions, such as those found in facial expressions. For example, Paul Ekman (1993) used facial expressions to categorize emotions and determined, based on cross-cultural examinations of facial expressions, that there were six "basic emotions" that were universally recognized. These included fear, anger, sadness, disgust, happiness, and surprise. He then went on to posit that each of these basic emotions, which could be distinguished based on emotional expressions, also shared other characteristics such as specific triggers or antecedent events (distinct for each emotion), automatic appraisals, and a distinctive physiology (Ekman, 1992). This framework shaped much of the early thinking on emotion research and continues to influence emotion theory to this day, as evidenced by the common focus on the basic emotions of fear, anger, sadness, disgust, and happiness (Phan, Wager, Taylor, & Liberzon, 2002; Wager, Phan, Liberzon, & Taylor, 2003; Murphy, Nimmo-Smith, & Lawrence, 2003; Vytal & Hamann, 2010), with little focus on emotional states outside of this inventory.

Interestingly, although much of what is intriguing and unique about emotion is the quality of the experience associated with it; this early, influential framework focused very little on emotions "from the inside"—from the perspective of experience. Instead, the basic emotion approach focused largely on categorizing emotions based on external behavior: common facial expressions, physiological responses, and behavioral responses. Hence, this early and (still) influential view of emotion may have overlooked certain emotional states, not because they are not emotional, but rather because they lack a characteristic emotional expression or behavioral response or did not fit easily into this basic emotion schema.

However, shifting the way we categorize emotions—from a focus on external expressions and behaviors to a focus on internal feeling states—may change our understanding of emotion. Focusing on emotions from the inside may reshuffle the deck of basic emotions from a focus on emotions with discrete expressions (such as fear or anger) to a focus on more basic dimensions of human emotional experience (such as pleasure and pain). Perhaps this is the perspective that some emotion theorists had in mind when they suggested that the two most basic emotions were pain and pleasure (Mowrer, 1960; Panksepp cited in Phillips, 2003). Indeed, although pain and pleasure are not typically considered emotions according to the basic emotion approach, they are definitely considered fundamental categories of emotional experience when focusing on emotional experience. What might emotion research look like if the focus was on categorizing internal experience rather than external expressions and behavior?

Models that focus on the internal experience associated with emotions tend to focus more on the language people use to describe their emotional feelings rather than on characterizing emotional outputs (physiology, emotional expressions). For example, the circumplex model of emotion, which focuses on internal affective feelings, was developed, in part, by exploring how affective language naturally clusters. This was accomplished by having subjects or factor analytic techniques sort various affect labels ("alarmed," "depressed," "relaxed," "serene," "pleased," "tense") into categories, revealing a two-dimensional set of axes consisting of the categories valence (positive, negative) and arousal (low, high; Russell, 1980; Barrett & Russell, 1999).

Each of these axes relates more strongly to the experience, rather than the expression, of emotion: either positive or negative, arousing or calm.

Likewise, much has been learned about social pain and social warmth from the words used to describe the experiences that follow social rejection and connection. And it is interesting to note that the words that people use to describe these events are not necessarily standard emotion words, but words that reflect experiences of physical pain and physical warmth (MacDonald & Leary, 2005). Hence, focusing on emotions from the inside may provide different but important clues about the nature of emotional experience.

- *Possibility 2: Pain and temperature have been conceptualized as sensations, which are different from emotions.* A second reason that social pain and social warmth may have been overlooked as fundamental emotional states is that their hypothesized substrates—pain and temperature—have typically been conceptualized as sensory, rather than affective, processes. Hence, while it may seem quite logical that the painful feelings that follow from broken social bonds may have co-opted the pain system and that the warm feelings associated with feeling socially connected may have co-opted temperature regulation mechanisms, it may seem harder to imagine that physical pain and physical warmth are similar to emotional processes. Physical pain and warmth have typically been conceptualized as cutaneous sensations (like touch), which have been distinguished from emotional states. However, new research on the nature of pain and temperature processing has suggested that these processes may share more in common with emotional states than with sensations.

Early thinkers distinguished feelings related to the body's state (pain, temperature, flush) from the five senses (Weber, 1846). However, in 1948, Sir Charles Sherrington (1948), a Nobel Prize laureate in physiology and medicine, mistakenly categorized pain and temperature as aspects of touch, an exteroceptive sense. This mistaken classification still figures prominently in textbooks and highlights the fact that pain and temperature are assumed to be cutaneous sensations (Craig, 2002). Hence, many researchers and clinicians, and thus the broader public, have regarded pain and temperature as a submodality of cutaneous sensation or exteroception.

Recent work, however, has challenged the idea that pain and temperature are exteroceptively processed and has shown instead that both are interoceptively processed—that is, these feeling states result from homeostatic processes intended to regulate the condition of the body and signal when the organism is at risk (Craig, 2002). Thus, pain reflects an adverse condition of the body that demands a behavioral response and warmth (in most, though not all, cases) represents the rewarding attainment of the biological need for thermoregulation.

Notably, a key feature that distinguishes pain and temperature from touch is their inherent association with emotion. Painful or warm feelings have an affective-motivational component, whereas touch (noting whether something is rough, bumpy, smooth, etc.) does not (with the exception of gentle stroking or "affective touch"; see Olausson et al., 2002). While the affective-motivational aspects of pain are easy to see, the affective-motivational components of temperature are more often overlooked because feelings of temperature tend to be projected onto the objects being touched. However, temperature reflects the physiological condition of the body and generates an inseparable affective response (pleasantness or unpleasantness) that signals this homeostatic role. For example, when we are overheated, the feeling of cool water is experienced as pleasant. However, when the body is cold, that same cool water can feel intensely unpleasant. This example highlights the fact that temperature is homeostatically regulated and that the feelings of pleasantness or unpleasantness reflect the body's survival needs. Indeed, it has been suggested that these "bodily feelings" not only provide information about the homeostatic needs of the body but also underlie various mood and emotional states (Craig, 2003; Denton, McKinley, Farrell, & Egan, 2009; James, 1884).

Based on research showing that pain and temperature are processed interoceptively and thus, by definition, have an affective-motivational component, it may seem less surprising that pain and warmth represent the substrates for feelings of social rejection or social closeness. Even though pain and temperature are not classified as emotions, they have certain affective and motivational properties that position them as important precursors for the emotional states of social pain and social warmth.

Indeed, like the homeostatic processes of pain and temperature, which provide information about the condition of the body, social pain and social warmth are homeostatic emotions that provide information about the condition of one's social bonds. For example, in the same way that a cold breeze feels less distressing when one is already warm than when one is cold, social rejection may not be experienced as quite as painful if one already has strong social bonds. Indeed, research has shown that individuals who have higher levels of social support or who spend more time with their friends show less pain-related neural activity in response to social exclusion (dACC, AI; Eisenberger, Taylor, Gable, Hilmert, & Lieberman, 2007; Masten, Telzer, Fuligni, Lieberman, & Eisenberger, 2012). Likewise, an experience of social rejection may be even more painful and an experience of social connection may be even more pleasurable if one does not have strong social bonds. Consistent with this, individuals high in anxious attachment, who tend to worry about being rejected by close others and thus may experience less social connection, show greater activity in pain-related neural regions in response to social exclusion (DeWall et al., 2012). Likewise, individuals who score higher in loneliness—indicating a lack of felt social connection—show greater activity in the VS, a reward-related neural region, in response to viewing pictures of social support figures (Inagaki, Muscatell, et al., in press). Thus, social pain and warmth may represent homeostatic emotional states, which fluctuate based on whether the need for social connection has been met.

- *Possibility 3: Pain and temperature seem to primarily affect the body, whereas emotions seem to primarily affect the self.* Even after acknowledging that pain and temperature have an affective component and are not purely sensory, it might still seem strange to include social pain and social warmth as emotional states, because their substrates—pain and temperature—are still not typically conceptualized as emotional states even if they are affective in nature. One of the main differences is that physical pain and physical warmth appear to provide information about the state of the body, whereas emotions provide information about the organism's relationship to the environment (Denton et al., 2009; reviewed in Kleinginna & Kleinginna, 1981). Because of this, pain and temperature "feel" like they primarily affect the physical body, whereas emotions, because they provide information about the person's relationship to the environment, "feel" like they primarily affect the self.

This fundamental distinction between the body and the mind or self is one that has repeatedly emerged throughout psychology (Lieberman, 2007) and appears to be a fundamental way in which the brain is organized (Lieberman, 2007, 2009; Uddin, Iacoboni, Lange, & Keenan, 2007). Studies have shown that a right-*lateralized* frontoparietal network is involved in understanding the physical aspects of the self, such as recognizing one's face or voice or retrieving information about the body, whereas a more *medial* frontoparietal network is involved in understanding the psychological self, such as when thinking about one's traits, qualities, or preferences (reviewed in Lieberman, 2007). Likewise, thinking about others in terms of their bodies (e.g., in order to imitate them) leads to activity in the *lateral* frontoparietal network (Iacoboni et al., 1999), whereas thinking about others in terms of their minds or "mentalizing" (e.g., thinking about what others might be thinking or feeling) leads to activity in the *medial* frontoparietal network (Mitchell, 2008). Hence, pain and temperature, which typically reflect a focus on the physical body, may be differentiated in important ways from emotion, which may be more focused on the psychological self.

Still, *social* pain and *social* warmth, unlike physical pain and physical warmth, seem to be processed in such a way that makes them "feel" like they are primarily affecting the self rather than the body and thus may be more akin to other emotional states. Indeed, social pain, like other emotional states (anger, sadness, happiness) can be reexperienced and relived, perhaps because one can relive the thoughts and intentions of oneself and others (which results in the emotional response), whereas physical pain can not be easily relived (Chen, Williams, Fitness, & Newton, 2008), perhaps because there are not typically intentions to relive. A recent study confirms this hypothesis (Meyer, Williams, & Eisenberger, 2015). Hence, not only did reliving social (vs. physical) pain lead to greater reports of pain during the reliving episode, but reliving social pain led to enhanced mental state processing (for oneself and others) and increased activity in the medial frontoparietal regions (associated with processing the minds of oneself and others), whereas reliving physical pain led to enhanced body state processing and increased activity in lateral prefrontal regions (associated with processing the bodies of oneself and others). Moreover, when reliving social pain, activity in the medial frontoparietal regions was functionally coupled with increased affective pain-related activity (dACC, AI) and that pain-related activity was associated with greater self-reported pain. On the other hand, when reliving physical pain, activity in the lateral frontal regions was functionally coupled with sensory-related neural regions (S1), and these sensory-related regions were not associated with self-reported pain. Hence, even though social pain and social warmth may be rooted in the neural circuitry that regulates physical pain and temperature, there are still important differences that suggest that social pain and social warmth are more in line with emotional states.

Conclusions

Although the emotional states that arise in response to social connection or rejection are some of the most intense and memorable experiences of our lives, these emotional states have not typically been the subject of focus in emotion research. Here, I have suggested that social pain and social warmth may indeed be fundamental emotional states and that they may be so central to human emotional experience that they may have piggybacked onto other basic systems that regulate an organism's survival needs. Indeed, considerable evidence has now shown that social pain relies on neural systems that process the distressing experience of physical pain and that social warmth relies on some of the same systems that process thermoregulation (detecting and approaching the pleasant feelings associated with warmth).

Interestingly, by including social pain and social warmth into our emotional lexicon, we may expand our ideas about emotions. By listening to the language associated with the emotional experiences of rejection and connection, we find clues to an underlying reliance on neural systems involved in regulating pain and warmth. What if we did the same for other socioemotional states that have not been typically investigated or included in emotion research? What hints are we given about the nature of socioemotional experience when we focus on the language individuals use to describe the emotions that arise from social interactions?

Indeed, this approach may lead to several new questions, such as What does it mean to feel emotionally touched? To feel safe and secure in another's presence? To feel the chills at witnessing an act of true compassion or selflessness? Though none of these experiences are neatly carved into standard emotion categories, each of these emotional experiences are worthy of further investigation. Exploring the nature of these socioemotional experiences may not only further our understanding of emotional experience, but may also continue to reveal important information about the ways in which our emotions are shaped by our inherent need for others.

References

Acevedo, B. P., Aron, A., Fisher, H. E., & Brown, L. L. (2012). Neural correlates of long-term intense romantic love. *Social Cognitive Affective Neuroscience, 7*, 145–159.

Apkarian, A. V., Bushnell, M. C., Treede, R.-D., & Zubieta, J.-K. (2005). Human brain mechanisms of pain perception and regulation in health and disease. *European Journal of Pain, 9*, 463–484.

Aron, A., Fisher, H., Mashek, D, Strong, G., Li, H., & Brown, L. (2005). Reward, motivation and emotion systems associated with early-stage intense romantic love. *Journal of Neurophysiology, 93*, 327–337.

Bargh, J. A., & Shalev, I. (2012). The substitutability of physical and social warmth in daily life. *Emotion, 12*, 154–162.

Barr, C. S., Schwandt, M. L., Lindell, S. G., Higley, J. D., Maestripieri, D., Goldman, D., et al. (2008). Variation at the mu-opioid receptor gene (OPRM1) influences attachment behavior in infant primates. *Proceedings of the National Academy of Sciences, 105*(13), 5277–5281.

Barrett, L. F., & Russell, J. A. (1999). The structure of current affect controversies and emerging consensus. *Current Directions in Psychological Science, 8*(1), 10–14.

Bartels, A., & Zeki, S. (2000). The neural basis of romantic love. *NeuroReport, 11*, 3829–3834.

Bartels, A., & Zeki, S. (2004). The neural correlates of maternal and romantic love. *NeuroImage, 21*, 1155–1166.

Becerra, L. R., Breiter, H. C., Stojanovic, M., Fishman, S., Edwards, A., Comite, A. R., et al. (1999). Human brain 'activation under controlled thermal stimulation and habituation to noxious heat: An fMRI study. *Magnetic Resonance in Medicine, 41*, 1044–1057.

Bernstein, M. J., & Claypool, H. M. (2012). Social exclusion and pain sensitivity: Why exclusion sometimes hurts and sometimes numbs. *Personality and Social Psychology Bulletin, 38*(2), 185–196.

Berthier, M., Starkstein, M. D., & Leiguarda, R. (1988). Asymbolia for pain: A sensory-limbic disconnection syndrome. *Annals of Neurology, 24*, 41–49.

Blumberg, M. S., Efimova, I. V., & Alberts, J. R. (1992). Ultrasonic vocalizations by rat pups: The primary importance of ambient temperature and the thermal significance of contact comfort. *Developmental Psychobiology, 25*, 229–250.

Cattaneo, L., Chierici, E., Cucurachi, L., Cobelli, R., &

Pavesi, G. (2007). Posterior insular stroke causing selective loss of contralateral nonpainful thermal sensation. *Neurology, 16*, 237.

Chen, Z., Williams, K. D., Fitness, J., & Newton, N. (2008). When hurt won't heal: Exploring the capacity to relive social and physical pain. *Psychological Science, 46*, 612–618.

Chou, W. Y., Wang, C. H., Liu, P. H., Tseng, C. C., & Jawan, B. (2006) Human opioid receptor A118G polymorphism affects intravenous patient-controlled analgesia morphine consumption after total abdominal hysterectomy. *Anesthesiology, 105*, 334–337.

Clark, S. M., Murphy, M. T., Lipton, J. M., & Clark, W. G. (1983). Effects of morphine on body temperature of squirrel monkeys of various ages. *Brain Research Bulletin, 10*, 305–308.

Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. *Nature Reviews Neuroscience, 3*, 655–666.

Craig, A. D. (2003). Interoception: The sense of the physiological condition of the body. *Current Opinion in Neurobiology, 13*(4), 500–505.

Darwin, C. (1872). *The expression of the emotions in man and animals.* New York: Philosophical Library.

Denton, D. A., McKinley, M. J., Farrell, M., & Egan, G. F. (2009). The role of primordial emotions in the evolutionary origin of consciousness. *Consciousness and Cognition, 18*(2), 500–514.

DeWall, C. N., & Baumeister, R. F. (2006). Alone but feeling no pain: Effects of social exclusion on physical pain tolerance and pain threshold, affective forecasting, and interpersonal empathy. *Journal of Personality and Social Psychology, 91*, 1–15.

DeWall, C. N., MacDonald, G., Webster, G. D., Masten, C. L., Baumeister, R. F., Powell, C., et al. (2010). Tylenol reduces social pain: Behavioral and neural evidence. *Psychological Science, 21*, 931–937.

DeWall, C. N., Masten, C. L., Powell, C., Combs, D., Schurtz, D. R., & Eisenberger, N. I. (2012). Do neural responses to rejection depend on attachment style?: An fMRI study. *Social Cognitive and Affective Neuroscience, 7*(2), 184–192.

Eisenberger, N. I. (2012). The pain of social disconnection: Examining the shared neural underpinnings of physical and social pain. *Nature Reviews Neuroscience, 13*(6), 421–434.

Eisenberger, N. I., Inagaki, T. K., Mashal, N. M., & Irwin, M. R. (2010). Inflammation and social experience: An inflammatory challenge induces feelings of social disconnection in addition to depressed mood. *Brain, Behavior, and Immunity, 24*, 558–563.

Eisenberger, N. I., Inagaki, T. K., Muscatell, K. A., Haltom, K. E. B., & Leary, M. R. (2011). The neural sociometer: Brain mechanisms underlying state self-esteem. *Journal of Cognitive Neuroscience, 23*, 3448–3455.

Eisenberger, N. I., Inagaki, T. K., Rameson, L., Mashal, N. M., & Irwin, M. R. (2009). An fMRI study of cytokine-induced depressed mood and social pain: The role of sex differences. *NeuroImage, 47*, 881–890.

Eisenberger, N. I., Jarcho, J. M., Lieberman, M. D., & Naliboff, B. D. (2006). An experimental study of shared sensitivity to physical pain and social rejection. *Pain, 126*, 132–138.

Eisenberger, N. I., & Lieberman, M. D. (2004). Why rejection hurts: The neurocognitive overlap between physical and social pain. *Trends in Cognitive Sciences, 8*, 294–300.

Eisenberger, N. I., Lieberman, M. D., & Williams, K. D. (2003). Does rejection hurt?: An fMRI study of social exclusion. *Science, 302*, 290–292.

Eisenberger, N. I., Master, S. L., Inagaki, T. K., Taylor, S. E., Shirinyan, D., Lieberman, M. D., et al. (2011). Attachment figures activate a safety signal-related neural region and reduce pain experience. *Proceedings of the National Academy of Sciences, 108*, 11721–11726.

Eisenberger, N. I., Taylor, S. E., Gable, S. L., Hilmert, C. J., & Lieberman, M. D. (2007). Neural pathways link social support to attenuated neuroendocrine stress responses. *NeuroImage, 35*(4), 1601–1612.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion,* 6(3–4), 169–200.

Ekman, P. (1993). Facial expression and emotion. *American Psychologist, 48*(4), 384.

Fisher, H. E., Brown, L. L., Aron, A., Strong, G., & Mashek, D. (2010). Reward, addiction, and emotion regulation systems associated with rejection in love. *Journal of Neurophysiology, 104*, 51–60.

Foltz, E. L., & White, L. E. (1962). Pain "relief" by frontal cingulumotomy. *Journal of Neurosurgery, 19*, 89–100.

Gündel, H., O'Connor, M.-F., Littrell, L., Fort, C., & Richard, L. (2003). Functional neuroanatomy of grief: An fMRI study. *Journal of Psychiatry, 160,* 1946–1953.

Gunnar, M. R., Bruce, J., & Grotevant, H. D. (2000). International adoption of institutionally reared children: Research and policy. *Development and Psychopathology, 12*, 677–693.

Hadland, K. A., Rushworth, M. F. S., Gaffan, D., & Passingham, R. E. (2003). The effect of cingulate lesions on social behaviour and emotion. *Neuropsychologia, 41*, 919–931.

Handler, C. M., Geller, E. B., & Adler, M. W. (1992). Effect of mu-, kappa-, and delta-selective opioid agonists on thermoregulation in the rat. *Pharmacology Biochemistry and Behavior, 43*, 1209–1216.

Harlow, H. F. (1958). The nature of love. *American Psychologist, 13*, 673–685.

Harlow, H. F., & Zimmermann, R. R. (1959). Affectional responses in the infant monkey. *Science, 130*, 421–432.

Herman, B. H., & Panksepp, J. (1978). Effects of morphine and naxolone on separation distress and approach and approach attachment: Evidence for opiate medication of social affect. *Pharmacology Biochemistry and Behavior, 9*, 213–220.

Higham, J. P., Barr, C. S., Hoffman, C. L., Mandalaywala, T. M., Parker, K. J., & Maestripieri, D. (2011). Mu-opioid receptor (OPRM1) variation, oxytocin levels and maternal attachment in free-ranging rhesus macaques Macaca mulatta. *Behavioral Neuroscience, 125*(2), 131.

Iacoboni, M., Woods, R. P., Brass, M., Bekkering, H., Mazziotta, J. C., & Rizzolatti, G. (1999). Cortical mechanisms of human imitation. *Science, 286*(5449), 2526–2528.

IJzerman, H., & Semin, G. R. (2009). The thermometer of social relations: Mapping social proximity on temperature. *Psychological Science, 20*, 1214–1220.

IJzerman, H., & Semin, G. R. (2010). Temperature perceptions as a ground for social proximity. *Journal of Experimental Social Psychology, 46*(6), 867–873.

Inagaki, T. K., & Eisenberger, N. I. (2013). Shared neural mechanisms underlying social warmth and physical warmth. *Psychological Science, 24*(11), 2272–2280.

Inagaki, T. K., Irwin, M. R., & Eisenberger, N. I. (2015). Blocking opioids attenuates physical warmth-induced feelings of social connection. *Emotion, 15*, 494–500.

Inagaki, T. K., Muscatell, K. A., Moeini, M., Dutcher, J., Jevtic, I., Irwin, M. R., et al. (in press). Yearning for connection?: Loneliness is associated with increased ventral striatum activity to close others. *Social, Cognitive, and Affective Neuroscience.*

Inagaki, T. K., Ray, L. A., Irwin, M. R., Way, B. M., & Eisenberger, N. I. (in press). Opioids and social bonding: Naltrexone reduces feelings of social connection. *Social Cognitive and Affective Neuroscience.*

James, W. (1884). What is an emotion? *Mind, 34*, 188–205.

Jaremka, L. M., Gabriel, S., & Carvallo, M. (2011). What makes us the best also makes us feel the worst: The emotional impact of independent and interdependent experiences. *Self and Identity, 10*, 44–63.

Kalin, N. H., Shelton, S. E., & Barksdale, C. M. (1988). Opiate modulation of separation-induced distress in non-human primates. *Brain Research, 440*, 285–292.

Kang, Y., Williams, L. E., Clark, M., Gray, J. R., & Bargh, J. A. (2011). Physical temperature effects on trust behavior: The role of the insula. *Social Cognitive and Affective Neuroscience, 6*, 507–515.

Kersting, A., Ohrmann, P., Pedersen, A., Kroker, K., Samberg, D., Bauer, J., et al. (2009). Neural activation underlying acute grief in women after their loss of an unborn child. *American Journal of Psychiatry, 166*, 1402–1410.

Kleinginna, P. R., Jr., & Kleinginna, A. M. (1981). A categorized list of emotion definitions, with suggestions for a consensual definition. *Motivation and Emotion, 5*(4), 345–379.

Kross, E., Berman, M. G., Mischel, W., Smith, E. E., & Wager, T. D. (2011). Social rejection shares somatosensory representations with physical pain. *Proceedings of the National Academy of Sciences, 108*, 6270–6275.

Kross, E., Egner, T., Ochsner, K., Hirsch, J., & Downey, G. (2007). Neural dynamics of rejection sensitivity. *Journal of Cognitive Neuroscience, 19*(6), 945–956.

LeDoux, J. (2012). Rethinking the emotional brain. *Neuron, 73*(4), 653–676.

Levine, F. M., Krass, S. M., & Padawer, W. J. (1993). Failure hurts: The effects of stress due to difficult tasks and failure feedback on pain report. *Pain, 54*, 335–340.

Lieberman, M. D. (2007). Social cognitive neuroscience: A review of core processes. *Annual Review of Psychology, 58*, 259–289.

Lieberman, M. D. (2009). What makes big ideas sticky? In M. Brockman (Ed.), *What's next?: Dispatches on the future of science* (pp. 90–103). New York: Vintage Books.

MacDonald, G., & Leary, M. R. (2005). Why does social exclusion hurt?: The relationship between social and physical pain. *Psychological Review, 131*, 202–223.

MacLean, P. D. (1993). Introduction: Perspective on cingulate cortex in the limbic system. In B. A. Vogt & M. Gabriel (Eds.), *Neurobiology of cingulate cortex and limbic thalamus: A comprehensive handbook* (pp. 1–15). Boston: Birkhauser.

MacLean, P. D., & Newman, J. D. (1988). Role of midline frontolimbic cortex in production of the isolation call squirrel monkeys. *Brain Research, 450*, 111–123.

Masten, C. L., Telzer, E. H., Fuligni, A., Lieberman, M. D., & Eisenberger, N. I. (2012). Time spent with friends in adolescence relates to less neural sensitivity to later peer rejection. *Social Cognitive and Affective Neuroscience, 7*, 106–114.

Master, S. L., Eisenberger, N. I., Taylor, S. E., Naliboff, B. D., Shirinyan, D., & Lieberman, M. D. (2009). A picture's worth: Partner photographs reduce experimentally induced pain. *Psychological Science, 20*, 1316–1318.

Meyer, M. L., Williams, K. D., & Eisenberger, N. I. (2015). Why social pain can live on: Different neural mechanisms associated with reliving social versus physical pain. *PLoS One, 10*, e0128294.

Mitchell, J. P. (2008). Contributions of functional neuroimaging to the study of social cognition. *Current Directions in Psychological Science, 17*(2), 142–146.

Moles, A., Kieffer, B. L., & D'Amato, F. R. (2004). Deficit in attachment behavior in mice lacking the mu-opioid receptor gene. *Science, 304*, 1983–1986.

Mowrer, O. H. (1960). *Learning theory and behavior.* New York: Wiley.

Murphy, F. C., Nimmo-Smith, I. A. N., & Lawrence, A. D. (2003). Functional neuroanatomy of emotions: A meta-analysis. *Cognitive, Affective, and Behavioral Neuroscience, 3*(3), 207–233.

O'Connor, M. F., Wellisch, D. K., Stanton, A., Eisenberger, N. I., Irwin, M. R., & Lieberman, M. D. (2008). Craving love?: Enduing grief activates brain's reward center. *NeruoImage, 42*, 969–972.

Olausson, H., Charron, J., Marchand, S., Villemure, C., Strigo, I. A., & Bushnell, M. C. (2005). Feelings of warmth correlate with neural activity in right anterior insular cortex. *Neuroscience Letters, 389*, 1–5.

Olausson, H., Lamarre, Y., Backlund, H., Morin, C., Wallin, B. G., Starck, G., et al. (2002). Unmyelinated tactile afferents signal touch and project to insular cortex. *Nature Neuroscience, 5*, 900–904.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions.* Oxford, UK: Oxford University Press.

Panksepp, J., Herman, B., Conner, R., Bichop, P., & Scott, J. P. (1978). The biology of social attachments: Opiates alleviate separation distress. *Biological Psychiatry, 13*, 607–618.

Parkinson, C., Liu, S., & Wheatley, T. (2014). A common cortical metric for spatial, temporal, and social distance. *Journal of Neuroscience, 34*(5), 1979–1987.

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *NeuroImage, 16*(2), 331–348.

Phillips, H. (2003). The pleasure seekers. *New Scientist, 2416*, 36–40.

Price, D. D., Harkins, S. W., & Baker, C. (1987). Sensory-affective relationships among different types of clinical and experimental pain. *Pain, 28*(3), 297–307.

Robinson, B. W. (1967). Neurological aspects of evoked vocalizations. In S. A. Altmann (Ed.), *Social communication among primates* (pp. 135–147). Chicago: University of Chicago Press.

Rolls, E. T., Grabenhorst, F., & Parris, B. A. (2008). Warm pleasant feelings in the brain. *NeuroImage, 41*, 1504–1513.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39*(6), 1161.

Sherrington, C. S. (1948). *The integrative action of the nervous system.* Cambridge, UK: Cambridge University Press.

Sia, A. T., Lim, Y., Lim, E. C., Goh, R. W., Landau, R., Teo, Y. Y., et al. (2008). A118G single nucleotide polymorphism of human mu-opioid receptor gene influences pain perception and patient-controlled intravenous morphine consumption after intrathecal morphine for postcesarean analgesia. *Anesthesiology, 109*, 520–526.

Silverman, W. A., Fertig, J. W., & Berger, A. P. (1958). The influence of the thermal environment upon the survival of newly born premature infants. *Pediatrics, 22*, 876–886.

Smith, W. (1945). The functional significance of the rostral cingular cortex as revealed by its responses to electrical excitation. *Journal of Neurophysiology, 8*, 241–255.

Spencer, R. L., Hruby, V. J., & Burks, T. F. (1988). Body temperature response profiles for selective mu, delta, and kappa opioid agonists in restrained and unrestrained rats. *Journal of Pharmacology and Experimental Therapeutics, 246*, 92–101.

Stone, E. A., Bonnet, K. A., & Hofer, M. A. (1976). Survival and development of maternally deprived rats: Role of body temperature. *Psychosomatic Medicine, 38*, 242–249.

Takahashi, H., Kato, M., Matsuura, M., Mobbs, D., Suhara, T., & Okubo, Y. (2009). When your gain is my pain and your pain is my gain: Neural correlates of envy and schadenfreude. *Science, 323*, 937–939.

Tow, P. M., & Whitty, C. W. M. (1953). Personality changes after operations on the cingulate gyrus in man. *Journal of Neuorology, Neurosurgery, and Psychiatry, 16*, 186–193.

Treede, R. D., Kenshalo, D. R., Gracely, R. H., & Jones, A. K. P. (1999). The cortical representation of pain. *Pain, 79*, 105–111.

Uddin, L. Q., Iacoboni, M., Lange, C., & Keenan, J. P. (2007). The self and social cognition: The role of cortical midline structures and mirror neurons. *Trends in Cognitive Sciences, 11*(4), 153–157.

Van den Hout, J. H. C., Vlaeyen, J. W. S., Peters, M. L., Engelhard, I. M., & van den Hout, M. A. (2000). Does failure hurt?: The effects of failure feedback on pain report, tolerance and pain avoidance. *European Journal of Pain, 4*, 335–346.

Verhagen, J. V., Kadohisa, M., & Rolls, E. T. (2004). Primate insular/opercular taste cortex: Neuronal representations of the viscosity, fat texture, grittiness, temperature, and taste of foods. *Journal of Neurophysiology, 92*, 1685–1699.

Vytal, K., & Hamann, S. (2010). Neuroimaging support for discrete neural correlates of basic emotions: A voxel-based meta-analysis. *Journal of Cognitive Neuroscience, 22*(12), 2864–2885.

Wager, T. D., Atlas, L. Y., Lindquist, M. A., Roy, M., Woo, C. W., & Kross, E. (2013). An fMRI-based neurologic signature of physical pain. *New England Journal of Medicine, 368*(15), 1388–1397.

Wager, T. D., Phan, K. L., Liberzon, I., & Taylor, S. F. (2003). Valence, gender, and lateralization of functional brain anatomy in emotion: A meta-analysis of findings from neuroimaging. *NeuroImage, 19*(3), 513–531.

Wager, T. D., van Ast, V. A., Hughes, B. L., Davidson, M. L., Lindquist, M. A., & Ochsner, K. N. (2009). Brain mediators of cardiovascular responses to social threat: Part II. Prefrontal–subcortical pathways and relationship with anxiety. *NeuroImage, 47*(3), 836–851.

Way, B. M., Taylor, S. E., & Eisenberger, N. I. (2009). Variation in the mu-opioid receptor gene (OPRM1) is associated with dispositional and neural sensitivity to social rejection. *Proceedings of the National Academy of Sciences, 106*, 15079–15084.

Weber, E. H. (1846). Der Tastsinn und das Gemeingefiihl. In R. Wagner (Ed.), *Handworterbuch des physiologie mit rucksicht auf physiologische pathologie* (Bd 3, Abt 2, pp. 481–588). Braunschweig, Germany: Biewig und Sohn.

Whitman, W. (1855). *Leaves of grass*. Brooklyn, NY: W. Whitman.

Williams, L. E., & Bargh, J. A. (2008). Experiencing physical warmth promotes interpersonal warmth. *Science, 322*, 606–607.

Woo, C. W., Koban, L., Kross, E., Lindquist, M. A., Banich, M. T., Ruzic, L., et al. (2014). Separate neural representations for physical pain and social rejection. *Nature Communications, 5*, 1–12.

Younger, J., Aron, A., Parke, S., Chatterjee, N., & Mackey, S. (2010). Viewing pictures of a romantic partner reduces experimental pain: Involvement of neural reward systems. *PLoS ONE, 5*, 1–7.

Zhong, C., & Leonardelli, G. J. (2008). Cold and lonely: Does social exclusion literally feel cold? *Psychological Science, 19*, 838–842.

CHAPTER 26

Emotion Regulation

A Valuation Perspective

Gaurav Suri and James J. Gross

Imagine a golfer getting ready to putt on the deciding green of an important tournament. He feels nervous, and cannot quite keep his hands completely still. There is a pit in his stomach, and he worries that his mounting anxiety will interfere with the all-important final shot. If only he could find a way to calm down and regain control! Then, he has an idea. He decides to reinterpret his nervous arousal as something that will enable him to be even more focused than usual (as opposed to being a source of disquiet). Thinking about his physiological reactions in this way lessens his anxiety and he more feels more confidence as he gets in position to make the putt.

In this vignette, the golfer's anxiety arose because the golfer *valued* the consequences of a missed putt as being very negative. Many emotions can be similarly thought to result from positive or negative valuations. Emotional responses such as joy, fear, and disgust all have, at their core, a valuation of whether something is good for me or bad for me (see The Emergence of Human Emotions, Chapter 15, this volume). A valuation relevant to an individual's goals triggers a loosely coordinated set of experiential, behavioral, and peripheral physiological responses (Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). Together, these responses constitute an emotion.

Given the major role that emotions play in shaping how we feel about and respond to the world around us, it is no surprise that emotions themselves can become the target of valuation (Ochsner & Gross, 2014). In this vignette, for example, the golfer judged his emotion (anxiety) as having negative value and thereby energized processes that tended to lessen it. In this instance, he was engaging in emotion regulation. Emotion regulation refers to a valuation process that targets another valuation (the one that is generating emotion), assigns this valuation a positive or negative value, and takes action to make the emotion either more or less likely to occur.

In this four-part chapter, we consider emotion regulation from a valuation perspective. In the first part, we describe a multilevel framework that treats emotion as a type of valuation. The second part conceptualizes emotion regulation as a type of meta-valuation. In the third part, we describe the utility of this framework in exploring decisions related to emotion regulation. Finally, in the fourth part, we outline future directions in the field of emotion regulation, emphasizing areas where a valuation-based perspective seems likely to continue to yield exciting new results.

Emotion as a Type of Valuation

According to a valuation perspective, emotions are a particular type of valuation that (1) have a well-specified object (i.e., one is angry about something), (2) unfold over seconds to minutes, and (3) involve coordinated changes in subjective experience, behavior, and physiology (Feldman Barrett, Ochsner, & Gross, 2007; Scherer, Schorr, & Johnstone, 2001). Like other valuation systems, emotions can be said to consist of the four-stage cycle outlined in Figure 26.1 (Ochsner & Gross, 2014).

The *world*, whether external or internal, provides input into the *perception* stage, which takes various types of stimuli as inputs (e.g., sensory or physiological). A *valuation* stage dynamically evaluates the value of these stimuli given the current context (evaluations could range from reflexive/implicit associations to slow/deliberative computations), and an *action* stage consisting of valuation-appropriate responses ranging from covert adjustments of low-level sensory (e.g., increased pupil dilation) or higher-level cognitive processes (e.g., shifts in effortful attention) to overt adjustments of a wide range of response systems (e.g., facial behavior, postural adjustments, sympathetic nervous system activation). These action outputs frequently change the state of the world, and this new state of the world acts as an input for the next world–perception–valuation–action (W-PVA) cycle. Because multiple W-PVA systems are typically active at any given time, these systems interact, and it is these processing dynamics that give rise to behavior.

The World Stage

The changing state of the world provides input to subsequent stages. This input can vary in complexity from low-level perceptual features (e.g., a single musical note) or physiological responses (e.g., sweaty palms) to organized perceptual exemplars (e.g., a room full of people at a party) to abstract constructs such as the self. Targets of valuation range from primary reinforcers—objects that are innately seen as "bad" or "good," like a putrid smell or a sweet drink, to secondary reinforcers—objects that derive their negative or positive value from their association with primary reinforcers, like a wad of cash (Rangel, Camerer, & Montague, 2008; Rolls, 1999).

The Perception Stage

In the perception stage of the W-PVA cycle, sensory systems encode these types of sensory inputs and pass them along to systems for computing value (Kravitz, Saleem, Baker, & Mishkin, 2011).

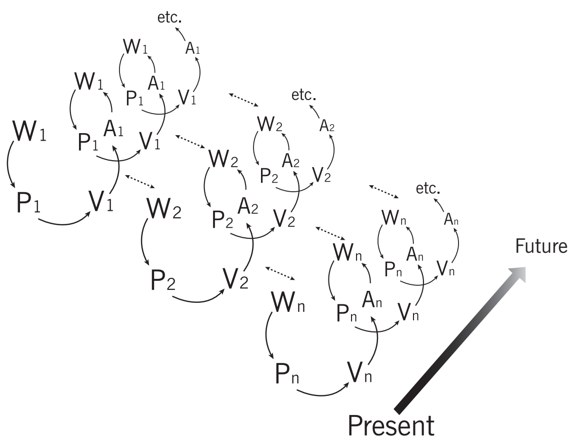

FIGURE 26.1. The perception–valuation–action (PVA) processing cycle that comprises the basic building block of emotion. Multiple PVA cycles can operate at once, here represented with subscripts 1 to *n*. Each cycle is comprises individual PVA sequences that iteratively feed into one another across time (shown here progressively spiraling from the present to the future), thereby comprising a PVA cycle. For each cycle, some set of internal and external stimuli comprising an initial state of the world (W) are represented perceptually (P), values are placed upon them (V), and associated action links (A) are activated that result in a new state of the world that feeds into the next iteration of the PVA processing cycle. PVAs can interact with one another, exciting or inhibiting each other's activation (schematically shown here by double-headed arrows between PVAs). Emotions are specific types of PVA sequences that involve specific types of perceptions, valuations, and actions. From Ochsner and Gross (2014). Copyright 2014 by The Guilford Press. Reprinted by permission.

The Valuation Stage

Valuations consist of a set of interacting processes that compute the badness or goodness of perceptual inputs (Hamann, Ely, Hoffman, & Kilts, 2002; Ochsner & Barrett, 2001; Rangel et al., 2008). Valuations provide a common currency for comparing various objects and events (Levy & Glimcher, 2011). Ochsner and Gross (2014) suggest that multiple valuations are computed for a given stimulus, and these vary along a continuum of representational complexity, with more complex valuations typically taking longer to compute than less complex valuations (Leventhal, 1984).

At the lowest level of this continuum, core valuations are made. These represent relatively direct associations between perceptual inputs and basic physiological and behavioral responses at the action stage (e.g., an approaching snake may often reliably induce a backward step). At an intermediate level, contextual valuations evaluate core inputs while factoring in the historical, social, and motivational contexts of the organism. For example, a familiar snake that is known to be harmless and is not inducing fear in anyone in the room may be valued as neutral (and not induce a backward step). At the highest level of this continuum, conceptual valuations represent appraisals of stimuli that are abstract and often verbalizable. By this we mean representations of evaluations and affective states that are abstracted across exemplars and contexts and are accessible to conscious awareness in the form of "belief–desire" language. For example, a conceptual valuation of a snake may involve activation of a conceptual representation of "fear," which one can verbalize using that word.

The Action Stage

At any given level of valuation, the action impulses associated with a W-PVA cycle can be either mental—like retrieving information from memory, forming a mental image, or introspecting about one's mood, or physical—including overt behaviors like shifts of gaze or starting to run, and autonomic/physiological responses, like heart rate increases or the release of stress hormones (Levenson, 1999).

At any given time multiple valuation computations may be concurrently active. Each valuation system has a particular target domain and creates action tendencies that operate with that particular domain. Sometimes valuation systems suggest complementary action tendencies and at other times they activate action tendencies that oppose each other. For example, a core valuation system may suggest approaching a plate of freshly baked cookies. A conceptual valuation system may support this tendency (if, e.g., one is celebrating a birthday) or oppose it (if, e.g., one is on a diet).

An Example of W-PVA Components Working Together

Imagine you are a passenger in an aircraft. Next to you sits a sleepy old man and a teenager. Suddenly, there is a spurt of turbulence and the plane loses altitude.

In our framework, emotional reactions to this change in the state of the world (altitude loss) can be conceived of as specific kinds of W-PVA sequences derived from particular perceptions, valuations, and associated action impulses (Ortony, Clore, & Collins, 1988). Thus, an initial response may reflect a core-level valuation of the dropping plane that triggers corresponding action impulses that mobilize you to avoid harm (e.g., increased heart rate, instinctively reaching for the seat belt; LeDoux, 2000; Phelps, 2006). As time passes, activation of the contextual level W-PVAs, which dictate other courses of action, can begin to build, and the initial valuation may evolve dynamic valuations of the altitude drop as relatively innocuous or highly dangerous, depending on whether you've previously experienced similar altitude drops (historical context), whether the drop elicits calm or anxious reactions from other passengers (social context), or you are stressed from a sleepless night or just had a great morning (motivational context). Then, at the conceptual level, the action outputs of activated contextual level W-PVAs are taken as inputs to systems that compute a valuation of the altitude drop in belief–desire terms that can—at the action stage—be introspectively accessed or reported to others as the thoughts and feelings you attribute to yourself or others, including, for example, the thoughts that you yourself are brave and that the sleepy old man and the teenager seem really anxious.

The order in which these valuation systems are activated, and their interplay, are not fixed and depend on the circumstances of your encounter with a stimulus. For example, if the pilot has already announced the potential of turbulence, then conceptual valuation systems might evaluate the threat (this will soon stop) and your own level of fear (I'm not scared—yet). As the turbulence continues and the steward straps himself to his seat, contextual systems might be most active as you evaluate the goodness or badness of potential courses of action based on your changing motivational state (increasing anxiety), recent history (the altitude drop is accompanied by an odd thudding sound), and the apparent anxiety of your fellow passengers (who look increasingly afraid). Finally, as the altitude drop suddenly deepens, and the threat level is very high, activation in core valuation systems may escalate to promote defensive actions like freezing, or bracing (Mobbs et al., 2009). The key idea is that taken together, all of these W-PVAs, however they were activated, and each with their associated mental and physical action tendencies, comprise an emotional response.

Emotion Regulation as Metavaluation

Just as emotion can be thought of as a W-PVA sequence, emotion regulation may also be conceptualized as a W-PVA sequence that takes as its input another W-PVA system, namely the one that is generating the underlying emotion. In the airplane example above, we might wish to protect our view of ourselves as unflappable, and thus as a consequence desire to decrease our fear responses. To do this, we can take as objects of valuation the action outputs of W-PVAs that comprise a fear response. When we do this—thereby activating a goal to influence the nature of the emotional response—we are engaging in emotion regulation.

In our framework, emotion regulation is initiated when a W-PVA cycle that gives rise to emotion becomes the object of valuation (see Figure 26.2; Gross & Ochsner, 2014). We propose that this typically happens across levels of valuation, as a higher-level W-PVA places a good or bad valuation on a lower-level W-PVA. It can also happen if there is a high level of conflict between active W-PVAs, such as whether the impulse to flee a potentially dangerous situation conflicts with the impulse to freeze, and a clear set of emotional responses is not activated. We propose that when that happens, the level of conflict constitutes an input to the next W-PVA cycle, and evaluation of that conflict triggers an appropriate course of regulatory action.

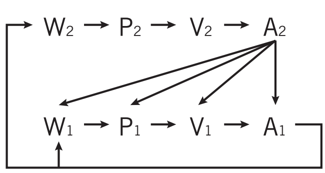

FIGURE 26.2. Emotion regulation is a functional relationship between two PVA sequences in which one (PVA_1) is "generating emotion" and the higher (PVA_2) is taking the first PVA as its "P," valuing it (negatively or positively), and targeting that first PVA for change via its "A." The "A" of PVA_2 enacts an emotion regulation strategy that influences one or more steps of PVA_1. From Ochsner and Gross (2014). Copyright 2014 by The Guilford Press. Reprinted by permission.

It is useful to consider the perception, valuation, and action stages of the higher-level regulatory W-PVA cycle. In the perception stage, the goodness or badness of underlying emotions is observed and emotions requiring regulation are identified. In the valuation stage, potential regulatory strategies are evaluated and an optimal regulatory strategy that best matches situational demands is selected. Finally, in the action stage, the particular tactics of the selected regulatory strategy are activated and implemented.

We have previously argued that emotion regulation processes can be differentiated into five families according to the stage of the emotion-generative process at which they have their primary impact (Gross, 1998). In the context of the present W-PVA framework, this idea may be expressed by suggesting that emotion regulatory processes differ in the stage of the W-PVA sequence at which they have their primary impact. Some strategies influence the state of the world (situation selection, situation modification) and perceptual inputs (attentional deployment). Others influence the valuation step itself (cognitive change). Still others influence the response output associated with activated action sequences (response modulation). By impacting different states of the W-PVA cycle, different strategies impact emotional responding in different ways, as detailed below.

Two complementary points should be made about this view of emotion regulation. First, although we make a PVA-focused distinction among emotion regulation processes, there are higher-order commonalities. For example, for some purposes, the first four emotion regulation families (situation selection, situation modification, attentional deployment, and cognitive change) may be considered antecedent focused, in that they occur before appraisals give rise to full-blown emotional responses. These may be contrasted with response-focused emotion regulation, which occurs after the responses are generated (Gross & Munoz, 1995).

The second point about these distinctions is that what someone does in everyday life to regulate emotions—such as going for a jog to cool down after a big fight with a supervisor—often involves multiple regulatory processes. Similarly, some regulatory processes do not neatly fit into any one of the PVA substeps. For example, in recent years, influential accounts from Eastern philosophy and Buddhism have introduced mindfulness as a form of emotion regulation. Mindfulness involves attending to emotional experiences by focusing on immediate here-and-now aspects with an orientation of curiosity, openness, and acceptance (Bishop et al., 2004). Mindfulness has proven to be an adaptive way to regulate negative emotions and has been incorporated into cognitive treatments of anxiety and depression (Goldin, McRae, Ramel, & Gross, 2008). Recent research suggests that the efficacy of mindfulness stems from increased executive control. This increased executive control is fostered by an improved response to incipient affective cues, which in turn is enabled by mindfulness (Teper, Segal, & Inzlicht, 2013). Despite these complexities, we believe that the W-PVA conceptualization provides a framework useful for understanding the causes, consequences, and mechanisms underlying various forms of emotion regulation.

In the following sections, we review research relevant to each of the five families of emotion regulation processes. Our focus is on emotion regulation processes in adults (see Gross, 2014b; Eisenberg & Morris, 2002; Gross & Thompson, 2007; Thompson, 1994, for a consideration of developmental issues; see John & Gross, 2004, for a consideration of individual differences in emotion regulation).

(State of the) World-Focused Strategies

Situation selection and situation modification are two families of strategies that are focused on the state of the world that leads to the emotion-generative process. Although they differ in important ways, they have in common the fact that they influence or modify the state of the world that acts as input to the emotion-generative W-PVA. *Situation selection* refers to altering the inputs to the W-PVA sequence through decisions about whether to expose oneself to a given situation/stimulus based on its projected affective impact. Thus, situation selection involves taking actions that make it more likely that we will be in a situation we expect will give rise to the emotions we would like to have (or less likely that we will be in a situation that will give rise to emotions we would prefer not to have).

We are often aware of the trajectory our emotions will likely take during a given period of time (e.g., a day) if we do not take steps to influence our emotions. This awareness may motivate us to take steps to alter the default emotional trajectory via situation selection. Thus, we may try hard to avoid situations we know will bring us face to face with an unpleasant acquaintance, or we may actively seek out situations that will provide us with contact with friends when we need a chance to vent and/or share positive emotions. Avoidance processes (such as those used in situation selection) function as a very strong regulatory option that intersects the emotion-generative process at the earliest point. Nevertheless, they can be clearly maladaptive if overused (Campbell-Sills & Barlow, 2007).

Of course, many of our everyday decisions about where to go to lunch and whether or not to go to a social event have implications for how we will later feel, but these decisions are not always determined by our estimates of the valuation of the emotions that these situations will engender. Situation selection refers only to the subset of these choices that consider the future consequences of our actions with respect to our emotional responses.

Situation modification refers to altering the situation one is in, thereby modifying the state of the world that is an input to the W-PVA sequence, and changing the potential emotion (e.g., shifting to a seat near the front of the aircraft where the effects of turbulence are relatively lower).

Similarly, imagine the case of not getting movie tickets to a long-anticipated new-release movie. This situation need not always lead to a negative emotional response. After all, one could always go to a nearby favorite restaurant and enjoy a meal with loved ones. Such efforts to directly modify the situation so as to alter its emotional impact are classified under the strategy of situation modification.

Given the vagueness of the term "situation," it is sometimes difficult to draw a clear distinction between situation selection and situation modification. This is because the W-PVA cycle of situation modification may effectively change the state of the world and call a new situation into being. Nevertheless, it is useful to separate the two strategies since situation selection often refers to entirely avoiding a negative W-PVA cycle, and situation modification often refers to changing some aspect of it. For a socially anxious person, for example, not going to an unwelcome party would be an example of situation selection, and going with a familiar friend would be an example of situation modification.

Perception-Focused Strategies

Attentional deployment refers to a family of perception-focused strategies that seek to alter the perception of the incoming input stream.

Specifically, *attentional deployment* refers to altering the inputs to the W-PVA sequence by increasing or decreasing attention to them (e.g., listening to loud music during turbulence or thinking about how one may remodel one's kitchen). In one form or another, attentional deployment is used from infancy through adulthood, particularly when it is not possible to change or modify one's situation (Rothbart, Ziaie, & O'Boyle, 1992). It is used, for example, by children who are waiting for delayed rewards, and spontaneous use of attentional deployment powerfully affects success during delay-of-gratification tasks (Mischel, Shoda, & Rodriguez, 1989). Attentional deployment may also include physical withdrawal of attention (such as covering the eyes or ears), internal redirection of attention (such as through distraction), and responding to others' redirection of one's attention (such as when a parent redirects a hungry child by having her listen to an interesting story). One of the best-researched forms of attentional deployment is distraction.

Distraction involves a shift in attention either away from emotional aspects of the situation, or away from the situation altogether, such as when an infant shifts its gaze during an overly intense emotional interaction (Stifter & Moyer, 1991). Distraction also may involve a change in internal focus, such as when an individual invokes thoughts or memories that are inconsistent with the undesirable emotional state. Distraction has often been studied in the context of pain, where it leads to increased activation of brain regions associated with cognitive control, such as lateral prefrontal cortical regions, and diminished activation of brain regions associated with pain generation, such as the insula (Ochsner & Gross, 2005).

Another attentional deployment strategy is rumination. Rumination involves directing attention inward, focusing on negative aspects of the self in an abstract, passive, and repetitive way (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008; Watkins, 2008). Rumination could be viewed as asking big "Why?" questions (e.g., "Why am I sad?" "Why do these bad things happen to me?") about the causes of negative events, without a translation into a concrete way to deal with things.

Valuation-Focused Strategies

Reappraisal is an important and extensively researched valuation-based strategy (Gross, 2002). It involves changing the situation's meaning in such a way that there is a change in the person's emotional response to that situation. For example, the golfer from the opening paragraph reappraised the nervous energy he was feeling to make his putt. Similarly, a reappraisal of the plane's drop in altitude may be interpreted as a preventative safety measure taken by the pilot.

To date, studies of reappraisal have focused on quantitative changes in emotion, particularly decreases in negative emotion. These studies have provided evidence that reappraisal leads to decreased negative emotion experience and expressive behavior (Dandoy & Goldstein, 1990; Gross, 1998). Reappraisal also has been shown to lead to decreased startle responses (Dillon & LaBar, 2005), decreased neuroendocrine responses (Abelson, Liberzon, Young, & Khan, 2005), and decreased autonomic responses (Stemmler, 1997). Importantly, comparable effects have been observed when research participants spontaneously use reappraisal, either in a negative emotion-eliciting situation in the lab (Egloff, Schmukle, Burns, & Schwerdtfeger, 2006), or in everyday life (Gross & John, 2003). These findings suggest that studies that manipulate emotion regulation have ecological validity, and provide insights into reappraisal as it naturally occurs in everyday life. Consistent with these behavioral and physiological findings, reappraisal in the service of emotion down-regulation is associated with decreased activation in subcortical emotion-generative regions such as the insula and amygdala (McRae et al., 2010).

Action-Focused Strategies

Response modulation is an action-focused strategy that refers to targeting manifestations of emotion (e.g., playing it cool by not showing fear of the plane's turbulence). Human research primarily has focused on one exemplar of this strategy—expressive suppression—which involves hiding behavioral manifestations of emotion (Gross, 1998). Examples of suppression abound, including our efforts to hide the anger we feel toward a boss, the anxiety we feel during an interview, or the amusement we feel at a coworker's decidedly non-politically-correct joke. Behaviorally, expressive suppression effectively reduces facial expressions of emotion, but the effort and attention required to do so triggers autonomic responses, impairs memory for visual cues, and can negatively impact social interactions (Gross, 1998; Richards & Gross, 2000).

These effects were measurably consequential: for example, the degree of memory impairment associated with suppression was as large as when we instructed participants to distract themselves as much as possible during the presentation of information (Richards & Gross, 2000). Similarly, suppression has been associated with important social costs. Partners of suppressors report less comfort and ease with their interaction partner (Butler et al., 2003). Importantly, the costs that have been associated with instructed suppression in the laboratory also seem to be evident when suppression is used spontaneously in the laboratory (Egloff et al., 2006), during an important life transition (e.g., the transition to college; Srivastava, Tamir, McGonigal, John, & Gross, 2009), and in everyday life (Gross & John, 2003).

The contrast between the outcomes associated with suppression and reappraisal has been extensively studied. The contrast is an interesting one because although both suppression and reappraisal are commonly employed to down-regulate emotion, suppression occurs in the action phase of the W-PVA module in which a person decreases emotion-expressive behavior while emotionally aroused, whereas reappraisal occurs in the earlier valuation phase in which a person tries to think about a situation in a way that alters the emotional response. Since suppression allows the underlying expression to fully develop, whereas reappraisal changes the valuation of the underlying emotion, we would expect the two strategies to have a range of differing outcomes.

Gross (2014b) notes that experimental studies—which allow one to make causal inferences—have shown different affective and cognitive effects of suppression relative to reappraisal. Affectively, suppression leads to decreased positive but not negative emotion experience (Gross, 1998; Gross & Levenson 1993, 1997; Stepper & Strack, 1993), increased sympathetic nervous system responses (Demaree et al., 2006; Gross, 1998; Gross & Levenson, 1993, 1997), and greater activation in emotion-generative brain regions such as the amygdala (Goldin et al., 2008). By contrast, reappraisal leads to decreased levels of negative emotion experience and increased positive emotion experience (Gross, 1998; Lieberman, Inagaki, Tabibnia, & Crockett, 2011; Wolgast, Lundh, & Viborg, 2011); has no impact on, or even decreases, sympathetic nervous system responses (Gross, 1998; Kim & Hammen, 2012); and leads to lesser activation in emotion-generative brain regions such as the amygdala (Goldin et al., 2008; Ochsner & Gross, 2008). Cognitively, suppression leads to worse memory for material presented during the regulation period (Johns, Inzlicht, & Schmader, 2008; Richards, Butler, & Gross, 2003). By contrast, reappraisal either has no impact on subsequent memory, or actually improves it (Richards & Gross, 2000; Hayes et al., 2011), and can be used to enhance performance on standardized exams (Jamieson, Mendes, Blackstock, & Schmader, 2010).

Using the W-PVA Framework to Analyze Emotion Regulation Decisions

At its core, the W-PVA framework focuses on valuation. Many decision-making frameworks also have a primary focus on how options are valued and selected. Not surprisingly, the W-PVA framework parallels several well-regarded frameworks in decision making. For example, Rangel et al. (2008) present a framework according to which (among other decision steps) viable selection options must be identified (representation phase), their value must be computed (valuation phase), and an appropriate action must be selected (action selection phase). March (1994) presents another decision-making framework with strong parallels to the W-PVA framework.

The presence of such decision-making frameworks suggests that it may be possible to use the W-PVA framework to analyze decisions and outcomes related to emotion regulation. There are two important decisions that we focus on in this section: (1) whether or not an emotional episode should be regulated (ER launch decision); and (2) if regulation is chosen, which regulation strategy should be selected for which types of emotion contexts (ER choice decision).

ER Launch Decision: To Regulate or Not to Regulate?

Let us revisit the golf vignette. Imagine that, as before, a golfer had launched a W-PVA sequence in which he negatively valued the consequences of missing the all-important final putt. The output of this W-PVA sequence is anxiety. He could now either launch another—higher-level—W-PVA sequence that takes the underlying emotion (anxiety) as an input, or he could stay with his default current state and leave the anxiety episode to unfold without intervening.

There are at least two ways to think about the golfer's decision. On one view, the golfer may decide based on benefits and costs of either action—regulating or doing nothing. Per this account, it stands to reason that the golfer will regulate his emotions if he derives a clear hedonic benefit from doing so (i.e., decreasing his anxiety that may interfere with his shot) and if the costs of regulation are low. This may often be how individuals approach emotion regulation decisions. On a second view, the golfer may decide to stick with the default (i.e., doing nothing) even if the benefits he derives outweigh the costs of regulation. Per this account, the golfer's default option is influential precisely because it is the default. A recent series of studies have shown that defaults can play an unexpectedly large role in shaping choices concerning emotion regulation initiation (Suri, Whittaker, & Gross, 2014).

Decision theorists have documented several decision contexts in which the default option is disproportionately chosen by decision makers (Dinner, Johnson, Goldstein, & Liu, 2010). A default option is defined as the option that is chosen if the decision maker does not act. Default preferences are seen as a bias because merely designating an option as the default increases the frequency of its selection even though its attractiveness remains unchanged. Such preferences have been observed in many decision domains including organ donation (Johnson & Goldstein, 2003) and patient compliance (Suri, Sheppes, Schwarz, & Gross, 2013). In the present case, the golfer may persist with the default because he did not launch the second-level W-PVA sequence that would have valued his anxiety.

To empirically determine what emotion regulators do in practice, researchers created a decision context in which participants were asked to watch negatively valenced affective images in a series of trials (Suri et al., 2014). On each viewing, they had the option of electing to reappraise in order to decrease negative affect and thus derive hedonic benefits. The cost of choosing to reappraise was a simple button press requiring negligible effort. The task was designed to ensure that participants had no instrumental motives to maintain negative emotion.

When doing nothing was the default option participants chose to regulate in only 16% of trials. However, when participants were required to explicitly choose between watching the image and regulating it (i.e., there was no default option present; participants were required to select one option or the other, each with a button press), their rate of regulation increased to nearly 50%.

When they did regulate, participants did derive hedonic benefits (measured by self-reported affect ratings). Thus it was the influence of the default, and not the absence of benefits from regulation, that (at least in part) drove participant behavior. The above results are consistent with the account that participants often did not launch the second-level W-PVA when doing nothing was the default. Had they launched a second-level W-PVA, they would have either regulated more frequently, or regulated trials would have indicated no benefits. In the context of everyday situations calling for explicit regulation, the default state—by definition—is to do nothing and experience the emotion. The above results suggest that many such everyday situations may go unregulated even though proactive regulation may have offered hedonic benefits.

Research on emotion regulation and psychopathology has suggested that compared with healthy controls, people who suffer from psychological disorders tend to regulate their emotions inadequately (e.g., Kring & Sloan, 2010). The above results suggest that the absence of emotion regulation may sometimes be driven by contextual variables—such as the presence of defaults. If an individual routinely lets emotions remain unregulated, he or she is less likely to overcome the default (of doing nothing), even in cases in which emotion regulation is proactively required. It is possible that there are intrinsic or environmental factors that create more inflexible default behavior in clinical populations.

ER Choice Decision: Which Regulation Strategy Should I Select?

Once again let us revisit the golf vignette. Now imagine that the golfer has decided that he needs to regulate his anxiety before attempting the final putt. What regulatory strategy, or combination of strategies, will he choose? Recent studies

(Sheppes, Schiebe, Suri, & Gross, 2011) have attempted to analyze this decision by limiting their analysis to two examined individuals' choice between two commonly used emotion regulation strategies: distraction and reappraisal.

For example, our golfer could attempt to distract himself by focusing on his breathing; alternatively, he could reappraise the meaning of his nervous energy by thinking of it as a source of focus rather than something that will detract from his shot. Part of his choice may hinge on context-specific factors, such as the type and intensity of his anxiety.

Sheppes and Gross (2011) hypothesized that in low-intensity negative situations, people would show a relative preference to choose to regulate emotions by reappraisal, which allows for emotional processing. However, in high-intensity negative situations, people would show a relative preference to choose to regulate emotions by distraction, which blocks emotional processing at an early stage before it gathers force. Thus, if our golfer was experiencing a low level of anxiety, he would be more likely to reappraise; otherwise he would be more likely to distract.

This hypothesis is consistent with the W-PVA framework. Distraction is a regulatory strategy operating in the perception phase, whereas reappraisal is a regulation strategy operating in the valuation phase. Thus, distraction acts as an "early filter" since it is used to block emotional information before it is represented in working memory for the valuation phase. On the other hand, reappraisal acts as a "late filter." It may be better to perceive and act on high-intensity stimuli before they gather force; lower-intensity stimuli may be better regulated by fuller engagement in the valuation phase.

The intensity hypothesis was empirically tested in decision contexts involving viewing images and receiving shocks. When the image or shock was of high intensity, participants, when asked to pick between reappraisal and distraction, frequently distracted. Conversely, when the image or shock was of low intensity, participants frequently reappraised (Sheppes et al., 2011).

These results as well as other theoretical accounts have emphasized the importance of flexible choice among emotion regulation strategies in the face of different situational demands (Kashdan & Rottenberg, 2010). A lack of flexibility in choosing emotional regulation strategies that are appropriate given contextual demands may result in psychopathology. For example, depression is thought to involve ruminative engagement with high-intensity negative emotional information, whereas anxiety is thought to involve an inflexible disengagement from low-intensity negative emotional information (Sheppes et al., 2011).

Although emotional intensity appears to be a key determinant of emotion regulation choice, other (noncontextual) factors may also play a role. For example, some people have incremental beliefs about emotion, and see emotions as things that can be changed. Others have entity beliefs about emotion, and see emotions as relatively immutable (Gross, 2014a). Those with incremental beliefs seem to utilize emotion regulation more effectively relative to those with entity beliefs. For example, in one study, college students who had incremental beliefs about emotion made greater use of reappraisal, and had a more positive adjustment to college than those with entity beliefs (Tamir, John, Srivastava, & Gross, 2007).

Other determinants of emotion regulation choice likely include person-specific factors such as the availability of cognitive resources, as well as situation-based factors such as situational nudges that may make some forms of emotion regulation easier to implement than others. We believe that the W-PVA framework could be useful is analyzing both types of factors.

Emerging Directions in the Study of Emotion Regulation

This is a time of unmatched excitement for the field of emotion regulation (Gross, 2014b). There has never before been such a focused scientific effort to examine emotion regulation processes, nor has there been such a variety of perspectives brought to bear.

In the following sections, we consider three promising new directions for research in emotion regulation, each of which seems likely to broaden and extend the way we think about emotion regulation, and each of which are informed by the valuation perspective we have adopted in this chapter. The first considers a valuation perspective on other forms of self regulation (not including emotion regulation), the second considers the neural bases of valuation, and the third considers how what we know about emotion regulation can be used to design effective interventions. While by no means exhaustive, these three selections exemplify the promise of emotion regulation research.

Links to Other Forms of Self-Regulation

Emotion is only one type of impulse that must be regulated. People often must also regulate their affect, moods, appetitive impulses, and learned responses. It certainly appears that a valuation framework can be applied in each of these cases. However, are the underlying W-PVA components in these domains similar to those in emotion regulation, or are there crucial differences?

Accounts from the ego control (Block & Block, 1980) and impulsivity (Newman et al., 1993) literatures suggest that there are crucial similarities across domains. Indeed, in the domains of affect and mood, it is possible that superordinate models of affect regulation may be substantially similar to models of emotion regulation.

However, it is less clear how processes that regulate emotional impulses should be distinguished from those that regulate impulses associated with hunger, thirst, aggression, and sexual arousal (Buck, 1985; Loewenstein, 1996). Presumably, the valuation components postulated in emotion are absent, or present in a simplified form, in the context of these appetitive impulses. The similarities and differences across these domains are certain to attract continued interest as researchers from a variety of domains (e.g., weight loss, substance abuse, aggression, emotion regulation) investigate links across different forms of self-regulation. One important way to understand these links is investigate the neural bases of valuation. We next turn to this topic.

Neural Bases of Valuation

Ochsner and Gross (2014) have outlined the brain systems that drive the multiple valuation systems in the context of emotion and emotion regulation discussed in this chapter. Their account leverages recent neuroscience research that has made great strides in describing the neural systems that give rise to emotional responses and those that permit their regulation. It is becoming evident that the neural systems implicated across various literatures—including those concerned with emotion and emotion regulation—are strikingly similar. While some progress has been made in identifying these systems, it is likely to be an area of growing focus. Future work should clarify the number and kind of valuation systems, as well as the rules that govern their engagement in particular contexts. A related direction concerns the inputs and outputs of valuation systems.

In this chapter, we have suggested a class of W-PVA sequences whose inputs are other W-PVA sequences, and whose outputs include the engagement of regulatory processes. However, the range of relevant inputs and outputs and the dynamics of input–output relationships require further study. In particular, it is yet to be understood the factors that contribute to the (nondefault) launching of a second-level W-PVA sequence.

A related direction concerns the efficacy of various forms of value regulation, and how they are intermixed in everyday life. Which "pure" or "hybrid" forms of value regulation are most effective? Other than intensity, what are the contextual variables that shape the effectiveness of particular regulation strategies? Another direction for future research concerns the translation of what we learn to illuminate individual differences. There are many potential sources of individual differences that are suggested by the W-PVA framework. These include (1) the level of initial valuations, (2) the speed with which these valuations are made, (3) the efficiency of conflict resolution among different valuation systems, (4) the process with which learning processes update these valuations, and (5) the capacity and ability to deploy top-down control systems to implement these strategies. One important direction for future research is examining how each of these differences—and others—may interact to produce various forms of psychopathology.

As we deepen our understanding of the neural underpinnings of regulatory processes, we become better positioned to design effective interventions that are driven by emotion regulation.

Emotion Regulation Interventions

Research on regulation, while rapidly growing, must still tackle a number of important questions regarding the psychological processes that are necessary for skillful and flexible emotion regulation. However, what is already known does give us some important starting points for helpful interventions. We consider interventions at the individual, couple, and group levels.

One type of application is individual-level interventions designed to teach healthier patterns of emotion regulation (Gross & Munoz, 1995). Such interventions may focus on both the "why" (creating awareness of the importance of skillful emotion regulation) and the "how" (providing practical skill sets to increase emotion regulation efficacy) of emotion regulation. They may take the form of widely distributable instruction materials or they may include more focused inperson workshops and/or classes designed to improve well-being in the classroom or the workplace.

More specific interventions could target individuals who have clinical diagnoses. For example, recent research suggests that how we view stress (as an enabler or a inhibitor) is a distinct and meaningful variable in determining the stress response (Crum, Salovey, & Achor, 2013). This suggests that future interventions designed to alter stress-related mind-sets may prove fruitful. Similarly, attention bias modification interventions that are designed to directly modify attention and interpretation biases via repeated practice on cognitive tasks are showing promise in the treatment of anxiety and mood disorders (Beard, 2011).

Another type of intervention is applicable to couples and/or to small groups of individuals. Many marriages and romantic relationships are important contributors to well-being. Researchers used a reappraisal-based intervention to attempt to arrest the normative decline in marital quality over time (Finkel, Slotter, Luchies, Walton, & Gross, 2012). The effectiveness of a brief (21-minute) intervention was mediated through reductions in conflict-related distress over time. This study suggests that theory-based, social-psychological interventions may preserve the quality of intimate relationships over time.

A third type of application involves making larger changes in the physical and social worlds in which we live. An example of this class of interventions comes from applying an emotion regulation perspective to seemingly intractable global conflicts (Halperin & Gross, 2011). These conflicts are characterized by high levels of negative emotions that powerfully shape attitudes and behaviors of each of the parties to the conflict. In particular, negative group-based emotions—emotions that arise as a result of belonging to a certain group—can lead to the commencement and maintenance of hostilities, and then block progress toward a peaceful solution to the ongoing conflict. Our prior W-PVA analysis has focused on the individual as the value-computing unit. However, it is possible that W-PVA analysis may focus on the group as the unit of analysis. Taking this approach may help yield valuable insights into how group-based emotions arise, and how they might be regulated.

Group-based emotion and emotion regulation certainly seem to be important factors in contemporary conflicts. For example, in the ongoing Israeli–Palestinian conflict, a nationwide survey of Jewish Israeli adults was conducted during one of the wars between Israelis and Palestinians. This survey assessed both reappraisal use and attitudes toward providing humanitarian aid to Palestinian citizens. Findings indicated that Israelis who regulated their negative emotions during the war by using reappraisal were more supportive of providing humanitarian aid than Israelis who did not use reappraisal (Halperin & Gross, 2011). Overall, these findings suggest that interventions based on an emotion regulation perspective can be helpful to individuals, couples, and groups.

Summary

Emotions have been said to represent the "wisdom of the ages" (Lazarus, 1991, p. 820), and many theoretical approaches to emotion have rightly emphasized its many adaptive benefits. But emotions are not always helpful, and in the last two decades, there has been a dramatic increase in the attention that's been given to how emotions can be regulated so as to help people benefit from what is useful about them, but avoid what is not useful.

In this chapter, we have conceived of emotion as a type of W-PVA sequence, in which a particular state of the world constitutes a perceptual input that is valued (negatively or positively), leading to an impulse to alter ongoing behavioral or cognitive responses. We have conceived emotion regulation another W-PVA sequence that takes the emotion-generation W-PVA as its "W" and "P," valuing it (negatively or positively), and targeting that first W-PVA for change via its "A." This W-PVA conception allowed us to classify the five families of emotion regulation strategies as being either concerned with modifying the state of the world (situation selection and situation modification), the perception of the emerging emotion (attentional deployment), changing its valuation (cognitive reappraisal), or altering action (response modulation). Additionally we were able to analyze decisions related to emotion regulation (i.e., whether to regulate or not and which regulation strategy to select) using the perception, valuation, and action components. Finally, the W-PVA framework was a useful tool in analyzing emerging directions in the growing field of emotion regulation.

References

Abelson, J. L., Liberzon, I., Young, E. A., & Khan, S. (2005). Cognitive modulation of the endocrine stress response to a pharmacological challenge in normal and panic disorder subjects. *Archives of General Psychiatry, 62*, 668–675.

Beard, C. (2011). Cognitive bias modification for anxiety: Current evidence and future directions. *Expert Review of Neurotherapeutics, 11*, 299–311.

Bishop, S. R., Lau, M., Shapiro, S., Carlson, L., Anderson, N. D., Carmody, J., et al. (2004). Mindfulness: A proposed operational definition. *Clinical Psychology: Science and Practice, 11*, 230–241.

Block, J. H., & Block, J. (1980). The role of ego-control and ego-resiliency in the organization of behavior. In W. A. Collins (Ed.), *Development of cognition, affect, and social relations: The Minnesota Symposia on Child Psychology* (Vol. 13, pp. 39–51). Hillsdale, NJ: Erlbaum.

Buck, R. (1985). Prime theory: An integrated view of motivation and emotion. *Psychological Review, 92*, 389–413.

Butler, E. A., Egloff, B., Wilhelm, F. W., Smith, N. C., Erickson, E. A., & Gross, J. J. (2003). The social consequences of expressive suppression. *Emotion, 3*, 48–67.

Campbell-Sills, L., & Barlow, D. H. (2007). Incorporating emotion regulation into conceptualizations and treatments of anxiety and mood disorders. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 542–559). New York: Guilford Press.

Crum, A. J., Salovey, P., & Achor, S. (2013). Rethinking stress: The role of mindsets in determining the stress response. *Journal of Personality and Social Psychology, 104*(4), 716.

Dandoy, A. C., & Goldstein, A. G. (1990). The use of cognitive appraisal to reduce stress reactions: A replication. *Journal of Social Behavior and Personality, 5*, 275–285.

Demaree, H. A., Schmeichel, B. J., Robinson, J. L., Pu, J., Everhart, D. E., & Berntson, G. G. (2006). Up- and down-regulating facial disgust: Affective, vagal, sympathetic, and respiratory consequences. *Biological Psychology, 71*, 90–99.

Dillon, D. G., & LaBar, K. S. (2005). Startle modulation during conscious emotion regulation is arousal-dependent. *Behavioral Neuroscience, 119*, 1118–1124.

Dinner, I., Johnson, E. J., Goldstein, D. G., & Liu, K. (2011). Partitioning default effects: Why people choose not to choose. *Journal of Experimental Psychology: Applied, 17*, 332.

Egloff, B., Schmukle, S. C., Burns, L. R., & Schwerdtfeger, A. (2006). Spontaneous emotion regulation during evaluated speech tasks: Associations with negative affect, anxiety expression, memory, and physiological responding. *Emotion, 6*, 356–366.

Eisenberg, N., & Morris, A. S. (2002). Children's emotion-related regulation. *Advances in Child Development and Behavior, 30*, 189–229.

Feldman Barrett, L., Ochsner, K. N., & Gross, J. J. (2007). Automaticity and emotion. In J. A. Bargh (Ed.), *Social psychology and the unconscious* (pp. 173–218). New York: Psychology Press.

Finkel, E. J., Slotter, E. B., Luchies, L. B., Walton, G. M., & Gross, J. J. (2013). A brief intervention to promote conflict reappraisal preserves marital quality over time. *Psychological Science, 24*(8), 1595–1601.

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: Reappraisal and suppression of negative emotion. *Biological Psychiatry, 63*, 577–586.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*, 271–299.

Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology, 39*, 281–291.

Gross, J. J. (2014a). Emotion regulation: Conceptual and empirical foundations. In J. J. Gross (Ed.), *Handbook of emotion regulation* (2nd ed., pp. 3–20). New York: Guilford Press.

Gross, J. J. (2014b). *Handbook of emotion regulation* (2nd ed.). New York: Guilford Press.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*, 348–362.

Gross, J. J., & Levenson, R. W. (1993). Emotional suppression: Physiology, self-report, and expressive behavior. *Journal of Personality and Social Psychology, 64*, 970–986.

Gross, J. J., & Levenson, R. W. (1997). Hiding feelings: The acute effects of inhibiting positive and negative emotions. *Journal of Abnormal Psychology, 106*, 95–103.

Gross, J. J., & Munoz, R. F. (1995). Emotion regulation and mental health. *Clinical Psychology: Science and Practice, 2*, 151–164.

Gross, J. J., & Thompson, R. A. (2007). Emotion regulation: Conceptual foundations. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 3–24). New York: Guilford Press.

Halperin, E., & Gross, J. J. (2011). Emotion regulation in violent conflict: Reappraisal, hope, and support for humanitarian aid to the opponent in wartime. *Cognition and Emotion, 25*(7), 1228–1236.

Hamann, S. B., Ely, T. D., Hoffman, J. M., & Kilts, C. D. (2002). Ecstasy and agony: Activation of the human amygdala in positive and negative emotion. *Psychological Science, 13*(2), 135–141.

Hayes, J. P., Morey, R. A., Petty, C. M., Seth, S., Smoski, M. J., McCarthy, G., et al. (2011). Staying cool when things get hot: Emotion regulation modulates neural mechanisms of memory encoding. *Frontiers in Human Neuroscience, 4*, 1–10.

Jamieson, J. P., Mendes, W. B., Blackstock, E., & Schmader, T. (2010). Turning the knots in your stomach into bows: Reappraising arousal improves performance on the GRE. *Journal of Experimental Social Psychology, 46*, 208–212.

John, O. P., & Gross, J. J. (2004). Healthy and unhealthy emotion regulation: Personality processes, individual differences, and lifespan development. *Journal of Personality, 72*, 1301–1334.

Johns, M. J., Inzlicht, M., & Schmader, T. (2008). Stereotype threat and executive resource depletion: Examining the influence of emotion regulation. *Journal of Experimental Psychology: General, 137*, 691–705.

Johnson, E., & Goldstein, D. (2003). Do defaults save lives? *Science, 302*, 1338–1339.

Kashdan, T. B., & Rottenberg, J. (2010). Psychological flexibility as a fundamental aspect of health. *Clinical Psychology Review, 30*(7), 865–878.

Kim, S. H., & Hamann, S. (2012). The effect of cognitive reappraisal on physiological reactivity and emotional memory. *International Journal of Psychophysiology, 83*, 348–856.

Kravitz, D. J., Saleem, K. S., Baker, C. I., & Mishkin, M. (2011). A new neural framework for visuospatial processing. *Nature Review Neuroscience, 12*(4), 217–230.

Kring, A. M., & Sloan, D. S. (2010). *Emotion regulation and psychopathology*. New York: Guilford Press.

Lazarus, R. S. (1991). Progress on a cognitive–motivational–relational theory of emotion. *American Psychologist, 46*, 819–834.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience, 23*, 155–184.

Levenson, R. W. (1999). The intrapersonal functions of emotion. *Cognition and Emotion. Special Issue: Functional Accounts of Emotion, 13*(5), 481–504.

Leventhal, H. (1984). A perceptual-motor theory of emotion. *Advances in Experimental Social Psychology, 17*, 117–182.

Levy, D. J., & Glimcher, P. W. (2011). Comparing apples and oranges: Using reward-specific and reward-general subjective value representation in the brain. *Journal of Neuroscience, 31*(41), 14693–14707.

Lieberman, M. D., Inagaki, T. K., Tabibnia, G., & Crockett, M. J. (2011). Subjective responses to emotional stimuli during labeling, reappraisal, and distraction. *Emotion, 11*, 468–480.

Loewenstein, G. (1996). Out of control: Visceral influences on behavior. *Organizational Behavior and Human Decision Processes, 65*, 272–292.

March, J. G. (1994). *Primer on decision making: How decisions happen*. New York: Simon & Schuster.

Mauss, I. B., Levenson, R. W., McCarter, L., Wilhelm, F. H., & Gross, J. J. (2005). The tie that binds?: Coherence among emotion experience, behavior, and physiology. *Emotion, 5*(2), 175–190.

McRae, K., Hughes, B., Chopra, S., Gabrieli, J. J. D., Gross, J. J., & Ochsner, K. N. (2010). The neural correlates of cognitive reappraisal and distraction: An fMRI study of emotion regulation. *Journal of Cognitive Neuroscience, 22*, 248–262.

Mischel, W., Shoda, Y., & Rodriguez, M. L. (1989). Delay of gratification in children. *Science, 244*, 933–938.

Mobbs, D., Hassabis, D., Seymour, B., Marchant, J. L., Weiskopf, N., Dolan, R. J., et al. (2009). Choking on the money: Reward-based performance decrements are associated with midbrain activity. *Psychological Science, 20*(8), 955–962.

Newman, J. P., Wallace, J. F., Strauman, T. J., Skolaski, R. L., Oreland, K. M., Mattek, P. W., et al. (1993). Effects of motivationally significant stimuli on the regulation of dominant responses. *Journal of Personality and Social Psychology, 1*, 165–175.

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science, 3*, 400–424.

Ochsner, K. N., & Barrett, L. F. (2001). A multiprocess perspective on the neuroscience of emotion. In T. J. Mayne & G. A. Bonanno (Eds.), *Emotions: Currrent issues and future directions* (pp. 38–81). New York: Guilford Press.

Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Sciences, 9*(5), 242–249.

Ochsner, K. N., & Gross, J. J. (2008). Cognitive emotion regulation: Insights from social cognitive and affective neuroscience. *Current Directions in Psychological Science, 17*, 153–158.

Ochsner, K. N., & Gross, J. J. (2014). The neural bases of emotion and emotion regulation: A valuation perspective. In J. J. Gross (Ed.), *Handbook of emotion regulation* (2nd ed., pp. 23–42). New York: Guilford Press.

Ortony, A., Clore, G. L., & Collins, A. (1988). *The cognitive structure of emotions*. New York: Cambridge University Press.

Phelps, E. A. (2006). Emotion and cognition: Insights from studies of the human amygdala. *Annual Review of Psychology, 57*, 27–53.

Rangel, A., Camerer, C., & Montague, P. R. (2008). A framework for studying the neurobiology of value-based decision making. *Nature Review Neuroscience, 9*(7), 545–556.

Richards, J. M., Butler, E., & Gross, J. J. (2003). Emotion regulation in romantic relationships: The cognitive consequences of concealing feelings. *Journal of Personal and Social Relationships, 20*, 599–620.

Richards, J. M., & Gross, J. J. (2000). Emotion regulation and memory: The cognitive costs of keeping one's cool. *Journal of Personality and Social Psychology, 79*, 410–424.

Rolls, E. T. (1999). *The brain and emotion*. Oxford, UK: Oxford University Press.

Rothbart, M. K., Ziaie, H., & O'Boyle, C. G. (1992). Self-regulation and emotion in infancy. In N. Eisenberg & R. A. Fabes (Eds.), *Emotion and its regulation in early development* (pp. 7–23). San Francisco: Jossey-Bass.

Scherer, K. R., Schorr, A., & Johnstone, T. (Eds.). (2001). *Appraisal processes in emotion: Theory, methods, research*. New York: Oxford University Press.

Sheppes, G., & Gross, J. J. (2011). Is timing everything?: Temporal considerations in emotion regulation. *Personality and Social Psychology Review, 15*, 319–331.

Sheppes, G., Scheibe, S., Suri, G., & Gross, J. J. (2011). Emotion-regulation choice. *Psychological Science, 22*, 1391–1396.

Srivastava, S., Tamir, M., McGonigal, K. M., John, O. P.,

& Gross, J. J. (2009). The social costs of emotional suppression: A prospective study of the transition to college. *Journal of Personality and Social Psychology, 96*(4), 883.

Stemmler, G. (1997). Selective activation of traits: Boundary conditions for the activation of anger. *Personality and Individual Differences, 22*, 213–233.

Stepper, S., & Strack, F. (1993). Proprioceptive determinants of emotional and nonemotional feelings. *Journal of Personality and Social Psychology, 64,* 211–220.

Stifter, C. A., & Moyer, D. (1991). The regulation of positive affect: Gaze aversion activity during mother–infant interaction. *Infant Behaviors and Development, 14*, 111–123.

Suri, G., Sheppes, G., Schwartz, C., & Gross, J. J. (2013). Patient inertia and the status quo bias: When an inferior option is preferred. *Psychological Science, 24*, 1763–1769.

Suri, G., Whittaker, K., & Gross, J. J. (2014). *Choosing to reappraise: It's less common than you might think*. Manuscript submitted for publication.

Tamir, M., John, O. P., Srivastava, S., & Gross, J. J. (2007). Implicit theories of emotion: Affective and social outcomes across a major life transition. *Journal of Personality and Social Psychology, 92*(4), 731.

Teper, R., Segal, Z. V., & Inzlicht, M. (2013). Inside the mindful mind. *Current Directions in Psychological Science, 22*(6), 449–454.

Thompson, R. A. (1994). Emotion regulation: A theme in search of definition. In N. A. Fox (Ed.), *The development of emotion regulation: Biological and behavioral considerations* (Vol. 59, pp. 25–52). Chicago: Monographs of the Society for Research in Child Development.

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*, 163–206.

Wolgast, M., Lundh, L.-G., & Viborg, G. (2011). Cognitive reappraisal and acceptance: An experimental comparison of two emotion regulation strategies. *Behaviour Research and Therapy, 49*, 858–866.

CHAPTER 27

Expression of Emotion

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The study of emotional expression has long been the provenance of scientific discovery and heated controversy. It has spurred advances in studies of emotion-related physiology (Matsumoto, Keltner, Shiota, O'Sullivan, & Frank, 2008), mammalian social behavior (Snowdon, 2003), cultural variation in emotion (Matsumoto, Olide, Schug, Willingham, & Callan, 2009), and evolutionary treatments of emotion (Shariff & Tracy, 2011). Alongside these discoveries are controversies that have propelled the science of expression forward. Questions persist about what kind of information expressions signal—feeling states, intentions, or both (Fridlund, 1991); the inferences to be drawn from emotion recognition data (Barrett, 2011; Russell, 1994); and the extent to which subjective feeling necessarily accompanies expressive behavior (Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). More recently, attention has turned to how contextual factors shape the interpretation of emotional expression (Barrett, Lindquist, & Gendron, 2007; Barrett, Mesquita, & Gendron, 2011).

In the last edition of this volume, this review centered on what has been learned about expression from a basic emotions perspective (Matsumoto et al., 2008). That review summarized discoveries related to the display of emotional behavior in other species; the covariations among expressive behavior, subjective experience, and physiology for a limited set of emotions; and the universality and cultural variations in labeling expressive behavior. Advances continue in those areas of inquiry, but in many ways the past 10 years has seen the study of expression broaden in consequential ways.

In the present review, we bring into focus these new directions in the study of emotional expression, concentrating on four emergent themes. A first is that signalling behavior is associated with a broader array of emotions than initially considered in early studies of emotional expression (e.g., Ekman, 1992). A second is the interest in new modalities of expression: studies of facial muscle movement and emotional speech prosody are increasingly complemented by an attention to vocal bursts, bodily movement, tactile contact, autonomic responses, and artistic forms of expression, including dance, music, and drawing. Our third focus is on how expressions of emotion shape social interactions. This idea traces back to ethologists' observations of how emotional expressions structure ritualized social interactions in remote peoples in the naturalistic contexts of their daily living, and is being actively pursued in laboratory research. And finally, we explore new advances in studies of the inferences that people draw in judging emotional displays. New theoretical developments have sought to capture how the perception of expressive behavior is shaped by contextual, cultural, and individual difference factors, a theme we bring into focus in the last section of this review (Barrett et al., 2011).

New Expressions of Emotion: A Widening Landscape of Emotional Expression

In 1872, Charles Darwin published *The Expression of the Emotions in Man and Animals*, which influenced profoundly the scientific search for the characteristic patterns of behavior that signal different emotions, their universality, and their origins in display behaviors of mammalian species (Ekman, 1998; Barrett, 2011; Shariff & Tracy, 2011). In Table 27.1, we represent the specific behaviors Darwin observed to be associated with positive emotional states (see Keltner, 2009).

One sees that Darwin (1872/1998) concerned himself with a wide array of states; in fact, over 40 in all (those in Table 27.1 are just the positive ones he referred to in his analysis). These states may cluster in emotion families, and represent variations or subtypes of one emotion (e.g., Ekman, 1992; Sauter, Gangi, McDonald, & Messinger, 2014). But clearly, Darwin cast his net much more

TABLE 27.1. Darwin's Descriptions of Expressive Behaviors Associated with Positive States

Admiration	Eyes opened, eyebrows raised, eyes bright, smile
Affirmation	Nod head, open eyes widely
Astonishment	Eyes open, mouth open, eyebrows raised, hands placed over mouth
Contemplation	Frown; wrinkle skin under lower eyelids; eyes divergent; head droops; hands to forehead, mouth, or chin; thumb/index finger to lip
Determination	Firmly closed mouth, arms folded across breast, shoulders raised
Devotion (reverence)	Face upward, eyelids upturned, fainting, pupils upward and inward, humbling kneeling posture, hands upturned
Happiness	Eyes sparkle, skin under eyes wrinkled, mouth drawn back at corners
High spirits, cheerfulness	Smile, body erect, head upright, eyes open, eyebrows raised, eyelids raised, nostrils raised, eating gestures (rubbing belly), air suck, lip smacks
Joy	Muscle tremble, purposeless movements, laughter, clapping hands, jumping, dancing about, stamping, chuckle/giggle, smile, muscle around eyes contracted, upper lip raised
Laughter	Tears, deep inspiration, contraction of chest, shaking of body, head nods to and fro, lower jaw quivers up/down, lip corners drawn backward, head thrown backward, shakes, head/face red, muscle around eyes contracted, lip press/bite
Love	Beaming eyes, smiling cheeks (when seeing old friend), touch, gentle smile, protruding lips (in chimps), kissing, nose rubs
Maternal love	Touch, gentle smile, tender eyes
Pride	Head, body erect, look down on others
Romantic love	Breathing hurried, faces flush
Surprise	Eyebrows raised, mouth open, eyes open, lips protruded, expiration, blowing/hissing, open hands high above head, palms toward person with straightened fingers, arms backward
Tender (sympathy)	Tears

broadly than the six or seven states that were of intensive focus in the early literature on facial expression.

In the past 10 years, scientific progress has been made in charting expressive behaviors of a wider array of emotions. Some studies have documented the expressive behaviors that covary with the experience of a specific emotion (see Matsumoto et al., 2008, for a review). Other studies have examined the patterns of behavior individuals emit when given different emotion concepts (e.g., "awe" or "love") and asked to express the emotion using their face, voice, or body. And emotion recognition studies have ascertained whether naïve observers can reliably identify emotions from patterns of expressive behavior.

From evidence generated by these methods, a case can be made for several "new" displays beyond the six traditionally studied. Here we profile a few more specific studies (see Table 27.2, for a synthesis of the literature). To establish whether self-conscious emotions would elicit unique nonverbal displays, Keltner (1995) coded muscle-by-muscle actions of participants who became embarrassed after making a silly face on camera. Careful frame-by-frame analysis uncovered a fleeting but highly

TABLE 27.2. Evidence Related to the Expression of Emotion in Different Modalities

Emotion	Face	Voice	Touch	Music	Dance
Amused	Yes[a,b,d,i]	Yes[y,z,bb]	n/a	n/a	Yes[gg]
Anger	Yes[d,w,x]	Yes[y,aa,bb]	Yes[dd,ee]	Yes[ff]	Yes[gg]
Awe	Yes[a,c,d]	Yes[y]	No	n/a	Yes[gg]
Boredom	Yes[n]	Yes[aa]	n/a	n/a	n/a
Confused	Yes[n,u]	n/a	n/a	n/a	n/a
Contempt	Yes[v,w]	Yes[y,aa]	n/a	n/a	n/a
Content	Yes[d]	Yes[z]	n/a	n/a	Yes[gg]
Coy	Yes[e,f,g]	n/a	n/a	n/a	n/a
Desire	Yes[h,i]	No[y]	n/a	n/a	n/a
Disgust	Yes[d,w,x]	Yes[y,aa,bb]	Yes[dd,ee]	n/a	Yes[gg]
Embarrassed	Yes[d,i,j,k,l]	Yes[y]	No[ee]	n/a	Yes[gg]
Fear	Yes[d,w,x]	Yes[y,aa,bb]	Yes[dd,ee]	Yes[ff]	Yes[gg]
Gratitude	n/a	No[y]	Yes[dd,ee]	n/a	n/a
Happiness	Yes[i,w,x]	Yes[aa]	Yes[dd]	Yes[ff]	n/a
Interested	Yes[i,m,n]	Yes[y]	n/a	n/a	n/a
Love	Yes[d,i]	No[y]	Yes[dd,ee]	Yes[ff]	Yes[gg]
Pain	Yes[o,p,q,r]	Yes[cc]	n/a	n/a	n/a
Pride	Yes[a,i]	No[y]	No[ee]	n/a	n/a
Relief	n/a	Yes[y,z,aa,bb]	n/a	n/a	n/a
Sadness	Yes[d,w,x]	Yes[y,bb]	Yes[dd,ee]	Yes[ff]	Yes[gg]
Shame	Yes[d,i,t]	No[y]	n/a	n/a	Yes[gg]
Surprise	Yes[w,x]	Yes[y,bb,ee]	No[ee]	n/a	n/a
Sympathy	Yes[i]	Yes[y]	Yes[dd,ee]	n/a	n/a
Triumph	n/a	Yes[y]	n/a	n/a	n/a

[a]Shiota, Campos, & Keltner (2003); [b]Keltner & Bonanno (1997); [c]Shiota, Keltner, & Mossman (2007); [d]Hejmadi, Davidson, & Rozin (2000); [e]Reddy (2000); [f]Reddy (2005); [g]Bretherton & Ainsworth (1974); [h]Gonzaga et al. (2006); [i]Keltner & Shiota (2003); [j]Keltner & Buswell (1997); [k]Keltner (1996); [l]Ekman & Rosenberg (1997); [m]Silvia (2008); [n]Reeve (1993); [o]Prkachin (1992); [p]Williams (2002); [q]Grunau & Craig (1987); [r]Botvinick et al. (2005); [s]Tracy & Robins (2004); [t]Tracy & Matsumoto (2008); [u]Rozin & Cohen (2003); [v]Ekman & Friesen (1986); [w]Ekman (1992); [x]Levenson, Ekman, & Friesen (1990); [y]Simon-Thomas et al. (2009); [z]Sauter & Scott (2007); [aa]Schröder (2003); [bb]Sauter, Eisner, Ekman, et al. (2010); [cc]Dubois, Bringuier, Capdevilla, et al. (2008); [dd]Hertenstein et al. (2009); [ee]Hertenstein et al. (2006); [ff]Juslin & Laukka (2003); [gg]Hejmadi et al. (2000); [hh]Piff et al., (2012).

coordinated 2- to 3-second display, which involved gaze aversion, controlled smiles, and partial face covering with one hand (Edelmann & Hampson 1979; Harris, 2001).

Other experiments sought to analyze self-conscious displays that accompany gaining or losing status (Tracy & Robins, 2004, 2007; Tracy & Matsumoto, 2008). Tracy and Robins (2004, 2007) documented expansive postures coincident with the emotion of pride, as well as head movements up and back, and expansive arm thrusts upward, or outward in an akimbo position with hands on hips. This expansive display, reliably recognized as pride by children and adults (Tracy, Robins, & Lagattuta, 2005), is the direct opposite of the shame display, which involves head tilt downward, eye gaze downward, and posture turned inward (Keltner, 1995; Haidt & Keltner, 1999; Izard, 1971; Tracy & Matsumoto, 2008). Images of both pride and shame displays were reliably recognized in both industrialized cultures and remote small-scale societies in Burkina Faso and Fiji (Tracy & Robins, 2008; Tracy, Shariff, Zhao, & Henrich, 2013). These expressions of pride and shame are also reliably displayed in response to success and failure, respectively, by children and adults (Lewis, Alessandri, & Sullivan, 1992).

Conceptual analyses of attachment processes emphasize distinctions among love, desire, and compassion or sympathy that enable specific attachments to reproductive partners and offspring (Bowlby, 1969). Guided by these claims, studies have found that when feeling romantic love, individuals show coordinated sequences of genuine smiling, mutual gaze, affiliative hand gestures, open posture, and leaning forward (Gonzaga, Keltner, Londahl, & Smith, 2001), a pattern of behavior found to covary with oxytocin release (Gonzaga, Turner, Keltner, Campos, & Altemus, 2006), and to occur when people are given the term "love" and asked to express or embody it in nonverbal behavior (e.g., Campos, Shiota, Keltner, Gonzaga, & Geotz, 2013). By contrast, individuals' reports of desire correlate with a different pattern of behavior that includes lip licks, bites, and puckering. Reactions to the suffering of others and experiences of sympathy are correlated with oblique eyebrows, concerned gaze, and approach behaviors such as forward leans (Eisenberg et al., 1989; Goetz, Keltner, & Simon-Thomas, 2010).

Still other studies have identified facial displays of awe (Campos et al., 2013), coyness (Reddy, 2000), pain (Prkachin, 1992; Grunau & Craig, 1987; Botvinick et al., 2005), and amusement (Ruch & Ekman, 2001). Different smiles accompany different positive states (Sauter et al., 2014). For example, in one recent study participants were given descriptions of eight different positive emotions—amusement, awe, interest, joy, love, pride, gratitude, and contentment—and asked to express these emotions nonverbally (Campos et al., 2013). Coding of these patterns of behaviors with Ekman and Friesen's (1978) Facial Action Coding System (FACS) found distinctions in the displays of all these emotions except gratitude, and several of the expressive behaviors observed in this paradigm replicated those observed in other investigations (see also Mortillaro, Mehu, & Scherer, 2011; Sauter, 2010).

Building upon studies of emotional prosody (Nelson & Russell, 2011a; Banse & Scherer, 1996), a similar broadening of the range of states shown to have signals has emerged in the study of emotion-related vocalization (Sauter & Scott, 2007; Sauter, Eisner, Calder & Scott 2010; Simon-Thomas, Keltner, Sauter, Sinicropi-Yao, & Abramson, 2009). In one illustrative study, participants read descriptions of 22 different emotions, and then produced "vocal bursts"—sighs, growls, grunts, and laughs—to convey each emotion (Simon-Thomas et al., 2009). Naïve observers could reliably identify several understudied emotional states, including awe, interest, relief, sensory pleasure, enthusiasm, sympathy, triumph, and contempt, from these vocal bursts. Other studies have documented similarly high rates of identification of emotion vocal bursts conveying triumph, amusement, contentment, sensory pleasure, and relief (Sauter & Scott, 2007).

Sauter, Eisner, Ekman, and Scott (2010) performed a two-way cross-cultural vocalization experiment with U.K. participants and members of the Himba, a culturally isolated group in Namibia. The vocal bursts collected from both cultures were decoded bidirectionally with above-chance accuracy ratings for anger, disgust, fear, sadness, and surprise. In addition, vocalizations of amusement were recognized across cultures, and relief expressions were similar, although not bidirectionally recognized. These findings have recently been replicated and extended by Laukka and colleagues (2013), who recorded emotional vocalizations of 18 emotions from actors in India, Kenya, Singapore, and the United States. Swedish participants performed well in identifying emotions that had been well recognized in Sauter, Eisner, Ekman, et al.'s (2010) study, and also could identify interest, lust, relief, and serenity from brief vocal bursts (but see Gendron, Roberson, van der Vyver, & Barrett, 2014; Gendron, Roberson, & Barrett, 2015).

Synthesizing these new studies, in Table 27.2 we present the states that can be signaled with reliable patterns of behavior, at least in one modality. It is clear the field is moving beyond the original six or seven emotions so sharply in focus in early studies of expression to a much broader landscape of emotion, one that likely includes over 10 signals each of positive and negative emotion.

Beyond the Face and Voice: Toward a Science of Multiple Modalities of Emotional Expression

Emotional expression is a multimodal phenomenon. Darwin (1872/1998) himself referred to facial muscle movements and vocalizations, but also autonomic responses (the blush, pupil activity), movements of the arms and hands (clapping), shifts in posture, head movements, gestures, respiration, and full-body actions like jumping and dancing about. Darwin's emphasis on dynamic behavior is also of note. With a few notable exceptions (see Krumhuber, Kappas, & Manstead, 2013; Nelson & Russell, 2011a, 2011b, for a review) though, the literature on facial expression has focused on static photos. Yet a great deal of information is likely contained in dynamic movement.

For the most part, however, the empirical literature on expression has removed the body from systematic inquiry (but see Atkinson, Dittrich, Gemmell, & Young, 2004; Kret, Pichon, Grèzes, & De Gelder, 2011, for exceptions) and focused narrowly on facial muscle movements or vocalizations. Attention to emotions like pride and embarrassment has necessitated the study of head, gaze, and bodily movements (Keltner, 1995; Tracy & Robins, 2004, 2007). There are select studies of other channels of nonverbal behavior, such as how emotions are communicated in patterns of posture (Dael, Mortillaro, & Scherer, 2012; Gross, Crane, & Fredrickson, 2010) and gaze (Graham & LaBar, 2007; Lobmaier, Tiddeman, & Perret, 2008; Sander, Grandjean, Kaiser, Wehrle, & Scherer, 2007). Clearly, Darwin's (1872/1998) more comprehensive analysis suggests that there should be signal value in how emotions are communicated in a vast array of communicative behaviors, from simple movements of the hands to shifts in body posture to head movements. Relatively little is known about these intriguing possibilities.

Several recent studies have begun to capture how people convey emotion in tactile contact (Hertenstein & Weiss, 2011). Studying touch poses methodological challenges. Touch is dyadic, involves multiple regions of the body, and has many dimensions, including pressure, duration, location, and intensity. Touch does not lend itself to portrayals in classes of stimuli that can be used in typical emotion recognition paradigms. Notwithstanding these methodological issues, progress is being made in understanding which emotions have tactile signals.

Hertenstein and colleagues (Hertenstein, Keltner, App, Bulleit, & Jaskolka, 2006; Hertenstein, Holmes, McCullough, & Keltner, 2009) have begun to ascertain which emotions can be conveyed by touch. In a first study, an encoder (the person charged with touching another person to convey emotion) and decoder (the person being touched) sat at a table, separated by an opaque black curtain, which prevented communication other than touch. The encoder was given a list of emotions and asked to make contact with the decoder on the arm to communicate each emotion, using any form of touch. The decoder could not see any part of the touch because his or her arm was positioned on the encoder's side of the curtain. After each touch, the decoder selected from 13 response options the term that best described what the person was communicating. In this study, participants could reliably communicate anger, disgust, and fear with a brief 1- or 2-second touch of another's forearm, as well as love, gratitude, and sympathy (see also Piff, Purcell, Gruber, Hertenstein, & Keltner, 2012, for replication). Emotions like embarrassment, awe, and sadness were not reliably communicated via touch. In other research, people prove to be better able to communicate emotion through touch when allowed to touch other regions of the body than the arm (Hertenstein et al., 2009), and there is cross-cultural similarity in which emotions can be conveyed in tactile contact (see Hertenstein et al., 2009).

There are also emerging literatures on potential autonomic signals of emotion. The blush arises during experiences of embarrassment (Shearn, Bergman, Hill, Abel, & Hinds, 1992) and has clear social signal value. The chills, or goosebumps, refer to the sympathetically mediated contraction of the muscle surrounding the hair follicles, and arise during the appreciation of music and art (e.g., Grewe, Kopiez, & Altenmüller, 2009). In nonhuman species, this action, piloerection, is thought to signal threat behavior toward conspecifics. Recent work by Maruskin and colleagues (Maruskin, Thrash, & Elliot, 2012) has mapped the emotional correlates of two kinds of chills, which they posit have different evolutionary origins in mammalian behavior. One variant of chills, goosebumps, covaries with experiences of awe (see also Campos et al., 2013). Another kind of chills response, shivers, involves more pervasive muscle contractions like those observed during experiences of cold, and covaries with social disgust and fear.

Alongside the blush and the chills, another autonomic response with almost certain signal value is a tearing response. Studies of tears—a chemosignal response—have recently examined the chemical content of tears and their effects, when displayed by women, upon males' sexual response (Gelstein et al., 2011). It will be interesting to determine whether the addition of tears to different facial expressions (e.g., to facial muscle configurations of sadness or laughter or pain) changes the inferences drawn from the expression (e.g., Provine, Krosnowski, & Brocato, 2009).

As scientists have begun to understand more richly how bodily responses express emotion, they also have turned with more focus to the artistic expression of emotion. The voice and music share many emotionally expressive properties (i.e., tempo, loudness, and timbre) that account, in part, for how instruments can resemble the human voice (Gabrielsson & Juslin, 2003; Juslin & Laukka, 2003). In an analysis of the cues that people use to infer emotion from speech prosody and music, Juslin and Laukka (2003) found that people vary their tempo, loudness, and pitch in similar ways to communicate emotion (see also Zentner, Grandjean, & Scherer, 2008). And scientific studies find that listeners can reliably discern distinct emotions from different musical performances. In music–emotion recognition studies, performers sing a brief melody with no words and attempt to communicate anger, fear, happiness, sadness, joy, and on occasion, tenderness or love. The listener is then asked to choose the word from a list of words that best matches the emotion conveyed in the musical performance. Across over a dozen studies of this kind, listeners on average achieved accuracy rates of about 70% (Gabrielsson & Juslin, 2003; Juslin & Laukka, 2003). Recent evidence suggests that at least a few basic emotions may be universal to the perception of music in radically different cultures (Fritz et al., 2009).

What about emotional expression in other art forms? One recent study ascertained whether Western observers could reliably identify the emotion conveyed in traditional Hindu dance (Hejmadi, Davidson, & Rozin, 2000). In the Hindu Indian *Natya Shastra*, from around the second-century B.C.E. (Bharata Muni, 200 B.C.E.), specific writings detail how actors and dancers are to express emotions in movements in the face, body, and with hand gestures. Hejmadi and colleagues presented participants in India and the United States with videotapes of Hejmadi's own renditions of anger, disgust, fear, heroism, humor, love, peace, sadness, embarrassment/shyness/modesty, and wonder (Hejmadi performed as a dancer in India for 20 years). Based on video clips only lasting between 4 and 10 seconds, observers achieved accuracy rates between 61 and 69% in judging the 10 emotions communicated through dance and gesture.

These growing literatures on emotional expression in art bring into focus an important theme: that emotional expression is not limited to how humans signal internal states with the communicative systems shaped by evolution and culture. Emotional expression is part of all forms of art and other creative acts. And emotions are likely to be expressed in other sensory modalities, including through scent (Delplanque et al., 2012), color (Palmer, Schloss, Xu, & Prado-León, 2013), and natural scenes (e.g., Zhang, Piff, Iyer, Koleva, & Keltner, 2014). These new areas of inquiry raise the deeper question of how emotions are expressed in cultural artifacts like painting, sculpture, dance, music, poems, and architectural design—a question we believe is ready for synthetic theorizing.

Table 27.2 represents the current state of knowledge with respect to which emotions can be signaled in the five modalities of expression with substantive literatures: face/body, voice, touch, music, and dance. "Yes" in the columns signify that either in production or perception evidence, the emotion was found to have a distinct display.

The study of emotional expression has broadened in the past 10 years. Signals for at least 24 states have been identified. New modalities and the temporal dynamics of expression are increasingly considered. The promise of new areas of inquiry that are likely to yield new empirical insights is great. For example, there is good evidence for the association between subjective experience and emotion-related behaviors for "basic" emotions like anger, fear, disgust, or happiness (see Lench, Flores, & Bench, 2011, for a meta-analysis). This sort of evidence is needed for more recently investigated emotion displays.

A continued focus on the mammalian parallels of these "new" expressions will yield intriguing insights into the functional origins of these displays (Shariff & Tracy, 2011). As one example, shivering and piloerection are common responses in mammals; their study is germane to understanding the origins of human goosebumps and emotions like awe.

As the study of these new signals progresses, we foresee several important issues on the horizon. A first is to study emotional expression across multiple modalities (e.g., Aviezer, Trope, & Todorov, 2012; Campos, Campos, & Barrett, 1989). That science will likely reveal the relative contribution of different modalities to the experience and signal value of distinct emotional displays (e.g., see App, McIntosh, Reed, & Hertenstein, 2011; Flack, 2006; Scherer & Ellgring, 2007). Table 27.2 hints at the possibility that certain emotions may be robustly signaled across modalities (e.g., anger), whereas others may privilege select modalities of expression (e.g., embarrassment, awe). For example, sympathy, or compassion, is reliably signaled in touch and the voice, but less so, in the face (Goetz et al., 2010). Studies of multimodal expressions will bear upon debates about the degree to which emotions are expressed in patterns of behavior (Barrett, 2011; Russell, 1994). Cross-modal integration of expressive stimuli has a long history of producing additive effects in emotion recognition accuracy (Vroomen, Driver, & de Gelder, 2001; Paulmann & Pell, 2011). The distinct possibility is that as studies examine multimodal expressions of emotion—involving face, voice, body, tactile contact, and gesture—those signals may prove to be more recognizable than static photographs of facial expressions or snippets of vocalizations.

It will be important to explore universals and cultural variations in these expressions (e.g., Russell, 1994; Nelson & Russell, 2013). There is already evidence suggesting that the Japanese privilege the voice in inferring intention and emotion (Tanaka et al., 2010). This raises the question that some cultures may privilege the face in inferring emotion, some the voice, some touch, and some bodily responses—all intriguing possibilities awaiting empirical inquiry.

It will also be important to continue the study of remote peoples. In work attempting to differentiate beyond the basic six emotions, there is a dearth of research on culturally isolated groups. Basing our knowledge on findings from participants from a culturally narrow range of groups limits the inferences that can be drawn from such findings (Henrich, Heine, & Norenzayan, 2010). The influence of cultural input emerges early: Recent work has documented the impact of cross-cultural differences in parenting behaviors on the development of emotional expression beyond the commonly studied emotional states (Wormann, Holodyski, Kartner, & Keller, 2014). The limited available evidence suggests that the role of culture-specific social learning is likely highly variable across emotions (Sauter, Einser, Ekman, et al., 2010).

Critically, it will be important to extend this research further to special samples of individuals with reduced cultural input, such as people who lack vision. In one example of this approach, Tracy and Matsumoto (2008) coded the pride and shame displays of sighted and blind—including congenitally blind—athletes from 37 different countries at the 2004 Olympic Games judo competition. Both sighted and blind winners showed expansive posture, smiles, head up, and arms in the air; sighted and blind losers showed slouched posture, shoulders slumped, and chest caved in. Interestingly, the tendency to display pride in response to success was found in all cultural groups examined. Shame displays, by contrast, were reliably shown in response to failure by individuals from all cultural groups except those that were particularly high in individualism and self-expression values—that is, North American and Western European cultures.

Finally, the work we have reviewed points to several states that do not figure in the classification schemes of theorists influential in the development of the science of emotion (see Keltner & Lerner, 2010, for synthesis). As the list of emotional displays expands, it will be important to consider how some states and their accompanying displays may fall within the same overarching emotion category (see Scarantino, 2012, for a discussion). For example, recent evidence points to distinct displays for fear and anxiety (Perkins, Inchley-Mort, Pickering, Corr, & Burgess, 2012). Other research, however, suggests that two variants of pride—labeled "authentic" and "hubristic"—share the same nonverbal display, and thus must be distinguished from contextual information (Tracy & Robins, 2007; Tracy & Prehn, 2012). However, as research on other modalities continues, perhaps these distinct forms of pride will be linked to distinct vocal, or even musical, displays.

Emotional Expression and the Coordination of Social Interaction

Based on his years of intensive observation of preindustrial people, Irenäus Eibl-Eibesfeldt (1989) posited that emotional expressions are like a grammar of social interaction. Facial expressions, vocalizations, patterns of bodily movement, gaze, gestures, and touch bind people into dyadic and group-based interactions—the soothing of a distressed child, the flirtation between potential suitors, sexual interaction, the play of young siblings, the aggressive encounters of rivals, or status conflicts in groups.

A corollary to this analysis is that emotional expressions trigger systematic inferences and behavioral responses in others. This thinking requires that we shift a level of analysis, and look at individuals' expressions of emotion at the dyadic or even group level (Tiedens & Leach, 2004), as has been done in the study of emotional mimicry (Hess & Fischer, 2013).

Consider the recent theorizing of Paula Niedenthal, Ursula Hess, and their colleagues concerning how different smiles evoke different inferences and responses in others (Niedenthal, Mermillod, Maringer, & Hess, 2010). Within 500 milliseconds, this theorizing posits, a warm smile of enjoyment triggers neural processes that lead the perceiver to seek more information about the smiler through eye contact, which in turn evokes feelings of pleasure, mimetic behavior, and the experience of positive emotion and approach behavior. A proud, dominant smile, by contrast, triggers the same automatic search for information about the smiler, along with neural activation that leads to a sense of threat and avoidant behavior.

Or consider a recent study of touch among members of professional basketball teams (Kraus, Huang, & Keltner, 2010). Drawing upon the new science of emotional touch, these researchers coded all observed touches in an entire game of each team in the National Basketball Association at the start of the 2008 season. Over 25 kinds of celebratory and encouraging touch were coded: high-fives, fist bumps, chest bumps, arm embraces, bear hugs, and the like. On average, each player touched his teammates for about 2 seconds during each game. The more a team's players touched each other at the beginning of the season, the better the team played at the end of the season, according to sophisticated basketball statistics, even when controlling for whether or not the team was winning, their preseason expectations, and how much money they were making.

So how do emotional expressions coordinate social interactions? Three ideas have emerged (Keltner & Kring, 1998; van Kleef, 2009). A first is that emotional expressions rapidly provide important information relevant to perceivers, useful in guiding subsequent behavior. For example, emotional expressions signal more trait-like tendencies of individuals, including the tendency to be dominant (Knutson, 1996), to be of upstanding character (Feinberg, Willer, & Keltner, 2012), and the degree of strength within a negotiation (van Kleef, De Dreu, Pietroni, & Manstead, 2006). Pride displays promote automatic, cross-cultural judgments of high status in the displayer—judgments that are strong enough to counter contextual information indicating that the displayer in fact merits low status (Shariff & Tracy, 2009; Tracy et al., 2013).

Emotional expressions also signal the trustworthiness of the sender. For example, Krumhuber and colleagues (2013) have found that people trust interaction partners more, and will give more resources to those partners who display authentic smiles (which have longer onset and offset times) than fake smiles, which have shorter onset and offset (Krumhuber et al., 2013). Social perceivers infer trustworthy intentions from people who spontaneously display intense embarrassment, and are more likely to cooperate with individuals who express embarrassment than other emotions (Feinberg et al., 2012). Pride displays direct social learning by providing information to others; individuals motivated to attain the correct answer to a difficult trivia question were found to selectively copy the answer provided by others showing pride, suggesting that pride displays communicate expertise or knowledge (Martens & Tracy, 2013).

Emotional expressions convey information about the environment, allowing individuals to coordinate their responses to outside opportunities or threats (e.g., Klinnert, Emde, Butterfield, & Campos, 1986). For example, parents use touch and voice to signal to their young children whether other people and objects in the environment are safe or dangerous (Hertenstein & Campos, 2004), using vocal cues that are consistent across cultures (Bryant & Barrett, 2007).

Emotional displays coordinate social interactions in a second way, by evoking specific responses in social perceivers. Early studies in this tradition found that some emotional expressions trigger complementary emotions in social perceivers: facial displays of anger enhance fear conditioning in observers, even when the facial displays are not consciously perceived (Ohman & Dimberg, 1978); expressions of distress can evoke sympathy in observers (e.g., Eisenberg et al., 1989); and displays of dominance trigger more submissive expressive behavior (Tiedens & Fragale, 2003). More recently, van Dijk and colleagues (van Dijk, de Jong, & Peters, 2009) have documented that social observers respond with more positive emotion to individuals who blushed after they made mistakes than if they showed other display behavior.

Finally, emotional expressions structure social interactions by serving as incentives for others' actions, by rewarding specific patterns of behavior in perceivers. Early studies on this notion focused on how parents use warm smiles and touches to increase the likelihood of certain behaviors in their children (e.g., Tronick, 1989) and the incentive value of laughter, and how it triggers cooperative interactions between friends (Owren & Bachorowski, 2001).

This analysis of the rewarding properties of emotional expression likewise sheds light on some of the direct effects of emotional touch upon recipients of touch. Gentle, pleasing touch triggers activation in the orbitofrontal cortex, a brain region involved in the representation of secondary rewards (Rolls, 2000). Given the rewarding quality of being touched, it has been claimed that touch motivates sharing behavior in others' altruism (De Waal, 1996). This may help explain why a warm touch increases compliance to requests (Willis & Hamm, 1980) and cooperation toward strangers in economic games (Kurzban, 2001).

Clearly, these studies on how expressions coordinate social interactions are in their infancy. Many of these studies have focused on the face; it will be important to extend this line of reasoning to studies of the voice, touch, body movement, gaze, and other modalities. This work has focused on a more limited set of emotional displays: smiles, anger displays, disgust expressions, and fear expressions. It will be important to examine how less-studied expressions of emotion—for example, of interest (in the voice), gratitude (in touch), sympathy (in the voice or touch), or awe (in the voice)—coordinate social interactions.

Studies of the social functions of emotional expressions have set the stage for new theorizing. One recent line of argument has outlined how emotional expressions evolved to serve these informative, evocative, and incentive-signaling functions, perhaps in the "second stage" of their evolution (see Shariff & Tracy, 2011). This account dates back to Darwin (1872/1998), and argues that internal physiological regulation was likely the original adaptive function of emotion expressions, which later evolved to serve communicative functions (e.g., Chapman, Kim, Susskind, & Anderson, 2009; Eibl-Eibsfeldt, 1989; Ekman, 1992; Shariff & Tracy, 2011).

To take the classic example of fear, the facial muscle movements that constitute a fear expression likely originally emerged as part of a functional response to threatening stimuli; widened eyes increase the scope of one's visual field and the speed of eye movements, allowing expressers to better identify (potentially threatening) objects in their periphery (Susskind et al., 2008). In contrast, the "scrunched" nose and mouth of the disgust expression results in constriction of these orifices, thereby reducing air intake (Susskind et al., 2008; Chapman et al., 2009). Given that disgust functions to alert expressers of the potentially noxious nature of the eliciting stimulus, and thereby disincline them from ingesting it (Rozin, Lowery, & Ebert, 1994), the reduced inhalation of airborne chemicals can well be considered part of the same adaptive response. In more recent work, these authors have shown that the opposing eye movements involved in fear and disgust expressions (i.e., widening vs. narrowing) function to increase visual sensitivity (localizing an object) and acuity (determining what the object is), respectively—further supporting the argument that these two expressions initially evolved to serve opposing yet equally important functions for the expresser.

However, these original physiological benefits experienced by the expressers eventually became transformed into communicative signals, which benefit both expressers and observers in terms of the more efficient and coordinated interactions. Over time, the facial and bodily behavioral components of certain emotions came to signal those emotional states to observers, through processes of ritualization, wherein mammalian nonverbal displays become exaggerated, more visible, distinctive and/or prototypic, and ultimately, more recognizable.

Beyond these theoretical implications, this new emphasis on how expressions coordinate social interactions has inspired studies of how the abilities to express and detect emotions predict positive social outcomes. For example, the ability to read emotions effectively predicts positive negotiation outcomes (Elfenbein, Der Foo, White, Tan, & Aik, 2007). The extent to which a person's felt positive emotion is expressed in positive social behaviors predicts better social connections and reduced symptoms of depression (Mauss et al., 2011). These two skills—to express emotions clearly and read others' emotions effectively—are correlated (see Elfenbein & Eisenkraft, 2010, for a meta-analysis) and central to conceptualizations of emotional intelligence, which consistently predicts increased social adjustment (see Brackett et al., 2013; Mayer, Salovey, Caruso, & Sitarenios, 2003, for a review).

Beyond Single-Word Emotion Recognition Paradigms: Context and Inference in Emotion Perception

The first wave of science on emotional expression—in particular, that on the face—involved emotion recognition studies that most typically entailed that participants match an emotion term from a list of options to a specific expression (see Elfenbein & Ambady, 2002). A meta-analysis of 182 independent samples examining judgments of emotion in the face and other nonverbal stimuli yielded an average accuracy rate of 58.0% (a notably large effect size), after correction for chance guessing (Elfenbein & Ambady, 2002). With respect to vocal expressions of emotion, in a review of over 60 studies largely using single-word emotion recognition paradigms, Juslin and Laukka (2003) concluded that listeners can judge five different emotions in the voice—anger, fear, happiness, sadness, and tenderness—with accuracy rates that approach 70% (see also Scherer, Johnstone, & Klasmeyer, 2003). There is continued debate about the meaning of these levels of accuracy, and the degree of universality they imply (Barrett, 2011; Russell, 1994).

Of course, emotion perception involves more than labeling expressive behaviors with single words, and the study of emotion perception has advanced in two new directions. A first is to begin to systematically examine the inferential processes by which individuals interpret expressive behavior. When people encounter expressive behavior in another person, or target, the inferential processes they likely engage in involve more than the ascription of single-word labels; they almost certainly make inferences about the target's desires and intentions, trait-like tendencies, strategic motivations, and surrounding context. This common-sense analysis begs two questions: What other sorts of inferences do people make in interpreting expressive behavior? and How do perceivers arrive at attributions of emotions to targets?

In work on this latter question, Scherer and colleagues propose that perceivers first infer specific appraisals upon observing expressive behavior (Scherer & Grandjean, 2008)—that is, if a person sees another person express anger in the face, or interest in the voice, or sympathy in a pattern of postural movement and tactile contact, the social perceiver first infers a pattern of appraisals that would lead the individual to express emotion as he or she has done. And from these inferred appraisals, the social perceiver would then infer the experience of specific emotions. Seeing someone express anger might lead to initial inferences that the person has been treated in an unpleasant, unfair, intentional, and immoral fashion, which in turn would increase the likelihood of attributing anger to the target. It may be that the first inferences perceivers draw on seeing others' expressive behavior is a pattern of appraisals, rather than distinct emotions, a notion in need of systematic study, and one that could shed light on cultural variations in attributions of emotion to individuals' expressive behavior (Fontaine, Scherer, & Soriano, 2013).

Another area of growth in the study of emotion perception is in the understanding of how the context influences how people perceive emotional expression (Barrett et al., 2011). How do emotional expressions vary in their meaning from one context to another? A pattern of touch will vary in the inferences it evokes depending on whether the people are friends or strangers, at work, or on a date. A laugh can be perceived as an expression of affection or sarcastic critique depending on the context. A blush could be read as a sign of self-conscious inhibition or flirtatious interest, again depending on the context.

In their constructivist account of emotion perception, Barrett and colleagues (2011) offer a theoretical synthesis for how to approach contextual variations in the meaning social perceivers derive in perceiving emotional expressions, highlighting three kinds of context. A first is called stimulus context, which refers to the surrounding stimulus features that accompany the expressive behavior. Most of the work on emotional expression has isolated specific display behaviors in the face or voice, largely for purposes of experimental control. But expressions of emotion in the real world most typically occur in multimodal patterns of behavior: A facial expression, or vocalization, is accompanied by other behaviors (gestures, bodily movements, intentional actions unrelated to emotion, gaze—static features of appearance—physical size, beauty, and even patterns of dress). These behaviors that accompany an expression of emotion are likely to shape the interpretation of the focal expression in interesting ways; something for which the field is turning its attention to.

In one line of work inspired by this analysis, studies are finding that the accuracy in labeling facial expressions of emotion varies according to other physical actions of the individual expressing emotion (see Barrett et al., 2011, for a review). When observers are given more than a decontextualized static facial expression to judge, they tend to take into account the surrounding contextual information in making their judgment. For example, Aviezer and colleagues (2008) presented a classic facial expression of disgust in one of four stimulus contexts, in which the person expressing disgust was engaged in different actions. Participants labeled the expression as disgust 91% of the time when the individual was holding a soiled article of clothing, 59% of the time when the person displayed fearful hand and arm movements, 33% of the time when the same person was clasping his or her hands sadly to the chest, and 11% of the time when the person was poised with fist clenched to punch.

A second kind of context highlighted is perceptual context. Perceptual context refers to the mental states within the perceiver's mind that shape his or her inferences upon observing expressive behavior. A person's current goals, intentions, values, emotions, physical state, and the like give rise to context-specific interpretations of social stimuli, and one would imagine, expressive behavior. Little is known about how a person's goals, current state, or values and ideals shape the perception of expressive behavior, although that is starting to change thanks to Barrett et al.'s (2011) constructivist theorizing. For example, recent studies find that the likelihood that participants will label a disgust expression (nose scrunch) rises when an anger expression precedes the presentation of the disgust expression, but drops when no anger expression precedes the target disgust expression (Pochedly, Widen, & Russell, 2012). The clear implication is that the perceiver's judgments of emotional expressions will be shaped by his or her encounters with stimuli that precede his or her judgments of the expressive behavior.

In another series of studies on perceptual context, Lindquist and colleagues induced participants into a state of what is known as semantic satiation by having them repeat an emotion word (e.g., "sadness") 30 times (Lindquist, Barrett, Bliss-Moreau, & Russell, 2006). This repetitive process makes specific emotion words less accessible, and less likely to be used in interpreting emotionally expressive behavior. Indeed, this semantic satiation slowed participants' identification of anger, disgust, sadness, surprise, and happiness, but did not influence their levels of accuracy.

A third kind of context is culture. In early studies in this tradition, researchers documented cultural differences in the accuracy of emotion perception (e.g., Russell, 1994) and cultural variations in attributed intensity to emotional displays (Biehl et al., 1997). More recently, studies have begun to explore cultural variations in the more complex inferences that perceivers make in perceiving expressions of emotion. For example, when compared with members of East Asian cultures, Americans indicate that the external display of emotion is more intense than the inner experience, consistent with the emphasis in the United States on expressing one's feelings (see also Matsumoto, Olide, & Willingham, 2009).

Still other findings suggest that cultures vary in their attention to the surrounding context of an expression. In one paradigmatic experiment, Masuda and colleagues showed Japanese and American participants cartoon figures with various expressions on their faces (Masuda, Ellsworth, Mesquita, Leu, & van de Veerdonk, 2004). The central, target face was always surrounded by smaller, less salient faces, with expressions that were dissimilar to those of the target. Japanese participants' judgments about the central target's facial expression were more influenced by the surrounding faces than were judgments made by Americans. In a similar vein, Kraus and colleagues (Kraus, Côté, & Keltner, 2010) have found that lower-class individuals—more oriented to the social context than upper-class individuals—also incorporate contextual information into their judgments of expressive behavior.

This new focus on the complex interpretations placed upon emotional expression represents one of the exciting areas for further inquiry. The general promise is to begin to understand the meaning attributed to expressive behavior beyond labels or relatively scripted stories, and to understanding systematically how interpretations of expressive behavior are similar across individuals, cultures, and contexts, and how they vary in their meaning.

Conclusions

Our review has focused on four emergent themes in the study of emotional expression. We have seen impressive advances in the study of new states that had only received scant attention in the past. The field is moving beyond the face and voice, to study other signaling modalities. We are learning how a pattern of emotionally expressive behavior might change from one context to the next. And the field is revealing how emotional expressions shape social interactions of all kinds. Throughout the review, we have highlighted promising lines of future inquiry represented by these four new developments and how they interact.

References

App, B., McIntosh, D. N., Reed, C. L., & Hertenstein, M. J. (2011). Nonverbal channel use in communication of emotion: How may depend on why. *Emotion, 11*(3), 603–617.

Atkinson, A. P., Dittrich, W. H., Gemmell, A. J., & Young, A. W. (2004). Emotion perception from dynamic and static body expressions in point-light and full-light displays. *Perception, 33*, 717–746.

Aviezer, H., Hassin, R. R., Ryan, J., Grady, C., Susskind, J., Anderson, A., et al. (2008). Angry, disgusted, or afraid?: Studies on the malleability of emotion perception. *Psychological Science, 19*(7), 724–732.

Aviezer, H., Trope, Y., & Todorov, A. (2012). Body cues, not facial expressions, discriminate between intense positive and negative emotions. *Science, 338*(6111), 1225–1229.

Banse, R., & Scherer, K. R. (1996). Acoustic profiles in vocal emotion expression. *Journal of Personality and Social Psychology, 70*(3), 614.

Barrett, L. F. (2011). Was Darwin wrong about emotional expressions? *Current Directions in Psychological Science, 20*(6), 400–406.

Barrett, L. F., Lindquist, K. A., & Gendron, M. (2007). Language as context for the perception of emotion. *Trends in Cognitive Sciences, 11*(8), 327–332.

Barrett, L. F., Mesquita, B., & Gendron, M. (2011). Context in emotion perception. *Current Directions in Psychological Science, 20*(5), 286–290.

Bharata Muni. (200 B.C.E.). *Natya Shastra*.

Biehl, M., Matsumoto, D., Ekman, P., Hearn, V., Heider, K., Kudoh, T., et al. (1997). Matsumoto and Ekman's Japanese and Caucasian Facial Expressions of Emotion (JACFEE): Reliability data and cross-national differences. *Journal of Nonverbal Behavior, 21*(1), 3–21.

Botvinick, M., Jha, A. P., Bylsma, L. M., Fabian, S. A., Solomon, P. E., & Prkachin, K. M. (2005). Viewing facial expressions of pain engages cortical areas involved in the direct experience of pain. *NeuroImage, 25*(1), 312–319.

Bowlby, J. (1969). *Attachment and loss: Vol.1. Attachment*. New York: Basic Books.

Brackett, M., Bertoli, M., Elbertson, N., Bausseron, E., Castillo, R., & Salovey, P. (2013). Emotional intelligence. In M. D. Robinson, E. R. Watkins, & E. Harmon-Jones (Eds.), *Handbook of cognition and emotion* (pp. 365–379). New York: Guilford Press.

Bretherton, I., & Ainsworth, M. D. S. (1974). Responses of one-year-olds to a stranger in a strange situation. In M. Lewis & L. A. Rosenblum (Eds.), *The origin of fear* (pp. 131–164). New York: Wiley.

Bryant, G. A., & Barrett, H. C. (2007). Recognizing intentions in infant-directed speech: Evidence for universals. *Psychological Science, 18*(8), 746–751.

Campos, B., Shiota, M., Keltner, D., Gonzaga, G., & Goetz, J. (2013). What is shared, what is different?: Core relational themes and expressive displays of eight positive emotions. *Cognition and Emotion, 27*, 37–52.

Campos, J. J., Campos, R. G., & Barrett, K. C. (1989). Emergent themes in the study of emotional development and emotion regulation. *Developmental Psychology, 25*(3), 394.

Chapman, H. A., Kim, D. A., Susskind, J. M., & Anderson, A. K. (2009). In bad taste: Evidence for the oral origins of moral disgust. *Science, 323*(5918), 1222–1226.

Dael, N., Mortillaro, M., & Scherer, K. R. (2012). Emotion expression in body action and posture. *Emotion, 12*(5), 1085.

Darwin, C. (1998). *The expression of the emotions in man and animals* (3rd ed.). New York: Oxford University Press. (Original work published 1872)

De Waal, F. B. (1996). *Good natured* (No. 87). Cambridge, MA: Harvard University Press.

Delplanque, S., Chrea, C., Grandjean, D., Ferdenzi, C., Cayeux, I., Porcherot, C., et al. (2012). How to map the affective semantic space of scents. *Cognition and Emotion, 26*(5), 885–898.

Dubois, A., Bringuier, S., Capdevilla, X., & Pry, R. (2008). Vocal and verbal expression of postoperative pain in preschoolers. *Pain Management Nursing, 9*(4), 160–165.

Edelmann, R. J., & Hampson, S. E. (1979). Changes in nonverbal behaviour during embarrassment. *British Journal of Social and Clinical Psychology, 18*(4), 385–390.

Eibl-Eibesfeldt, I. (1989). *Human ethology*. New York: Aldine-De Gruyter.

Eisenberg, N., Fabes, R. A., Miller, P. A., Fultz, J., Shell, R., Mathy, R. M., et al. (1989). Relation of sympathy and personal distress to prosocial behavior: A multimethod study. *Journal of Personality and Social Psychology, 57*(1), 55.

Ekman, P. (1992). All emotions are basic. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion* (pp. 15–19). New York: Oxford University Press.

Ekman, P. (1998). Universality of emotional expression?: A personal history of the dispute. In P. Ekman (Ed.), *The expression of the emotions in man and animals* (pp. 363–393). New York: Oxford University Press.

Ekman, P., & Friesen, W. V. (1978). *Facial Action Coding System: Investigator's guide*. Palo Alto, CA: Consulting Psychologists Press.

Ekman, P., & Friesen, W. V. (1986). A new pan-cultural facial expression of emotion. *Motivation and Emotion, 10*(2), 159–168.

Ekman, P., & Rosenberg, E. L. (Eds.). (1997). *What the face reveals: Basic and applied studies of spontaneous expression using the Facial Action Coding System (FACS)*. New York: Oxford University Press.

Elfenbein, H. A., & Ambady, N. (2002). On the universality and cultural specificity of emotion regulation: A meta-analysis. *Psychological Bulletin, 128*(2), 203–235.

Elfenbein, H. A., Der Foo, M., White, J., Tan, H. H., & Aik,

V. C. (2007). Reading your counterpart: The benefit of emotion recognition accuracy for effectiveness in negotiation. *Journal of Nonverbal Behavior, 31*(4), 205–223.

Elfenbein, H. A., & Eisenkraft, N. (2010). The relationship between displaying and perceiving nonverbal cues of affect: A meta-analysis to solve an old mystery. *Journal of Personality and Social Psychology,* 98(2), 301.

Feinberg, M., Willer, R., & Keltner, D. (2012). Flustered and faithful: Embarrassment as a signal of prosociality. *Journal of Personality and Social Psychology, 102*(1), 81.

Flack, W. (2006). Peripheral feedback effects of facial expressions, bodily postures, and vocal expressions on emotional feelings. *Cognition and Emotion, 20*(2), 177–195.

Fontaine, J. R., Scherer, K. R., & Soriano, C. (Eds.). (2013). *Components of emotional meaning: A sourcebook*. New York: Oxford University Press.

Fridlund, A. J. (1991). Evolution and facial action in reflex, social motive, and paralanguage. *Biological Psychology, 32*(1), 3–100.

Fritz, T., Jentschke, S., Gosselin, N., Sammler, D., Peretz, I., Turner, R., et al. (2009). Universal recognition of three basic emotions in music. *Current Biology, 19*(7), 573–576.

Gabrielsson, A., & Juslin, P. N. (2003). *Emotional expression in music*. New York: Oxford University Press.

Gelstein, S., Yeshurun, Y., Rozenkrantz, L., Shushan, S., Frumin, I., Roth, Y., et al. (2011). Human tears contain a chemosignal. *Science, 331*(6014), 226–230.

Gendron, M., Roberson, D., & Barrett, L. F. (2015). Cultural variation in emotion perception is real: A response to Sauter et al. *Psychological Science, 26*, 357–359.

Gendron, M., Roberson, D., van der Vyver, J. M., & Barrett, L. F. (2014). Cultural relativity in perceiving emotion from vocalizations. *Psychological Science, 25*, 911–920.

Goetz, J. L., Keltner, D., & Simon-Thomas, E. (2010). Compassion: An evolutionary analysis and empirical review. *Psychological Bulletin, 136*(3), 351–374.

Gonzaga, G. C., Keltner, D., Londahl, E. A., & Smith, M. D. (2001). Love and the commitment problem in romantic relations and friendship. *Journal of Personality and Social Psychology, 81*(2), 247.

Gonzaga, G. C., Turner, R. A., Keltner, D., Campos, B., & Altemus, M. (2006). Romantic love and sexual desire in close relationships. *Emotion,* 6(2), 163.

Graham, R., & LaBar, K. S. (2007). Garner interference reveals dependencies between emotional expression and gaze in face perception. *Emotion, 7*(2), 296.

Grewe, O., Kopiez, R., & Altenmüller, E. (2009). Chills as an indicator of individual emotional peaks. *Annals of the New York Academy of Sciences, 1169*(1), 351–354.

Gross, M. M., Crane, E. A., & Fredrickson, B. L. (2010). Methodology for assessing bodily expression of emotion. *Journal of Nonverbal Behavior, 34*(4), 223–248.

Grunau, R. V., & Craig, K. D. (1987). Pain expression in neonates: Facial action and cry. *Pain, 28*(3), 395–410.

Haidt, J., & Keltner, D. (1999). Culture and facial expression: Open-ended methods find more faces and a gradient of recognition. *Cognition and Emotion, 13*, 225–266.

Harris, C. R. (2001). Cardiovascular responses of embarrassment and effects of emotional suppression in a social setting. *Journal of Personality and Social Psychology, 81*(5), 886.

Hejmadi, A., Davidson, R. J., & Rozin, P. (2000). Exploring Hindu Indian emotion expressions: Evidence for accurate recognition by Americans and Indians. *Psychological Science, 11*(3), 183–187.

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioural and Brain Sciences, 33*(2-3), 61–83.

Hertenstein, M. J., & Campos, J. J. (2004). The retention effects of an adult's emotional displays on infant behavior. *Child Development, 75*(2), 595–613.

Hertenstein, M. J., Holmes, R., McCullough, M., & Keltner, D. (2009). The communication of emotion via touch. *Emotion,* 9(4), 566.

Hertenstein, M. J., Keltner, D., App, B., Bulleit, B. A., & Jaskolka, A. R. (2006). Touch communicates distinct emotions. *Emotion,* 6(3), 528.

Hertenstein, M. J., & Weiss, S. J. (Eds.). (2011). *The handbook of touch: Neuroscience, behavioral, and health perspectives*. New York: Springer.

Hess, U., & Fischer, A. (2013). Emotional mimicry as social regulation. *Personality and Social Psychology Review, 17*(2), 142–157.

Izard, C. E. (1971). *The face of emotion*. New York: Appleton Century Crofts.

Juslin, P. N., & Laukka, P. (2003). Communication of emotions in vocal expression and music performance: Different channels, same code? *Psychological Bulletin, 129*(5), 770.

Keltner, D. (1995). Signs of appeasement: Evidence for the distinct displays of embarrassment, amusement, and shame. *Journal of Personality and Social Psychology,* 68(3), 441–454.

Keltner, D. (1996). Evidence for the distinctness of embarrassment, shame, and guilt: A study of recalled antecedents and facial expressions of emotion. *Cognition and Emotion, 10*(2), 155–172.

Keltner, D. (2009). *Born to be good: The science of a meaningful life*. New York: Norton.

Keltner, D., & Bonanno, G. A. (1997). A study of laughter and dissociation: Distinct correlates of laughter and smiling during bereavement. *Journal of Personality and Social Psychology, 73*(4), 687.

Keltner, D., & Buswell, B. N. (1997). Embarrassment: Its distinct form and appeasement functions. *Psychological Bulletin, 122*(3), 250.

Keltner, D., & Kring, A. M. (1998). Emotion, social function, and psychopathology. *Review of General Psychology, 2*(3), 320–342.

Keltner, D., & Lerner, J. (2010). Emotion. In S. T. Fiske, D. T. Giblert, & G. Lindzey (Eds.), *Handbook of social psychology* (Vol., pp. 317–342). New York: Wiley.

Keltner, D., & Shiota, M. N. (2003). New displays and new emotions: A commentary on Rozin and Cohen. *Emotion, 3*(1), 86–91.

Klinnert, M. D., Emde, R. N., Butterfield, P., & Campos,

J. J. (1986). Social referencing: The infant's use of emotional signals from a friendly adult with mother present. *Developmental Psychology, 22*(4), 427.

Knutson, B. (1996). Facial expressions of emotion influence interpersonal trait inferences. *Journal of Nonverbal Behavior, 20*, 165–182.

Kraus, M. W., Côté, S., & Keltner, D. (2010). Social class, contextualism, and empathic accuracy. *Psychological Science, 21*, 1716–1723.

Kraus, M. W., Huang, C., & Keltner, D. (2010). Tactile communication, cooperation, and performance: An ethological study of the NBA. *Emotion, 10*(5), 745.

Kret, M. E., Pichon, S., Grèzes, J., & De Gelder, B. (2011). Men fear other men most: Gender specific brain activations in perceiving threat from dynamic faces and bodies—an fMRI study. *Frontiers in Psychology, 2*, 3.

Krumhuber, E. G., Kappas, A., & Manstead, A. S. R. (2013). Effects of dynamic aspects of facial expressions: A review. *Emotion Review, 5*(1), 41–46.

Kurzban, R. (2001). The social psychophysics of cooperation: Nonverbal communication in a public goods game. *Journal of Nonverbal Behavior, 25*(4), 241–259.

Laukka, P., Elfenbein, H. A., Söder, N., Nordström, H., Althoff, J., Chui, W., et al. (2013). Cross-cultural decoding of positive and negative non-linguistic emotion vocalizations. *Frontiers in Psychology, 4*, 353.

Lench, H. C., Flores, S. A., & Bench, S. W. (2011). Discrete emotions predict changes in cognition, judgment, experience, behavior, and physiology: A meta-analysis of experimental emotion elicitations. *Psychological Bulletin, 137*(5), 834–855.

Levenson, R. W., Ekman, P., & Friesen, W. V. (1990). Voluntary facial action generates emotion-specific autonomic nervous system activity. *Psychophysiology, 27*(4), 363–384.

Lewis, M., Alessandri, S. M., & Sullivan, M. W. (1992). Differences in shame and pride as a function of children's gender and task difficulty. *Child Development, 63*(3), 630–638.

Lindquist, K. A., Barrett, L. F., Bliss-Moreau, E., & Russell, J. A. (2006). Language and the perception of emotion. *Emotion, 6*(1), 125.

Lobmaier, J. S., Tiddeman, B. P., & Perrett, D. I. (2008). Emotional expression modulates perceived gaze direction. *Emotion, 8*(4), 573.

Martens, J. P., & Tracy, J. L. (2013). The emotional origins of a social learning bias: Does the pride expression cue copying? *Social Psychological and Personality Science, 4*(4), 492–499.

Maruskin, L. A., Thrash, T. M., & Elliot, A. J. (2012). The chills as a psychological construct: Content universe, factor structure, affective composition, elicitors, trait antecedents, and consequences. *Journal of Personality and Social Psychology, 103*(1), 135.

Masuda, T., Ellsworth, P. C., Mesquita, B., Leu, J., & van de Veerdonk, E. (2004). *A face in the crowd or a crowd in the face: Japanese and American perceptions of others' emotions*. Unpublished manuscript, Hokkaido University.

Matsumoto, D., Keltner, D., Shiota, M. N., O'Sullivan, M., & Frank, M. (2008). Facial expressions of emotion. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 211–234). New York: Guilford Press.

Matsumoto, D., Olide, A., Schug, J., Willingham, B., & Callan, M. (2009). Cross-cultural judgments of spontaneous facial expressions of emotion. *Journal of Nonverbal Behavior, 33*(4), 213–238.

Matsumoto, D., Olide, A., & Willingham, B. (2009). Is there an ingroup advantage in recognizing spontaneously expressed emotions? *Journal of Nonverbal Behavior, 33*(3), 181–191.

Mauss, I. B., Levenson, R. W., McCarter, L., Wilhelm, F. H., & Gross, J. J. (2005). The tie that binds? Coherence among emotion experience, behavior, and physiology. *Emotion, 5*(2), 175.

Mauss, I. B., Shallcross, A. J., Troy, A. S., John, O. P., Ferrer, E., Wilhelm, F. H., et al. (2011). Don't hide your happiness!: Positive emotion dissociation, social connectedness, and psychological functioning. *Journal of Personality and Social Psychology, 100*(4), 738.

Mayer, J. D., Salovey, P., Caruso, D. R., & Sitarenios, G. (2003). Measuring emotional intelligence with the MSCEIT V2.0. *Emotion, 3*(1), 97.

Mortillaro, M., Mehu, M., & Scherer, K. R. (2011). Subtly different positive emotions can be distinguished by their facial expressions. *Social Psychological and Personality Science, 2*(3), 262–271.

Nelson, N. L., & Russell, J. A. (2011a). Preschoolers' use of dynamic facial, bodily, and vocal cues to emotion. *Journal of Experimental Child Psychology, 110*(1), 52–61.

Nelson, N. L., & Russell, J. A. (2011b). When dynamic, the head and face alone can express pride. *Emotion, 11*(4), 990.

Nelson, N. L., & Russell, J. A. (2013). Universality revisited. *Emotion Review, 5*(1), 8–15.

Niedenthal, P. M., Mermillod, M., Maringer, M., & Hess, U. (2010). The simulation of smiles (SIMS) model: Embodied simulation and the meaning of facial expression. *Behavioral and Brain Sciences, 33*(6), 417–433.

Ohman, A., & Dimberg, U. (1978). Facial expressions as conditioned stimuli for electrodermal responses: A case of "preparedness"? *Journal of Personality and Social Psychology, 36*, 1251–1258.

Owren, M. J., & Bachorowski, J. (2001). The evolution of emotional expression: A "selfish-gene" account of smiling and laughter in early hominids and humans. In T. J. Mayne & G. A. Bonanno (Eds.), *Emotions: Current issues and future directions* (pp. 152–191). New York: Guilford Press.

Palmer, S. E., Schloss, K. B., Xu, Z., & Prado-León, L. R. (2013). Music–color associations are mediated by emotion. *Proceedings of the National Academy of Sciences, 110*(22), 8836–8841.

Paulmann, S., & Pell, M. D. (2011). Is there an advantage for recognizing multi-modal emotional stimuli? *Motivation and Emotion, 35*(2), 192–201.

Perkins, A. M., Inchley-Mort, S. L., Pickering, A. D., Corr,

P. J., & Burgess, A. P. (2012). A facial expression for anxiety. *Journal of Personality and Social Psychology, 102*(5), 910.

Piff, P. K., Purcell, A., Gruber, J., Hertenstein, M. J., & Keltner, D. (2012). Contact high: Mania proneness and positive perception of emotional touches. *Cognition and Emotion, 26*(6), 1116–1123.

Pochedly, J. T., Widen, S. C., & Russell, J. A. (2012). What emotion does the "facial expression of disgust" express? *Emotion, 12*(6), 1315.

Prkachin, K. M. (1992). The consistency of facial expressions of pain: A comparison across modalities. *Pain, 51*(3), 297–306.

Provine, R. R., Krosnowski, K. A., & Brocato, N. W. (2009). Tearing: Breakthrough in human emotional signaling. *Evolutionary Psychology, 7*(1), 52–56.

Reddy, V. (2000). Coyness in early infancy. *Developmental Science, 3*(2), 186–192.

Reddy, V. (2005). Feeling shy and showing-off: Self-conscious emotions must regulate self-awareness. J. Nadel & D. Muir (Eds.), *Emotional development* (pp. 183–204). Oxford, UK: Oxford University Press.

Reeve, J. (1993). The face of interest. *Motivation and Emotion, 17*(4), 353–375.

Rolls, E. T. (2000). The orbitofrontal cortex and reward. *Cerebral Cortex, 10*(3), 284–294.

Rozin, P., & Cohen, A. B. (2003). High frequency of facial expressions corresponding to confusion, concentration, and worry in an analysis of naturally occurring facial expressions of Americans. *Emotion, 3*(1), 68.

Rozin, P., Lowery, L., & Ebert, R. (1994). Varieties of disgust faces and the structure of disgust. *Journal of Personality and Social Psychology, 66*(5), 870.

Ruch, W., & Ekman, P. (2001). The expressive pattern of laughter. In A. W. Kaszniak (Ed.), *Emotion, qualia, and consciousness* (pp. 426–443). Tokyo: World Scientific Publisher.

Russell, J. A. (1994). Is there universal recognition of emotion from facial expressions?: A review of the cross-cultural studies. *Psychological Bulletin, 115*(1), 102–141.

Sander, D., Grandjean, D., Kaiser, S., Wehrle, T., & Scherer, K. R. (2007). Interaction effects of perceived gaze direction and dynamic facial expression: Evidence for appraisal theories of emotion. *European Journal of Cognitive Psychology, 19*(3), 470–480.

Sauter, D. (2010). More than happy: The need for disentangling positive emotions. *Current Directions in Psychological Science, 19*(1), 36–40.

Sauter, D. A., Eisner, F., Calder, A. J., & Scott, S. K. (2010). Perceptual cues in non-verbal vocal expressions of emotion. *Quarterly Journal of Experimental Psychology, 63*(11), 2251–2272.

Sauter, D. A., Eisner, F., Ekman, P., & Scott, S. K. (2010). Cross-cultural recognition of basic emotions through nonverbal emotional vocalizations. *Proceedings of the National Academy of Sciences, 107*(6), 2408–2412.

Sauter, D. A., Gangi, D., McDonald, N., & Messinger, D. S. (2014). Nonverbal expressions of positive emotions. In M. N. Shiota, M. M. Tugade, & L. D. Kirby (Eds.), *Handbook of positive emotion* (pp. 179–200). New York: Guilford Press.

Sauter, D. A., & Scott, S. K. (2007). More than one kind of happiness: Can we recognize vocal expressions of different positive states? *Motivation and Emotion, 31*(3), 192–199.

Scarantino, A. (2012). How to define emotions scientifically. *Emotion Review, 4*(4), 358–368.

Scherer, K. R., & Ellgring, H. (2007). Multimodal expression of emotion: Affect programs or componential appraisal patterns? *Emotion, 7*(1), 158.

Scherer, K. R., & Grandjean, D. (2008). Facial expressions allow inference of both emotions and their components. *Cognition and Emotion, 22*(5), 789–801.

Scherer, K. R., Johnstone, T., & Klasmeyer, G. (2003). Vocal expression of emotion. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 433–456). New York: Oxford University Press.

Schröder, M. (2003). Experimental study of affect bursts. *Speech Communication, 40*(1), 99–116.

Shariff, A. F., & Tracy, J. L. (2009). Knowing who's boss: Implicit perceptions of status from the nonverbal expression of pride. *Emotion, 9*(5), 631.

Shariff, A. F., & Tracy, J. L. (2011). What are emotion expressions for? *Current Directions in Psychological Science, 20*(6), 395–399.

Shearn, D., Bergman, E., Hill, K., Abel, A., & Hinds, L. (1992). Blushing as a function of audience size. *Psychophysiology, 29*(4), 431–436.

Shiota, M. N., Campos, B., & Keltner, D. (2003). The faces of positive emotion: Prototype displays of awe, amusement, and pride. *Annals of the New York Academy of Sciences, 1000*, 296.

Shiota, M. N., Keltner, D., & Mossman, A. (2007). The nature of awe: Elicitors, appraisals, and effects on self-concept. *Cognition and Emotion, 21*, 944–963.

Silvia, P. J. (2008). Interest: The curious emotion. *Current Directions in Psychological Science, 17*(1), 57–60.

Simon-Thomas, E. R., Keltner, D. J., Sauter, D., Sinicropi-Yao, L., & Abramson, A. (2009). The voice conveys specific emotions: Evidence from vocal burst displays. *Emotion, 9*(6), 838.

Snowdon, C. T. (2003). Expression of emotion in nonhuman animals. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 457–534). New York: Oxford University Press.

Susskind, J. M., Lee, D. H., Cusi, A., Feiman, R., Grabski, W., & Anderson, A. K. (2008). Expressing fear enhances sensory acquisition. *Nature Neuroscience, 11*(7), 843–850.

Tanaka, A., Koizumi, A., Imai, H., Hiramatsu, S., Hiramoto, E., & de Gelder, B. (2010). I feel your voice: Cultural differences in the multisensory perception of emotion. *Psychological Science, 21*(9), 1259–1262.

Tiedens, L. Z., & Fragale, A. R. (2003). Power moves: Complementarity in dominant and submissive nonverbal behavior. *Journal of Personality and Social Psychology, 84*(3), 558.

Tiedens, L. Z., & Leach, C. W. (Eds.). (2004). *The social life of emotions* (Vol. 2). New York: Cambridge University Press.

Tracy, J. L., & Matsumoto, D. (2008). The spontaneous expression of pride and shame: Evidence for biologically innate nonverbal displays. *Proceedings of the National Academy of Sciences, 105*(33), 11655–11660.

Tracy, J. L., & Prehn, C. (2012). Arrogant or self-confident?: The use of contextual knowledge to differentiate hubristic and authentic pride from a single nonverbal expression. *Cognition and Emotion, 26*(1), 14–24.

Tracy, J. L., & Robins, R. W. (2004). Show your pride evidence for a discrete emotion expression. *Psychological Science, 15*(3), 194–197.

Tracy, J. L., & Robins, R. W. (2007). *The self-conscious emotions: Theory and research.* New York: Guilford Press.

Tracy, J. L., & Robins, R. W. (2008). The nonverbal expression of pride: Evidence for cross-cultural recognition. *Journal of Personality and Social Psychology, 94*(3), 516.

Tracy, J. L., Robins, R. W., & Lagattuta, K. H. (2005). Can children recognize pride? *Emotion, 5*(3), 251.

Tracy, J. L., Shariff, A. F., Zhao, W., & Henrich, J. (2013). Cross-cultural evidence that the nonverbal expression of pride is an automatic status signal. *Journal of Experimental Psychology: General, 142*(1), 163.

Tronick, E. Z. (1989). Emotions and emotional communications in infants. *American Psychologist, 44*, 112–119.

van Dijk, C., de Jong, P. J., & Peters, M. L. (2009). The remedial value of blushing in the context of transgressions and mishaps. *Emotion, 9*, 287–291.

Van Kleef, G. A. (2009). How emotions regulate social life: The emotions as social information (EASI) model. *Current Directions in Psychological Science, 18*, 184–188.

Van Kleef, G. A., De Dreu, C. K., Pietroni, D., & Manstead, A. S. (2006). Power and emotion in negotiation: Power moderates the interpersonal effects of anger and happiness on concession making. *European Journal of Social Psychology, 36*(4), 557–581.

Vroomen, J., Driver, J., & De Gelder, B. (2001). Is crossmodal integration of emotional expressions independent of attentional resources? *Cognitive, Affective, and Behavioral Neuroscience, 1*(4), 382–387.

Williams, A. C. D. C. (2002). Facial expression of pain, empathy, evolution, and social learning. *Behavioral and Brain Sciences, 25*(4), 475–480.

Willis, F. N., & Hamm, H. K. (1980). The use of interpersonal touch in securing compliance. *Journal of Nonverbal Behavior, 5*, 49–55.

Wormann, V., Holodynski, M., Kartner, J., & Keller, H. (2014). The emergence of social smiling: The interplay of maternal and infant imitation during the first three months in cross-cultural comparison. *Journal of Cross-Cultural Psychology, 45*(3), 339–361.

Zentner, M., Grandjean, D., & Scherer, K. R. (2008). Emotions evoked by the sound of music: Characterization, classification, and measurement. *Emotion, 8*(4), 494.

Zhang, J. W., Piff, P. K., Iyer, R., Koleva, S., & Keltner, D. (2014). An occasion for unselfing: Beautiful nature leads to prosociality. *Journal of Environmental Psychology, 37*, 61–72.

CHAPTER 28

Emotional Body Perception in the Wild

Beatrice de Gelder

The study of cognition and emotion is a very broad area of research and it is fair to say that it is still expanding. New methods have become available for researchers and in part as a consequence of that, the age-old wall between emotion and cognition is rapidly crumbling. The classical picture of posterior to anterior processing in the cortex and the feedforward push of information from the simple to the more complex is gradually replaced by a combination of feedforward and feedback projections. The rich connectivity of the brain areas, not to forget their connections with subcortical structures, offers an exciting new perspective to see how emotion and cognition are intertwined.

Still, it often seems that emotion research is an area where scientists are divided by barriers of methods as well as by questions. Focusing on the search for integration of findings in the specific field of human emotion, or even more narrowly within that, the field of threat perception, it is easy to find examples of research endeavors that have proceeded unrelated to one another. It therefore seems remarkable that one barrier that does not seem to exist, or at least that does not appear to be experienced as a barrier by researchers in the field, is that of language. Across vastly different theories and models, the language used to talk about and investigate emotions is remarkably similar. But does this mean that the phenomena and underlying explanations are similar?

Let us continue with the example of fear and threat perception. Whichever aspect of threat perception is being considered—at the individual or group level and whether the threat is triggered by natural, social, or symbolic factors—studies tend to speak the same language and use the same core notions. This suggests that whatever the level of analysis (from behavioral to molecular) or whatever the level of detail, we are somehow talking about one and the same phenomenon, of fear or threat-of-fear experience, and we are talking about it in the same way, that is, by using the same central concepts that are understood similarly by all.

Is this indeed the case? In the spirit of other recent work discussed below, this chapter reconsiders emotion language as a blueprint for the neural basis of body language at the subpersonal level and the phenomena it covers by focusing on one specific area of research: that of body expression perception. In the course of a decade of researching the perceptual and neural basis of bodily expression of emotion, some basic assumptions have been challenged and some certainties have become unhinged.

This chapter is devoted to the current understanding of emotion and body expressions. It does not review systematically the studies on this topic from our own lab or from others. Such reviews have been done recently on other occasions (de Gelder, 2016; de Gelder, de Borst, Watson, 2014). Here I take a further theoretical step and one that mostly remained implicit in previous work. In reviewing our current understanding of the perception of body language, this chapter argues that our findings necessitate a revision of a core notion of many familiar and classical emotion theories, which is the dogma of the conceptual and categorical continuity across levels of analysis. I challenge the notion that the brain is integrated in such a way that across levels of descriptions I refer to the same holistic process. My rejection of this integrative dogma follows from evidence indicating that the brain processes body language in two different ways and that each of these requires a different account, with different ontologies. The first section of the chapter sets out the findings. The second, more theoretical section, describes what the distinctions are and why we can probably not ignore them. The third section develops the issue of threat perception as an example, sketches two ways to talk about threat signals, and considers body language from these two different perspectives.

Body Expression Perception: The Body as Object of Representation

In the few years that emotional body language has been studied, some interesting findings have come to the fore. These are, first, that the results on the perception of emotional body expressions seem more difficult to fit what is commonly assumed about the primacy of category-specific areas in the brain. What we have learned about bodily emotion perception does not square easily with the role assigned to the extrastriate body area (EBA), or to its twin brother, the fusiform body area (FBA), in studies of category representation in the temporal cortex. Second, significant activation has been found in other areas than the temporal cortex that are specifically important for emotion but do not depend on stimulus processing in the temporal cortex body areas. Third, these activations are earlier than the time courses typically associated with category perception. Fourth, there appear to be strong effects of congruency between a body expression and the natural and social context in which it is seen. Finally, body expressions are multisensory events not involving only putative visual recognition of body form. I review these findings in turn.

Body Area(s) and Encoding of Body Expression

The exact role of the body area(s) is still a matter of debate. The notion that there is an area whose function it is to assign category membership and thereby to be the gateway to subsequent attribute processing is borrowed from classical models of face perception. In this perspective, the emotional information is processed based on links between the body area and the amygdala (AMG), as envisaged for the case of some facial expressions like anger or fear, and this influences the activation level of the face category selective area(s). Support for this explanation was provided, for example, by a study on a direct AMG–fusiform gyrus (FG) connection (Vuilleumier, Richardson, Armony, Driver, & Dolan, 2004). To anticipate the arguments provided below, note though that a similar explanation would require that an EBA–AMG connection exists, which is not clear (Peelen, Atkinson, Andersson, & Vuilleumier, 2007). The debate has become more complex with the localization of a secondary body area in the FG (the FBA), and then with later studies providing evidence for a more fine-grained representation of bodies in the temporal cortex. In view of the uncertainty about function, one reasonable position is that the area that presumably is the gateway to body perception and body attribute recognition, the EBA, is itself not directly involved in representing the emotional information of body images (Downing & Peelen, 2011).

There are different types of findings here that speak to the notion of the body area as a category-specific area endowed with this gateway function. Admittedly, most of the relevant studies that have investigated body processing have used functional magnetic resonance imaging (fMRI) and cannot easily or directly provide a causal link between an area and its gateway function. However, some studies used transcranial magnetic stimulation (TMS) in normal controls and some were done with brain-damaged patients. The simplest and most conventional prediction, in line with standard models of hierarchical visual processing, is that the first stage of body perception is the one during which the overall body shape is encoded.

Our first fMRI study (de Gelder, Snyder, Greve, Gerard, & Hadjikhani, 2004) found a number of areas that react selectively to fear expressions, which included the FG, but the EBA was not among them. However, we did report an increased activation in FG as well as AMG activation. The studies used a whole-brain analysis and passive viewing without any requirement to name or even recognize explicitly the emotions expressed in the body images. In a later study, we used specific category localizers for face and body areas. When comparing activation in these areas (EBA, fusiform face area [FFA], posterior superior temporal sulcus [pSTS]) we did indeed observe that their level of activation was higher when the images were showing fear rather than being neutral (van de Riet, Grèzes, & de Gelder, 2009), as is consistent with the explanation based on an FBA–AMG connection.

One may ask whether some of these findings might in part be artifacts resulting from the use of still images. How would this pattern change when dynamic images are used? There is reason to believe that the use of dynamic stimuli would not radically change this picture (De Winter et al., 2015; de Gelder & Van den Stock, 2011). We undertook a systematic comparison of still and dynamic images (Grèzes, Pichon, & de Gelder, 2007) and found that the areas where there is a critical difference in activity level between fear dynamic and fear still images are the superior temporal sulcus (STS) and the premotor (PM) cortex, but not areas directly related to emotion perception such as the amygdalae. Interestingly, EBA activity was neither influenced by movement nor by emotion.

Critical Activation Outside Temporal Cortex Areas

TMS is a technique that allows the researcher to establish a direct relation between a specific brain area and its function so it should enlighten us on the role of the body category area in the temporal cortex. TMS studies targeting EBA present a complex and interesting picture.

A few TMS studies have focused on the role of the EBA in comparison with the FBA (Pitcher, Charles, Devlin, Walsh, & Duchaine, 2009; Pitcher, Goldhaber, Duchaine, Walsh, & Kanwisher, 2012) but did not engage directly in the neutral versus emotion comparison. As with fMRI studies, for TMS-based conclusions we ideally need studies that have directly compared neutral and expressive bodies. Three studies from our lab used TMS for this purpose. The first study (Candidi et al., 2011) showed that applying TMS to the EBA did not influence the task results of the participants when recognizing small changes in posture in two successive frames taken from a video clip. Instead, only stimulation to the pSTS clearly modified performance and this effect was specific for the fearful body expressions. The second study (Candidi, Stienen, Aglioti, & de Gelder, 2105) used a different technique, as the focus was on conscious versus nonconscious perception of face and body expressions. A third study (Engelen, de Graaf, Sack, & de Gelder, 2015) compared the effects of TMS on V1, the EBA, and the inferior parietal lobule (IPL). Here also, no effects were seen for EBA stimulation, while IPL stimulation improved expression recognition performance.

The Matter of Time Course

There are currently only a few studies that have looked into the time course of body expression perception. Stekelenburg and de Gelder (2004) found that fearful body expressions are processed holistically and show the same inversion effect in the N170 (a component of the event-related potential observed in the window of 150–200 ms after stimulus onset) that was originally thought to reflect specifically the neural processing of faces. As we showed, it also reflects upright body perception. Depending on one's view about the source of the N170, this activation could be seen as corresponding to the increase in activation in the FFA typically observed in many fMRI studies. But there was no posterior activation that could possibly be seen as related to the EBA. Instead, fearful body expressions triggered a sustained frontocentral potential at a longer latency. Using a more sensitive method, Meeren, Hadjikhani, Ahlfors, Hämäläinen, & de Gelder (2016) recently reported in a magnetoencephalography (MEG) study that the first time window corresponding to the presentation of fearful, as contrasted with neutral body expression, was 80–100 milliseconds. And this activity was located in the posterior parietal cortex (IPL), not in the ventral cortex area. Thus, there was no earlier emotion-specific activity in visual areas or in the EBA. This role for the IPL is compatible with findings that fearful body expressions rely on activity in the IPL shown in the TMS study by Engelen et al. (2015).

Context Influences Body Expressions

Emotional body expressions take place in natural environments. Our actions reflect our understanding of the environment. Thus, there has to be a close link between our understanding of a scene and the behavior. In a recent fMRI study, the relation between natural scenes and body expressions was investigated (van den Stock, Vandenbulcke, Sinke, & de Gelder, 2014). The participants were shown images of various categories of natural scenes. They consisted of natural landscapes or objects, each shown in a neutral and in an emotionally laden variant (a car or a crashed car, a quiet streetscape and one devastated after a storm). These images were either shown alone or were used as backdrop for neutral or fearful body expressions. In the latter case, the scene–body combination had either a congruent or incongruent valence for the body. An analysis focusing on the EBA shows an increased response to threat signals displayed by the body, whereas response to threat in the scenes is only seen when no body is present and when the body expression in the foreground is neutral. This intricate pattern reveals that scenes on their own can trigger activation in the body area, as happens in the face area (Sinke, Sorger, Goebel, & de Gelder, 2010), and that the information provided by the scene influences how neutral body images may be colored by the affective meaning of the scene (Hortensius et al., 2016). More research is needed to understand how these effects arise in real life.

Body Expressions Are Multisensory Events

We not only see people, but we hear, feel, and smell them. We still know very little about the way affective signals operate in these different modalities, and how they connect with information residing in the brain and are constantly reactivated in imagination (Bertelson & de Gelder, 2004). So far the standard way to investigate the issue of affective signaling in different sensory modalities is to present a stimulus in each of the different modalities and asking for a recognition judgment. A recent fMRI study explored modality-independent representations of emotion (Peelen, Atkinson, & Vuilleumier, 2010) by having participants evaluate the intensity of the emotion expressed by body movements, facial movements, or vocal intonations. They then utilized multivoxel pattern analysis to search for brain regions in which emotion-specific patterns in one modality (e.g., bodies) could predict emotion-specific patterns in a different modality (e.g., voices). Interestingly, they found modality-independent activity patterns in the medial prefrontal cortex (mPFC) and left STS. This leaves open the question of which aspects of modality-specific representations exist when no explicit emotion judgment is requested from the participants. Does the EBA then figure as a critical area for the visual modality (Watson & de Gelder, 2014)?

The Matter of Development

So far there is little research on the development of body representation during infancy, childhood, and adolescence. There is evidence from electroencephalogram (EEG) measurement that around 7 months infants react selectively to body images (Filippetti, Lloyd-Fox, Longo, Farroni, & Johnson, 2014). On the other hand, fMRI studies of youngsters and adolescents show that the body areas are not fully developed until adulthood (Ross, de Gelder, Crabbe, & Grosbras, 2014).

In contrast, few parents or educators, cartoonists or painters, would doubt that at a very early age children perfectly understand bodily expressions for what they are, that they convey their meaning unambiguously and trigger adaptive reactions in the youngsters. Clearly, the notion that body expressions are recognized in infants and children before full maturation of the cortical areas pinpointed for body categorization in an adult brain may be consistent with the notion that body categorization is a prerequisite for the recognition of body expressions of emotion.

Conscious or Not?

Body expressions are also processed when one is not attending to them and without being aware of it. The behavioral studies that have established this have been reviewed elsewhere (de Gelder, 2015). Here I review evidence only for the involvement in the body areas provided by fMRI and patient studies. Let us first consider the role of attention deficit related to a right parietal lesion. Tamietto, Geminiani, Genero, and de Gelder (2007) tested three such patients with hemispatial neglect in visual awareness for fearful, happy, and neutral bodily expressions. When fearful bodies were presented in the contra-lesional visual field together with neutral bodies in the ipsi-lesional visual field, they were detected more frequently than happy or neutral bodies in the contra-lesional visual field. This shows that the presence of a salient signal such as a full body fearful expression reduces the attention deficit. This result was followed up in an fMRI study of one of the cases in order to pin down which areas are specifically related to conscious emotional body perception (Tamietto et al., 2015). Interestingly, the EBA and FBA did not show a different pattern of activity depending on whether the image was perceived and consciously reported or not. Conscious perception of fearful bodies was uniquely associated with activity in the anterior insula; the somatosensory, motor, and premotor cortex; and in the cerebellum. These areas are implicated in interoception, the perception of sensory–motor changes in the organism. Of course, in my view one cannot conclude from this that these are the structures that play a crucial role in bridging the gap between nonconscious and conscious processes.

Visual unawareness due to attention disorders like neglect is a condition quite different from that caused by cortical blindness because only in the latter case is processing in the striate cortex ruled out. Functionally and anatomically, the role of body areas may thus be different depending on the processing route. Furthermore, whether or not the whole-body images provide emotional information, may make the difference between attentional blindness and cortical blindness more radical in the case of cortical blindness. To give one example, Van den Stock, Tamietto, et al. (2014) observed activation triggered by the presentation of neutral body images in the EBA without visual awareness of the stimuli in a bilaterally blind patient.

To conclude this section, current evidence suggests that the body areas, which are the putative loci of the body concept as the basis of conscious perception, may not be critically involved in the perception of body expressions and may not be the stage through which further processing of body information needs to be gated. If so, what is the neural basis of our recognition of and reaction to emotional body expressions?

Personal or Subpersonal?: The Importance of Making Distinctions

In the above studies, researchers have used notions such as perception, recognition, and action, and the various terms referring to the processing of emotions, in the same way and presumably therefore meaning the same reality. But is this the case?

There are a number of traditional, updated, and recent emotion theories around, but remarkably, most of them adopt the same explanatory schema and center on very similar central issues; the reasoning goes as follows. A description of the stimuli is a (set of) processing stages in the individual and a decision behavior. All along this chain of transformation from stimulus perception to behavior, the same concepts figure and language is used from the lowest (i.e., physiological) to the highest (i.e., cognitive) level to refer to what is processed (an affective stimulus) and who processes it (a subject). The intuition is that these levels hang together, building upon the same core concepts, referring to the same "natural kinds," and the same conceptual apparatus applies. When distinguishing between subpersonal and personal processes, or between individual or social processes, the validity of the personal-level language is usually not questioned. But this is more than we can assume or accept without argument.

Barrett (2009) discussed and summarized the situation of the diversity of behaviors that expresses anger as the *emotion paradox*. There are fundamental difficulties with this familiar picture, as has been shown in a series of arguments by constructionist theorists like Lisa Barrett and her group. Noteworthy, constructionist theories of emotion explicitly do not take an S → O → R approach to emotion (Barrett & Simmons, 2015). Nor do constructionist views assume that emotions are natural kinds and the basic building blocks of the emotional brain. In this sense, constructionist theories address some long-standing controversies in the human emotion literature and may be symptomatic of deeper problems. I consider two of them, as they are directly relevant to theories of body expression recognition. One is the old but still active debate about whether basic emotions actually exist; the other is the issue of whether emotion perception depends on the conceptual category representation that is available, as previously discussed in the section "Body Expression Perception."

Basic Emotions?

As is well known, most of the research on facial expression has been conducted from the vantage point of the central hypothesis of basic emotions. It seemed obvious for the new field of bodily expressions to take the same point of departure and assume that there are also six basic body expressions. Multisensory research has been conducted along these lines. If the same emotion is conveyed similarly by the face and the voice, there is reason to expect that information from each sensory input converges rapidly, as I showed originally for face–voice combinations (de Gelder, Böcker, Tuomainen, Hensen, & Vroomen, 1999) and as has been replicated by different researchers (Collignon et al., 2008; Hagan et al., 2009; Jessen &

Kotz, 2011). Reasoning along these lines, researchers have investigated the perception of emotion from the face, voice, and body and concluded that what is underlying the perception of these different inputs is a common core emotion substrate that qualifies as the abstract representation of the emotion in the brain.

Will this approach withstand close scrutiny? What if either current critiques are correct or future research establishes that there are no "basic" facial expressions? In the area of emotion research, the debate has centered on the existence of a few basic emotions originally opposing Ekman (1984) and Russell (2003). We can simplify the debate in the following way. Defenders of basic emotions argue for a bottom-up approach to cataloging emotions. Basic emotions are present in the organism at birth in whatever conceptual format, neurobiological substrate, or physiological engram. Much as the notion of basic emotions has triggered debates by Ekman himself in later statements (Griffiths, 1997, 2002) all versions of this basic emotion approach share the bottom-up picture about a circumscribed set of affective states. We may not know just how to characterize them, but across the different levels at which we describe the emotional life of the mind, the same familiar common-sense pillars are holding the organism together, from basement to roof. And, most importantly, these affective states are something very similar to what we mean in ordinary language by fear, anger, happiness, and so forth.

By contrast, we sketch the alternative view as a top-down approach. Basic emotions, viewed as biological entities or natural kinds, are the opposite of experiential, social, or interactive constructions (Hacking, 1999). A major argument of the opposition to basic emotions is that whether by the power of language or by that of culture, it is the conceptual apparatus of familiar emotion labels that allows us to cast a net over the ensemble of affective phenomena and characterize them in a more or less stable way. Constructivists argue that in the course of this procedure we created the impression that there are basic emotions in the brain while, in fact, emotions exist only in our way of talking about our experience. A recent argument in favor of this position was developed by Barrett (2009). It is important to note that recently the constructivist position has received a boost from meta-analytic studies of fMRI data, which may be considered as illustrating that there is remarkably little consensus on the neurofunctional basis of emotions in the brain (Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012).

Admittedly, this is an oversimplification of positions that have been formulated with much more nuance by their defenders. For example, the approach elaborated by Barrett and Satpute (2013) is different from the position originally argued for by Russell (2003). In line with some view about constructivism in other social science disciplines, emotion constructivism was associated with personal-level experience. But my goal in drawing this sketch is to bring out what in fact both positions have in common. This is adherence to a *unitarian* notion of the subject of emotions. It is the fundamental presupposition in all our thinking about emotion that the "I" or the self, the person or the subject of the emotional experience, is always present and understanding. To paraphrase in the simplest terms, if one does not feel it (or cannot verbalize, testify to it, communicate or otherwise express), then it is not an emotion and he or she cannot explain the affect. The notion that we are conscious of our emotions and intentions and that our conscious feelings and intentions cause, and therefore explain, our actions are at the core of how we conceive of human beings.

We cannot use this familiar framework and its conceptual categories to understand subpersonal processes, which are *de jure* the processes that are currently targeted by the scientific methods of affective science.

The distinction between personal and subpersonal explanations has been present in contemporary philosophy of mind, since at least the 1970s (Dennett, 1969). The distinction is easy to grasp but its consequences for scientific theories of the mind are vast. In a nutshell, at the personal level theories use the familiar and common-sense notions about mental processes, action, thinking, goals, and most relevant here, about emotions and emotional experience (see Metzinger, 2011, for fine analyses). But none of those concepts are applicable at the subpersonal level—that is, when we talk about brain areas, physiological processes, and so forth.

Now, in the present context, the issue is whether—given that we accept the distinction between personal and subpersonal processes—it is actually conceptually coherent to talk about conceptual representation at the subpersonal level. If not, theories of emotion addressing processes, mechanisms, and explanations at this level need a radically different conceptual apparatus in which the ontology of daily experience is not altogether deterministic vis-à-vis our scientific hypotheses about the brain. The familiar approach of emotions as motivational feelings and states or as explanatory constructs, around which both basic and constructivist emotion theories are built, is not applicable to the description and explanation of humans at the reflex-like behavior level.

First, experiencing fear or reacting to threat are states that can be well described at the personal level, and are the ingredients of explanation of someone's actions. But this is not the case when we consider the subpersonal level. We simply cannot take for granted that there is or must be a correlate of personal and conscious experience in the subpersonal affective mechanisms.

Second, on the cognitive process model side, the conceptual apparatus used to describe and explain emotional experience are models that are built on the familiar daily object categories.

In the context of this chapter I make the case with findings from studies on body expressions. If one maintains the notion of basic emotions in the biological sense, the issue is whether and how these translate at the personal level in the observable behavior. Can we classify the bodily expressions along those basic categories, or, more pertinently, is this a good way to investigate how the brain deals with body expressions?

Body Expression Perception as Action and as Experience

Here is a sketch of the approach. As already implied, a crucial notion is that of multiple processing streams. For the sake of the argument in this chapter we use a model of dual-processing streams. But this is not to be taken as a theoretical position carved in stone, it is only a simplification reflecting current understanding. The organism reacts to the sight of body expressions along separate but parallel routes that were previously referred to as reflex-like and reflective behaviors (de Gelder, 2006). With that approach as background, we can now clarify some further aspects of each route in relation to the processing of bodily signals. The reflex-like processing route is based on activation of *immersive scenarios* or scenarios where the context and the action are welded together—for example, the scenario of running from the sight and smell of fire. One could call these scenarios immersive because the perceiver is immersed in the context reality and is not in a mode of analytically dealing with separate components of the environment and adding them together to get at the meaning of the scene. The other route is by activating concept-based representations (the category body) and subsequently (as a matter of logical requirement, a matter of time course of both) combining them. Here the perceptual process is first and foremost a matter of object categorization. This category representation stage is followed by further processing consisting of object attribute decoding and context decoding. The bare bones of this model of emotion perception as cognitive (re)description of physiological reactions is already found in James (1884). To put this traditional contrast in the most simplistic formulation, top-down or constructivist theories envisage projection of higher-order concepts onto lower-level descriptions. Bottom-up theories postulate content-preserving redescriptions translating from organismic processes to cognitive descriptions and onto explanations of behavior.

Contrary to the bottom-up and top-down theories, I argue here that the two processing streams coexist and are involved in most of the processing history of an affective stimulus. An essential aspect of this approach is that the two processing routes are normally both active and trigger independently. The personal and the subpersonal simply do not map onto each other; these two worlds do not meet. But I return to that matter below. This means that the lower levels of organismic responses are not automatically preserved and represented through successive cognitive descriptions. There is no transparency or content-preserving transformation from low-level physiological responses to phenomenal experience and to the upper levels of cognitive appraisal. This implies that the organismic processes like freezing, for example, cannot be described with the use of cognitive language consisting of concepts that have cash value in only personal and cognitive levels of analysis.

A position like the one just sketched has recently been described very clearly by LeDoux (2012) and, along somewhat similar lines but in a different framework, by Panksepp (1998). This means that, for example, even for the case of fear, which is presumably the one candidate emotion concept that can be "translated" most closely in organismic reactions, we cannot really identify a fear circuit or project the conceptual content of the conscious fear experience on the organismic reactions.

No Basic Emotions at the (Sub)personal Level

For an outsider, it must surely be bewildering that activations of brain areas as discovered with sophisticated fMRI have not yet led to clear function assignments that would take the formula of one emotion: one brain area (a few, a network). The areas that were originally pinpointed as the seat of fear (the amygdalae), disgust (anterior insula), sadness (anterior cingulate cortex), and anger (orbitofrontal cortex) have come under attack from the experimental data, even in studies that are restricted to the cortex. The field is moving away from the original notions where one emotion concept and its perceived function (including the typical behavior and experience) could be pinned down to one area. Recent meta-analyses (Vytal & Hamann, 2010; Lindquist et al., 2012) have provided new evidence that there is no such thing as a 1:1 relation between a specific emotion and its corresponding brain area (the fear area in the AMG) or even a corresponding brain network (the fear network). The fact that this one emotion:one brain area type of relation between a familiar object of emotion and its neurofunctional correlate now seems increasingly unlikely, does not stop optimists from arguing that there are differences in stimuli, methods, analysis techniques, and tasks across the different studies. The consequence is that we do not yet know exactly which area does what and that the search for a 1:1 relation is still on. More advanced fMRI methods like high-field scanning and analysis methods like multivoxel pattern analysis (MVPA) and searchlight techniques may still contribute data that support this classical emotion picture.

Depending on one's viewpoint there are different ways to deal with the current picture. Traditional constructivism argues, often convincingly, that one emotion:one area is the wrong agenda for emotion research. Alternatively, networks may replace emotion modules, and emotion labels themselves may disappear at the brain level to be replaced by structure–function mappings that are domain general and shared by different brain functions whether they are predominantly cognitive, social, or emotional (Barrett & Satpute 2013).

Is there then a better chance of finding and naming basic emotions when the theory is restricted to the subpersonal level? The answer depends on whether we can develop a methodology to investigate subpersonal processes that does not depend of a predefined cognitive categorical system.

No Body Representation at the (Sub)personal Level?

At the subpersonal level the affective brain is built of integrated perception–action scenarios. What this means is that an element in the environment triggers a scenario or a program, not a single representation that would require extensive processing and interpretation by cognitive structures. For example, seeing a whole-body expression of fear triggers a scenario of escape or escape preparation. Different fear situations trigger different fear scenarios. Similarly, hearing a loud noise triggers a survival scenario. One can think of these as integrated body–environment scenarios, or face–body scenarios, face and/or face and body–voice or –sound scenarios. They correspond to organism-specific interaction patterns and survival scenarios of the actions of the individual organism, its interactions with others, and the actions of the group of conspecifics in their natural environment. They do not require higher-level reflection or decision and are not dependent on cognitive control, mental state attribution or theory of mind, cognition, decision, or action–intention understanding on the part of the conscious agent.

Disconnection: The Methodological Conundrum

Historically, the earliest approaches to the scientific study of human emotions were already confronting the issue of the interface between the newly gained scientific language to investigate correlates of affective processes and the commonsense language of emotional experiences. In the human emotion literature, physiological processes and the notion of arousal presented the interface that links the conscious individual to its organismic roots. For example, physiological arousal supposedly lowers the threshold for awareness, making us aware of salient and relevant aspects of the environment that would otherwise go unnoticed or remain within the realm of nonconscious processes. But attributing this content-delivering role to physiological processes flies in the face of evidence. Indeed, it has long been known that physiological arousal carries no specific identifying label about its causes.

What about an interface then? Is there an interface between levels and mechanisms, between the raw emotions and the cognitive processes, as is usually assumed in cognitive theories of emotion perception and appraisal? The logic of the distinction between personal and subpersonal level compels us to reject the notion of an interface in the sense of an automatic mapping of subpersonal states and processes to personal states, processes, attitudes, and so forth. At the subpersonal level there is no epistemic agency and there is no thinking autonomous agent willfully planning his or her actions and initiating behaviors. At the personal level there is cognitive accountability exercised with intentions, plans, and concepts. It is not a translation but an active representation by a "self" with the aid of a model of its actions.

Art and Emotion: An Illustration

One may argue that, of the various art forms, dance combines a few characteristics that make it among the most basic and ancient forms of art. Watching dance creates emotion in the observer; it moves the observer often literally and always metaphorically. For example, people report being brought to tears by the choreographies from Pina Bausch. Yet the dance movements we are watching, the patterns making the dance "language," are utterly unfamiliar. Not only is it not feasible for nonprofessionals to mimic the movements of the dancers without extensive training, but the movements do not have referents in the motor repertoire of nonprofessionals, nor do they have a clear meaning that is activated in watching a performance. Yet it is the meaning of the movements that moves us, such that some spectators are brought to tears. No concept is expressed or represented in these movements yet they stir clear and strong emotions in the observer. These facts are a challenge for explanations that view concepts like motor perception, imitation, and motor contagion as central. In contrast, one can take the emotional impact of watching unknown dance movements as an indication that at the subpersonal level bodily movements are not necessarily perceived with the help of the well-known conceptual categories and do not correspond to known or canonical descriptions of body movements associated with each everyday emotion.

The concept of fear seems fully transparent in the sense that everybody knows what it means and what experiences and behaviors it is about. But at the same time this concept covers a wide variety of fear triggers, behaviors, and experiences. Social fear versus environmental fear is just one very superficial distinction. Still, phenomenologically, they are all experienced as fear. Introspectively, they may all feel like fear and therefore be lumped together. Hence the notion is that there is a fear system in the brain that represents all these variants and that is their common core. We are beginning to understand, so far mainly from animal experiments, that there are as many kinds of fear as there are contexts, behaviors, types of attacking, or conditions for self-defense. For example, animal studies adapt the distinction between social fear versus predator fear (Gross & Canteras, 2012; Silva et al., 2013).

The issue addressed in these last paragraphs is discussed with a different terminology than used here in a number of papers by Jaak Panksepp (2011) in the context of animal feelings and consciousness.

The implications of the distinctions I just made for understanding emotional body expressions are straightforward. I have argued that the question of whether there are basic body expressions is not easy to answer. Whether there ultimately are basic body expressions will depend on whether it is useful to describe and categorize the vast number of bodily expressions encountered in real life along some organizing and explanatory lines. But the prediction is that once such a research program becomes more advanced, we will see that these will not be the same at the subpersonal and at the personal level. The point is well illustrated with the example of defensive behavior. The following is far from an exhaustive list of common ways to behave in the presence of an aggressive person. Defensive behaviors can vary among at least all of these: running away, grabbing any tool to attack, looking for cover; hiding and covering oneself, typically by holding the hands in front of the face; adopting a nonaggressive face expression; making oneself disappear; protecting vulnerable things in the environment (children, wallets, telephones, etc.); or submitting to the attack, giving in, and showing surrender in voice, posture, and so forth. All of these behaviors would in the appropriate circumstances qualify as adaptive behavior. But two things stand out when we consider the variety of such defensive behaviors. First is that in order to be adaptive or to explain that they are adaptive, people do not necessarily need to assume they are under cognitive control, initiated by higher-order cognitive processes, or following so-called processes of mentalizing. Subpersonal-level explanations involving sensorimotor loops embedded in specific contexts and responding to characteristic adaptive demands go a long way toward understanding such behaviors. There are as yet not many examples of studies that have investigated emotion-related behavior from that perspective—that is, unbiased by the traditional conceptual apparatus and conceptual categories of the conscious intentional mind. The second aspect that stands out is that it does not add anything to what needs to be understood or explained to view any of these behaviors as derived from fear in the mind. Of course, one can view all of these behaviors as manifestations of fear, but it does not add anything new to our understanding to do so.

The distinction between personal and subpersonal descriptions can be illustrated with an analogy. In the literature on body awareness and its disorders in brain-damaged patients a contrast emerged quite early on between body schema and body image (see, e.g., Paillard, 1999). The first refers to a sensorimotor map of the body space that is mainly based on proprioception. The second refers to the mostly explicit description of the body as based on external information. The neuropsychological literature is rich in examples illustrating how these two notions of the body do not map onto each other (e.g., Berlucchi & Aglioti, 2010). In the same vein, bodily expressions in the wild may not correspond to body expression as described from the perspective of a conscious willful and intentional agent.

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REFERENCES

Barrett, L. F. (2009). Variety is the spice of life: A psychological construction approach to understanding variability in emotion. *Cognition and Emotion, 23*(7), 1284–1306.

Barrett, L. & Satpute, A. B. (2013). *Current Opinion in Neurobiology, 23*, 361–372

Barrett, L. & Simmons, W. K. (2015). Nature Reviews Neuroscience, *16*(7), 419–429

Berlucchi, G., & Aglioti, S. (2010). The body in the brain revisited. *Experimental Brain Research, 200*(1), 25–35.

Bertelson, P., & de Gelder, B. (2004). The psychology of multimodal perception. In C. Spence & J. Driver (Eds.), *Crossmodal space and crossmodal attention* (pp. 140–177). Oxford, UK: Oxford University Press.

Candidi, M., Stienen, B. M., Aglioti, S. M., & de Gelder, B. (2011). Event-related repetitive transcranial magnetic stimulation of posterior superior temporal sulcus improves the detection of threatening postural changes in human bodies. *Journal of Neuroscience, 31*(48), 17547–17554.

Candidi, M., Stienen, B. M., Aglioti, S. M., & de Gelder, B. (2015). Virtual lesion of posterior superior temporal sulcus modulates conscious visual perception of fearful expressions in faces and bodies. *Cortex, 65*, 184–194.

Collignon, O., Girard, S., Gosselin, F., Roy, S., Saint-Amour, D., Lassonde, M., et al. (2008) Audio-visual integration of emotion expression. *Brain Research, 25*, 126–135.

de Gelder, B. (2006). Towards the neurobiology of emotional body language. *Nature Reviews Neuroscience, 7*(3), 242–249.

de Gelder, B. (2016). *Emotions and the body*. New York: Oxford University Press

de Gelder, B., Böcker, K. B., Tuomainen, J., Hensen, M., & Vroomen, J. (1999). The combined perception of emotion from voice and face: Early interaction revealed by human electric brain responses. *Neuroscience Letters, 260*(2), 133–136.

de Gelder, B., de Borst, A. W., & Watson, R. (2014). The perception of emotion in body expressions. *WIREs Cognitive Science, 6*(2), 149–158.

de Gelder, B., Snyder, J., Greve, D., Gerard, G., & Hadjikhani, N. (2004). Fear fosters flight: A mechanism for fear contagion when perceiving emotion expressed by a whole body. *Proceedings of the National Academy of Sciences of the United States of America, 101*(47), 16701–16706.

de Gelder, B., & Van den Stock, J. (2011). Real faces, real emotions: Perceiving facial expressions in naturalistic contexts of voices, bodies and scenes. In A. Calder, J. V. Haxby, M. Johnson, & G. Rhodes (Eds.), *The handbook of face perception* (pp. 535–550). Oxford, UK: Oxford University Press.

de Winter, F. L., Zhu, Q., Van den Stock, J., Nelissen, K., Peeters, R., de Gelder, B., et al. (2015). Lateralization for dynamic facial expressions in human superior temporal sulcus. *NeuroImage, 106*, 340–352.

Dennett, D. (1969). Personal and sub-personal levels of explanation: Pain. In *Content and consciousness* (pp. 90–96). New York: Humanities Press.

Downing, P. E., & Peelen, M. V. (2011). The role of occipitotemporal body-selective regions in person perception. *Cognitive Neuroscience, 2*(3-4), 186–203.

Ekman, P. (1984). Expression and the nature of emotion.

In K. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 319–344). Hillsdale, NJ: Erlbaum.

Engelen, T., de Graaf, T. A., Sack, A. T., & de Gelder, B. (2015). A causal role for inferior parietal lobule in emotion body perception. *Cortex, 73*, 195–202.

Filippetti, M. L., Lloyd-Fox, S., Longo, M. R., Farroni, T., & Johnson, M. H. (2014). Neural mechanisms of body awareness in infants. *Cerebral Cortex, 25*(10), 3779–3787.

Grèzes, J., Pichon, S., & de Gelder, B. (2007). Perceiving fear in dynamic body expressions. *NeuroImage, 35*(2), 959–967.

Griffiths, P. E. (1997). *What emotions really are: The problem of psychological categories*. Chicago: University of Chicago Press.

Griffiths, P. E. (2002). What is innateness? *The Monist, 85*(1), 70–85.

Gross, C. T., & Canteras, N. S. (2012). The many paths to fear. *Nature Reviews Neuroscience, 13*(9), 651–658.

Hacking, I. (1999). *The social construction of what?* Cambridge, MA: Harvard University Press.

Hagan, C. C., Woods, W., Johnson, S., Calder, A. J., Green, G. G., & Young, A. W. (2009). MEG demonstrates a supra-additive response to facial and vocal emotion in the right superior temporal sulcus. *Proceedings of the National Academy of Sciences of the United States of America, 106*, 20010–20015.

Hortensius, R., Terburg, D., Morgan, B., Stein, D. J., van Honk, J., & de Gelder, B. (2016). The role of basolateral amygdala in the perception of faces in natural contexts. *Philosophical Transactions of the Royal Society B, 371*, 20150376.

James, W. (1884). What is an Emotion? *Mind, 9*, 188–205.

Jessen, S., & Kotz, S. A. (2011). The temporal dynamics of processing emotions from vocal, facial, and bodily expressions. *NeuroImage, 58*(2), 665–674.

LeDoux, J. (2012). Rethinking the emotional brain. *Neuron, 73*(4), 653–676.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*(3), 121–143.

Meeren, H. K. M., Hadjikhani, N., Ahlfors, S. P., Hämäläinen, M. S., & de Gelder, B. (2014, June). *Human right parietal cortex shows early preferential responses to naturalistic emotional stimuli: An MEG study*. Poster presented at the Society for Neuroscience Conference, Washington, DC.

Meeren, K. M., Hadjikhani, N., Ahlfors, S. P., Hämäläinen, M. S., & de Gelder, B. (2016). Act first, think later. Early preferential responses to fear in human right dorsal visual stream measured with MEG. *Scientific Reports*.

Metzinger, T. (2011). *Being no one: The self-model theory of subjectivity*. Cambridge MA: MIT Press.

Paillard, J. (1999). Body schema and body image—A double dissociation in deafferented patients. In G. N. Gantchev, S. Mori, & J. Massion (Eds.), *Motor control: Today and tomorrow* (pp. 197–214). Sofia, Bulgaria: Academic Publishing House.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions*. New York: Oxford University Press.

Panksepp, J. (2011). Cross-species affective neuroscience decoding of the primal affective experiences of humans and related animals. *Plos One, 6*(8), e21236.

Peelen, M. V., Atkinson, A. P., Andersson, F., & Vuilleumier, P. (2007). Emotional modulation of body-selective visual areas. *Social Cognitive and Affective Neuroscience, 2*(4), 274–283.

Peelen, M. V., Atkinson, A. P., & Vuilleumier, P. (2010). Supramodal representations of perceived emotions in the human brain. *Journal of Neuroscience, 30*, 10127–10134.

Pitcher, D., Charles, L., Devlin, J. T., Walsh, V., & Duchaine, B. (2009). Triple dissociation of faces, bodies, and objects in extrastriate cortex. *Current Biology, 19*(4), 319–324.

Pitcher, D., Goldhaber, T., Duchaine, B., Walsh, V., & Kanwisher, N. (2012). Two critical and functionally distinct stages of face and body perception. *Journal of Neuroscience, 32*(45), 15877–15885.

Ross, P. D., de Gelder, B., Crabbe, F., & Grosbras, M. H. (2014). Body-selective areas in the visual cortex are less active in children than in adults. *Frontiers in Human Neuroscience, 8*, 941.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*(1), 145.

Silva, B. A., Mattucci, C., Krzywkowski, P., Murana, E., Illarionova, A., Grinevich, V., et al. (2013). Independent hypothalamic circuits for social and predator fear. *Nature Neuroscience, 16*(12), 1731–1733.

Sinke, C., Sorger, B., Goebel, R., & de Gelder, B. (2010). Tease or threat?: Judging social interactions from bodily expressions. *NeuroImage, 49*(2), 1717–1727.

Stekelenburg, J. J., & de Gelder, B. (2004). The neural correlates of perceiving human bodies: An ERP study on the body-inversion effect. *Neuroreport, 15*(5), 777–780.

Tamietto, M., Cauda, F., Celeghin, A., Diano, M., Costa, T., Cossa, M., et al. (2015). Once you feel it, you see it: Insula and sensory-motor contribution to visual awareness for fearful bodies in parietal neglect. *Cortex, 62*, 56–72.

Tamietto, M., Geminiani, G., Genero, R., & de Gelder, B. (2007). Seeing fearful body language overcomes attentional deficits in patients with neglect. *Journal of Cognitive Neuroscience, 19*, 445–454.

van de Riet, W. A., Grèzes, J., & de Gelder, B. (2009). Specific and common brain regions involved in the perception of faces and bodies and the representation of their emotional expressions. *Social Neuroscience, 4*(2), 101–120.

Van den Stock, J., Tamietto, M., Zhan, M., Heinecke, A., Hervais-Adelman, A. G., Legrand, L., et al. (2014). Neural correlates of body and face perception following bilateral destruction of the primary visual cortices. *Frontiers in Behavioral Neuroscience, 8*, 30.

Van den Stock, J. V., Vandenbulcke, M., Sinke, C. B., & de Gelder, B. (2014). Affective scenes influence fear perception of individual body expressions. *Human Brain Mapping, 35*(2), 492–502.

Vytal, K., & Hamann, S. (2010). Neuroimaging support for discrete neural correlates of basic emotions: A voxel-based meta-analysis. *Journal of Cognitive Neuroscience, 22*(12), 2864–2885.

Vuilleumier, P., Richardson, M. P., Armony, J. L., Driver, J., & Dolan, R. J. (2004). Distant influences of amygdala lesion on visual cortical activation during emotional face processing. *Nature Neuroscience, 7*(11), 1271–1278.

Watson, R., & de Gelder, B. (2014, June). *Investigating implicit crossmodal decoding of body–voice emotion using multivariate pattern analysis*. Poster presented at the Society for Neuroscience Conference, Washington, DC.

CHAPTER 29

Form and Function in Facial Expressive Behavior

Daniel H. Lee and Adam K. Anderson

Facial expressions of emotion are a salient and important means of social communication (Ekman, 1973; Fridlund, 1994; Izard, 1977). Visually, the face is the most important part of an individual's identity. So it is not surprising that how our facial information changes by its expressivity captures our attention (Vuilleumier, Armony, Driver, & Dolan, 2001) and serves as an important source of nonverbal communication (Bruce & Young, 1986; Calder & Young, 2005). Among the various expressive forms the human face can take, researchers have found six expressions that are recognized as communicating distinct mental states (fear, disgust, surprise, anger, happy, and sad) consistently across cultures, literate and preliterate (Ekman, Sorenson, & Friesen, 1969; Ekman & Friesen, 1971). The most likely explanation for these expressions' cross-cultural consistency is a common point in their evolutionary selection that passed them down to all humans, rather than the less likely, independent emergence of them within each culture. These categories of facial expressions have been labeled "basic expressions" (Ekman, 1973, 1999; Izard, 1977, 1994), and over time, their recognition has been found to be reliable (e.g., Etcoff & Magee, 1992; Scherer & Wallbott, 1994; Young et al., 1997; see Elfenbein & Ambady, 2002, for a definitive meta-analysis), with the pattern of their forms being recognized similarly in machines as in humans (Susskind, Littlewort, Bartlett, Movellan, & Anderson, 2007).

Providing balance to this view, some of the stronger inferences made based on the evidence for basic expressions have been criticized, mainly against the notion that basic expressions might be "universal" in a strong sense, rather than a more relativistic, "cultural universality." Critics emphasizing socially and psychologically constructivist influences over absolute universals suggest a weaker form of basic expressions in that they are not fixed categories, nor immutable readouts of our internal states. In the argument against strong categories of expressions, constructivists note: the variance of facial expression space, of which six expressions capture a small fraction; the psychological tendency to impose distinct categories within this multidimensional space (Barrett, 2006a, 2006b); and that these basic and other expressions become susceptible to higher-order associations for social and contextual utility (Fridlund, 1997). Evidence supporting this view has shown basic expressions' cultural (Jack, Garrod, Yu, Caldara, & Schyns, 2012) and contextual variance (Aviezer et al., 2008; Aviezer, Trope, & Todorov, 2012), and that our faces are able to communicate more than just six mental state categories (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Baron-Cohen, Wheelwright, & Jollife, 1997; Du, Tao, & Martinez, 2014).

With the empirical evidence supporting culturally invariant and culturally variant expression forms, one theory that incorporates both sides is the dialect theory of expressions (Elfenbein, 2013). It considers cultural variations in expressions form as "accents" and "dialects" that emerge as socially learned ingroup advantages (Elfenbein & Ambady, 2003; Marsh, Elfenbein, & Ambady, 2003) that developed atop a global grammar of culturally invariant basic expressions (Elfenbein & Ambady, 2002). The application of a language metaphor (Tomkins & McCarter, 1964) to the nonverbal medium of facial expression communication connotes the utility of understanding the invariant grammar and lexicon of English, as well as the variant accents and dialects that emerge within local regions of England.

Taken together, much evidence and theory has been accrued in accounting *what* our culturally invariant and variant forms of expressions are. However, a notably neglected line of research in our understanding of expressions forms is *why*—that is, *why* do our expressions look the way they do? One reason for the paucity of research understanding why certain culturally variant expressions exist may be the challenge in theorizing their abstract, emergent origins. However, we are better positioned to understand the origins of our culturally invariant basic expressions for two reasons. First, we have an evolutionary theory that accounts for their cultural invariance. While our facial expressions are now used primarily for communicative purposes, Darwin (1872/1998) theorized that their forms originated for sensory function for the expresser, which were then co-opted for social function. Second, because this theory is grounded in a primitive sensory function, rather than a more abstract communicative function, we are equipped to test such specific hypotheses of function. Investigating the origins of these nonverbal communicative forms is worthwhile, considering that their cultural invariance encompasses a wider scope than the etymology of any spoken word.

In this chapter, we discuss research inquiring into the evolutionary origins of our common expression forms and examine evidence for their origins grounded in Darwin's (1872/1998) theories of egocentric function. Afterward, we take a preliminary look at how some of these egocentric functional forms may have been co-opted for allocentric function.

In his book *The Expression of the Emotions in Man and Animals*, published in 1872, Darwin posited his theories on the origins of our emotions. He proposed three principles by which emotional expressions may be understood: the principle of serviceable associated habits, the principle of antithesis, and the principle of direct action (or expressive discharge) of the nervous system. The first two of these principles addressed how nature shaped and organized our expressions and are relevant here. The first principle argues that expressions originated for some immediate egocentric functional benefit, rather than their modern, allocentric communicative purpose. Thus, an emotional expression's appearance is not arbitrary but was selected for its congruent adaptive function with its emotion. The second principle of antithetical form argues that expressions can be understood as originating from opposing actions. Thus, an expression may have another that is opposite in appearance for an opposing function.[1] And because the face contains many of our key sensory apertures (e.g., eyes, nose, mouth, ears), Darwin (1872/1998) theorized that the function of emotional expressivity was to adaptively modulate sensory intake, such as lowering of the brows to reduce the eyes' exposure to sunlight.

Darwin's (1872/1998) principles are less concerned with expressions' explicit categories and their immutability from higher-order social associations. Instead, he placed emphasis on the bottom-up expressive features that once served the animal for some sensory function (i.e., *why* they appear the way they do). From this perspective, a basic "fear" expression represents not so much a universal ideal but rather a probable grouping of facial action tendencies that cohere toward some sensory function (e.g., vigilance toward threat in fear; Whalen, 1998). Then, the basis of these expressions, which were originally predicated on utility for the expresser, would have been co-opted as communicative signals for utility for the expressions' receiver (Andrew, 1963; Shariff & Tracy, 2011). In the following, we discuss a series of studies that examined Darwin's principles, toward understanding facial expressions' form and egocentric function, and how they may have undergone social exaptation for allocentric function. We begin with basic expressions' form.

Form

A useful starting point for understanding expression form is to be impressed by the sheer physical breadth of the facial musculature that supports it—our potential expression space. Based on the taxonomy of our facial muscle units, the Facial Action Coding System (Ekman, Friesen, & Hager, 1978), we computed that a conservative estimate of our possible expression space amounts to 3.7×10^{16} possibilities.[2] To put this number in perspective, it means that correctly identifying an expression in this space is the probabilistic equivalent of a person winning two Powerball jackpots.[3] This combinatorial complexity affirms the multidimensional nature of our expression space, which cannot be fully captured by six distinct categories, and leave ample possibility for higher-order expressive associations for social utility, whether as ingroup dialects (Elfenbein, 2013) or complex mental states (Baron-Cohen et al., 1997, 2001; Du et al., 2014). At the same time, it provides a statistically appropriate context for affirming the cross-cultural consistency of basic expressions. If our expressions were purely higher-order associations, each shaped arbitrarily for social communication, there could not be any recognition of expressions across cultures. We would instead be left with sets of arbitrary expressions that would have to be translated across cultures, akin to the symbolic associations of verbal languages. Thus within this expressive framework, basic expressions need not be universal in the strong sense but in having maintained statistical stability across the myriad influences of culture and context they would indicate a common ancestry.

It is daunting to try to understand the raw complexity of this expressive space, and how our basic expressions fit in it. A dimensional perspective (Oosterhof & Todorov, 2008; Plutchik, 1980; Rolls, 1990; Russell, 1980; Russell & Barrett, 1999; Watson & Tellegen, 1985) is helpful in keeping some of this variance tractable, but we still require a theory to organize and interpret those dimensions. Moreover, familiar dimensions of psychological experience (Rolls, 1990; Russell, 1980; Russell & Barrett, 1999; Watson & Tellegen, 1985) or physiological changes (Bradley, Codispoti, Cuthbert, & Lang, 2001; Cacioppo & Berntson, 1994), such as valence and arousal, may not be the most applicable way to frame dimensions of physical form, in particular if the physical forms have been evolutionarily selected for survival. A more aptly organizing perspective may be that evolutionary selection implies function, and when it comes to nature's selection of behaviors or features that interface with the physical world, form follows function.[4] We thus applied Darwin's (1872/1998) principles as a framework for understanding basic expression form.

Framed by Darwinian principles, the cross-cultural consistency of basic expressions (Ekman et al., 1969; Ekman & Friesen, 1971) may be important as reference points that reveal how natural selection organized those expressive features as probable action tendencies rather than categorical ideals. Then, toward uncovering these natural origins, basic expressions' features may be useful to consider as anchors, without which we would find ourselves adrift in facial expressions' combinatorial complexity. Darwin's second principle of antithesis also provides an organizing influence toward aligning opposing expressions and dimensional continua of expression variance based on appearance and function. Applying these ideas may reveal a more predictable pattern for understanding the basic expressions that anchor our vast expressive space.

Indeed, while facial action units may be taxonomized independently, our basic expressions appear to have systematic relationships in activation and thus expressive appearance (Dailey, Cottrell, Padgett, & Adolphs, 2002; Susskind et al., 2007). To concretely examine these facial action tendencies, we applied a computer graphics model of facial appearance (Cootes, Edwards, & Taylor, 2001) to the six basic expressions from a standard cross-cultural dataset (Matsumoto & Ekman, 1988). The appearance model allowed us to create a prototype for each basic expression as vector representations that coded its expressive shape. This revealed an important dimension of expressive action of widening versus narrowing of the sensory apertures across a number of basic expressions. For example, fear and surprise demonstrated expressive widening, while in opposition, disgust and anger demonstrated expressive narrowing (Susskind & Anderson, 2008). These similarities in expression form were corroborated by similarities in expression perception, where fear and surprise were perceived alike, and disgust and anger were perceived alike, and each pair was perceived highly unlike the other pair (Susskind et al., 2007). Of these expressions along this dimension, we focused our examination on the two that occupied the extremes of expressive widening versus narrowing: fear and disgust (Susskind et al., 2008).

Based on these vectorized models of facial form, we first tested a prediction of this widening versus narrowing expressive dimension. We generated computerized fear and disgust "antiprototypes" by reversing the direction of the facial action vectors of the fear and disgust prototypes, predicting that these antiprototypes would be perceived as its prototype's dimensional opposite. Indeed, participants perceived antifear most strongly as disgust and antidisgust most strongly as fear (Susskind et al., 2008). These vectorized facial models also indicated the expressive directions that represented these action tendencies that either stretched or compressed features of the face. To visualize the action tendencies of these expressions, we generated vector flow diagrams of these expression prototypes relative to their antiprototypes (Figure 29.1). They demonstrated expanding versus compressing longitudinal actions of the muscular frames around the mouth, nose, and eyes (Susskind et al., 2008; Susskind & Anderson, 2008), suggestive of Darwin's (1872/1998) theories of expressive form and its opposition.

Beyond just demonstrating opposition in form, if these actions that widen versus narrow the sensory apertures were indeed selected for function (Darwin, 1872/1998), they should cohere with theorized functions of the emotions associated with the expressions. Next, we examine Darwin's principles on whether these forms confer sensory benefits to the expresser.

Egocentric Function

A prominent theory of the function of fear is vigilance toward threats (Öhman & Mineka, 2001; Whalen, 1998). For an animal confronted with immediate potential threats in its environment, survival would be enhanced by increasing its sensitivity toward detecting and locating those threats (even if they turned out to be benign, false positives). Thus, congruent with fear's theorized function, we predicted that widening of sensory apertures, such as the eyes and nasal passages, would promote the gathering of relevant sensory information. Conversely, disgust is theorized to be an emotion of rejection toward threats of a different kind (Rozin & Fallon, 1987; Rozin, Haidt, & McCauley, 2000; Chapman & Anderson, 2012). Potentially originating in older principles of distaste and rejection of chemosensory stimuli (Chapman, Kim, Susskind, & Anderson, 2009), expressions of disgust may reflect a different response, such as a deliberate discrimination (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Sherman, Haidt, & Clore, 2012) of threats of a more proximal, stationary kind. Thus, in addition to fear and disgust expressions potentially serving as anchoring ends of a widening versus narrowing facial expressive dimension (Susskind

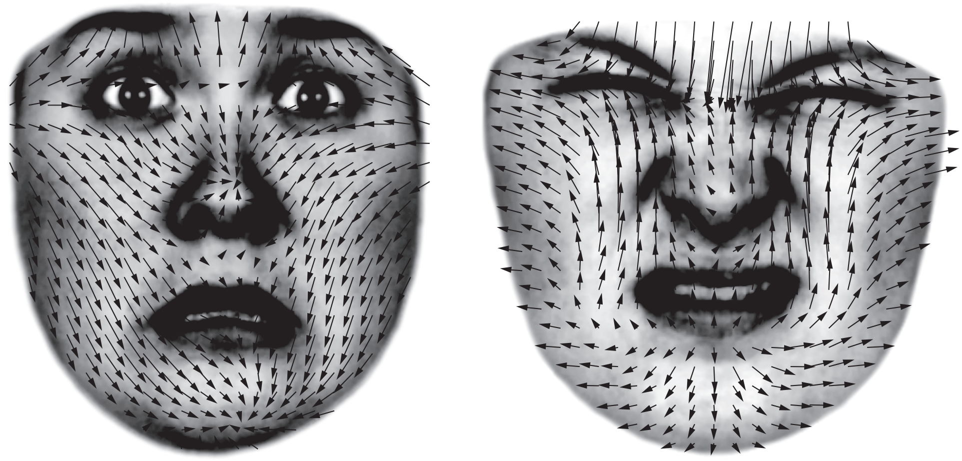

FIGURE 29.1. Opposition in facial actions of fear and disgust expressions. Arrows depict vector flow fields of skin surface deformations of an expression prototype from its corresponding antiprototype. Visualizing these underlying facial–action patterns indicates the opposing expansion in fear (left) versus compression in disgust (right) along the longitudinal axis emanating from the bridge of the nose, resulting in raised versus lowered brows, increased versus decreased eye aperture, and vertical elongation versus compression of the nose associated with raised versus lowered lips. Adapted from Susskind et al. (2008).

et al., 2008), these independently theorized functions of fear and disgust emotions provided specific hypotheses of egocentric function to test about their sensory consequences.

We tested this thesis of facial form's function using a variety of experiments on how expressive actions functionally influence two conspicuous sensory apertures: the nose and the eyes. Participants posed expressions in a directed facial action paradigm as we measured various sensory functions and perceptual consequences. The use of directed facial actions (instructions for fear: raising the eyebrows and drawing them together, opening the eyelids, letting their mouths drop open and stretching their lips horizontally; for disgust: raising their upper lips, wrinkling their noses and raising their cheeks[5]; for neutral: relaxing the facial muscles; Ekman et al., 1978) rather than inducing fear or disgust was important in being able to isolate the sensory effects of facial expressions through facial form, independent from the cognitive influences emotions can have at the level of the central nervous system (e.g., enhancing attention; Vuilleumier et al., 2001).

Nose

Beginning with nasal effects of expressive action, we acquired nasal respirometry, nasal temperature, and abdominal–thoracic respiratory measures during a controlled instructed breathing cycle. Given equal duration of inspiration (2.2 seconds in/out per breath), fear was associated with an increase in air velocity and volume relative to neutral and disgust expressions, even when corrected for respiratory effort (Figure 29.2a; Susskind et al., 2008).

Altered air intake may reflect a variety of factors rather than genuine structural changes in sensory capacity afforded by facial expression form. We thus directly examined whether fear and disgust altered the underlying structure of the nasal passages in opposing manners. High-resolution magnetic resonance images of the nasal passages were acquired during the directed facial action task, which resulted in nasal passage volume significantly modified by expression (Figure 29.2b; Susskind et al., 2008). More specifically, these structural images revealed that fear expressions resulted in a dilation of the entry to the inferior nasal turbinates of the respiratory mucosa, consistent with horizontal mouth stretching and lowering facilitating nasal passage dilation; in contrast, disgust resulted in a sealing off of this normally open passage, consistent with upper lip raising and nose wrinkling (Figure 29.2c).

Eyes

Moving on to visual function, we examined how expressions influence the visual field. First, testing subjective measures of visual field change, participants reported seeing farther out into the periphery of a visual grid space while posing fear relative to neutral as well as disgust (Figure 29.3a; Susskind et al., 2008). Next, testing objective measures of visual field change, we used two kinds of stimuli in separate experiments. In a simple dot target detection task, fear widened the peripheral visual field relative to neutral and disgust (Susskind et al., 2008). This visual field expansion of fear was similarly found in a rigorous psychophysical task where participants identified orientations of Gabor gratings that were controlled for visual angle size (Figure 29.3b; Lee, Susskind, & Anderson, 2013). In the latter psychophysical study, eye widening of fear expressions enhanced the effective visual field of the expresser 9.4% farther out in the available periphery compared with neutral (Lee et al., 2013). These visual field changes were direct physical effects of opening versus occluding of the upper visual periphery by eye opening, as corroborated by the larger effect in the vertical rather than oblique meridians (due to the morphology of our vertically opening eyes) and an opposing visual periphery reduction for eye-narrowing disgust expressions.

Although we found visual field enhancements along the vertical and oblique meridians and not the horizontal, participants maintained central fixation in order to test their peripheral, and not foveal, vision. However, in the real world, eye movements are critical for gathering information about one's visual surroundings. In another experiment, we examined whether fear expressions facilitate muscle units for eye scanning. We found that horizontal saccades to peripheral targets (27° apart) were faster for fear relative to neutral and disgust, for both, average and peak speeds (Susskind et al., 2008).

These visual field effects were due to a basic sensory gating mechanism, involving simple retraction of eye features that occlude the visual periphery. But beyond peripheral occlusion effects we theorized that expressive eye opening may fundamentally influence how light is gathered along a functional dimension seen throughout the visual system. Although facial muscles that reconfigure superficial eye features should have no direct influence on the pupil or the accommodative lens behind it, approximately two-thirds of the eye's full refractive power comes from the cornea (Duke-

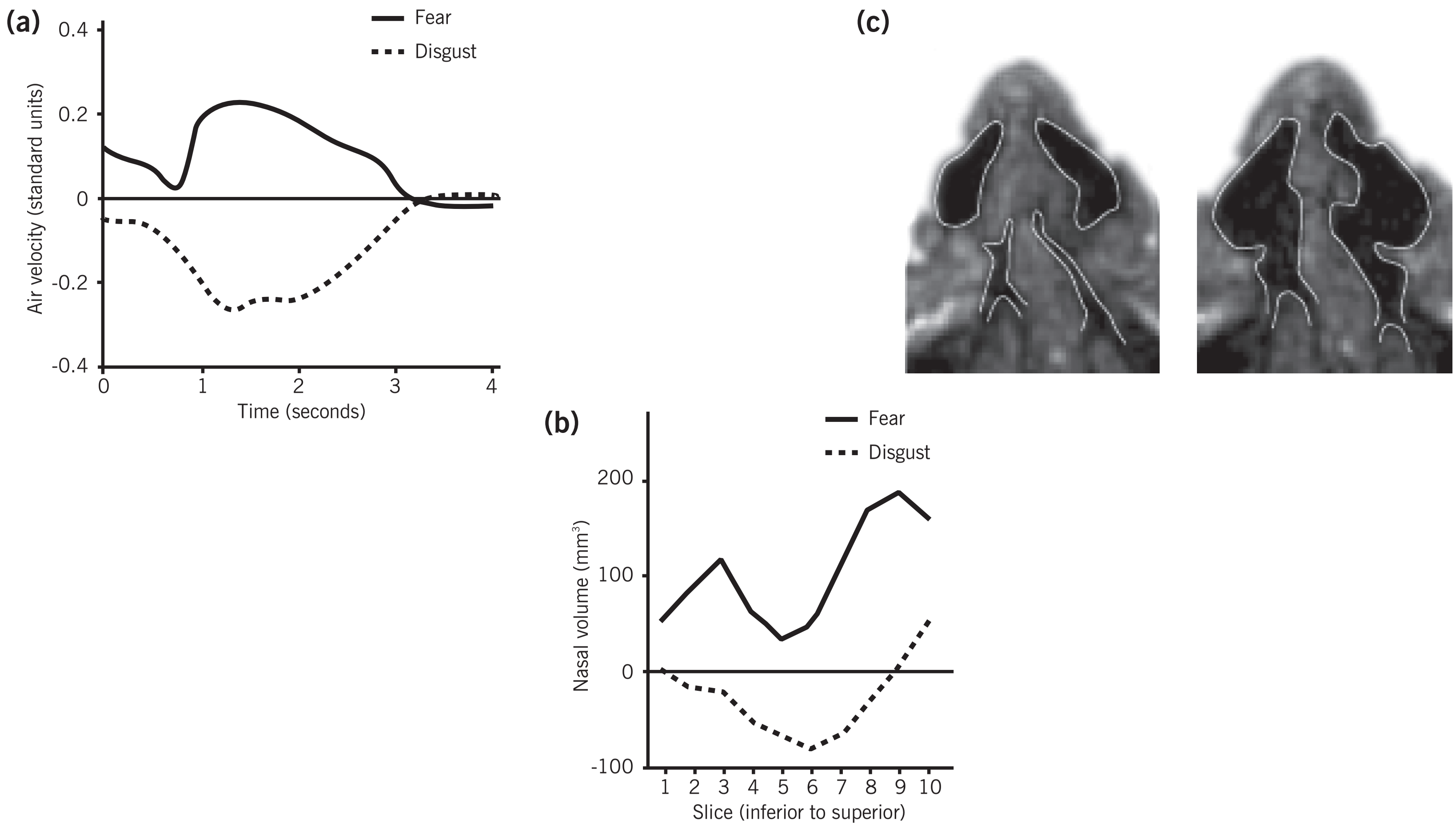

FIGURE 29.2. Nasal effects of fear and disgust expressions. (a) Mean air-flow velocity (in standardized units) for fear and disgust expressions relative to neutral during inhalation over time (2.2 seconds). (b) Volume of air cavity of the ventral portion (12 millimeters) of the nasal passages for fear and disgust expressions relative to neutral. Each slice was 1.2-millimeters thick with an in-plane resolution of 0.86 × 0.86 mm. (c) Passageways to the inferior turbinate of the respiratory mucosa from magnetic resonance imaging. Expressions of disgust (left) and fear (right) resulted in closure and dilation, respectively. Adapted from Susskind et al. (2008).

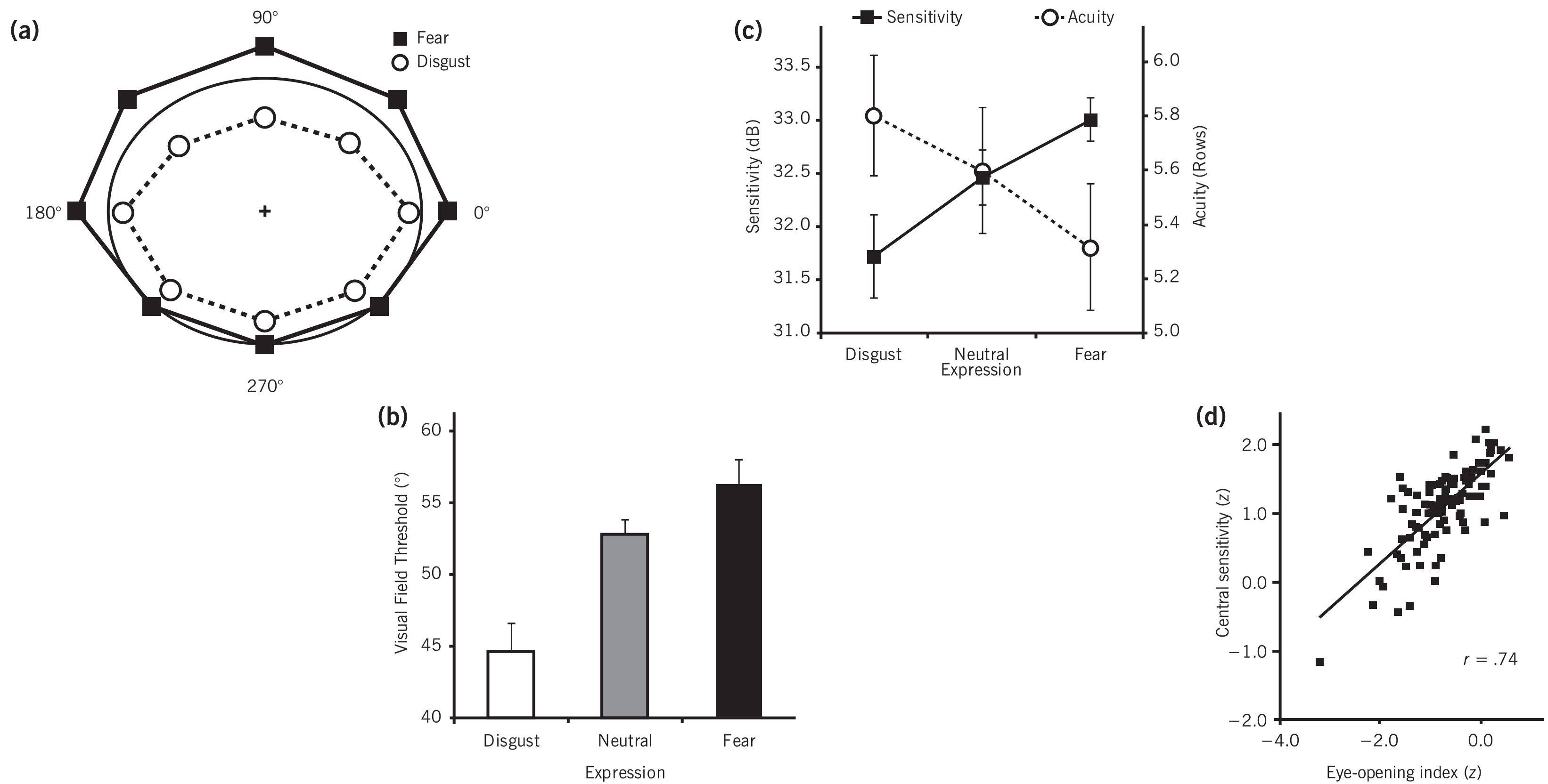

FIGURE 29.3. Visual effects of eye widening and narrowing in fear and disgust expressions. (a) Subjective visual field changes in visual field estimation along horizontal, vertical, and oblique axes. Central ellipse is neutral baseline. (b) Objective visual field thresholds for identifying Gabor orientations for each expression. Fear expanded the visual field relative to neutral and disgust expressions. Error bars represent SEM. (c) Visual sensitivity (left *y*-axis) and visual acuity (right *y*-axis) effects of expression. Sensitivity scores are restricted to the central visual field (4.2° visual angle from fovea). Acuity scores are the number of correctly read rows of eye-chart letters. Higher scores indicate greater sensitivity or acuity. Error bars represent SEM. (d) Relationship of central visual field sensitivity to degree of eye opening, indexed by visual sensitivity measured at the peripheral visual field (mean visual angle from fovea = 20.6°, SD = 2.1°). Expression effects on visual sensitivity in the periphery are due to light occlusion by eyebrow and eyelids, whereas central visual field is due to light refraction. Adapted from Susskind et al. (2008) and Lee et al. (2013, 2014).

Elder & Abrams, 1970). We thus predicted facial expressive behaviors that expose or conceal the cornea to have adaptive consequences on the eye's optics. Specifically, an optical model predicted eye widening to increase light gathering and enhance sensitivity over acuity, prioritizing fear's function for vigilance of threat detection and localization (Öhman & Mineka, 2001; Whalen, 1998). Conversely, eye narrowing would focus light more sharply to enhance acuity over sensitivity, prioritizing visual discrimination of different kinds of threat, such as contaminated foods or disease vectors (Chapman & Anderson, 2012; Rozin et al., 2000; Sherman et al., 2012).

This functional tradeoff between sensitivity and acuity is a familiar division in the visual system, from retinal rods and cones to the crude but fast magnocellular and slow but sharp parvocellular systems (Livingstone & Hubel, 1987), which are carried on to the dorsal and ventral streams for processing "where" and "what" information, respectively (Ungerleider & Mishkin, 1982). The optical tradeoff suggested by our model predicted that expressive actions that alter the eyes' capacity to gather and focus light may have arisen from a differential need to filter light information toward the "where" (magnocellular) versus "what" (parvocellular) channels, in a situation-appropriate manner.

We tested this optical tradeoff hypothesis in experiments that used standard optometric measures of visual sensitivity and visual acuity. In a psychophysical contrast-sensitivity task, eye-widening fear expressions enhanced visual sensitivity, whereas disgust reduced it. Conversely, in a visual acuity task using standardized eye charts (Bailey & Lovie, 1976), eye-narrowing disgust expressions enhanced acuity, whereas fear reduced it (Figure 29.3c; Lee, Mirza, Flanagan, & Anderson, 2014).

Continuous Physical Dimension

Across the nasal and visual experiments, we also found reliable, linearly increasing effects from disgust to fear (Susskind et al., 2008; Lee et al., 2013, 2014). The clearest demonstration of this was in the sensitivity measures eye aperture, where degree of eye opening across participants and conditions was directly related to central sensitivity effects (Figure 29.3d). This suggests that these sensory effects are tied to a continuum of expressive action tendencies rather than discrete facial configurations, emphasizing the underpinning of a physical nature, rather than psychological categories. The physical underpinning of these sensory effects, which can occur in the absence of their discrete emotions, such as fear and disgust and their associated autonomic expression, suggest that the egocentric functional dimension of eye opening may extend to other expressions (e.g., raising eyebrows in surprise or lowering them in anger; Susskind & Anderson, 2008). This availability of continuous physical form and the degrees of influence on egocentric changes also leaves open a potentially wider and more complex window into the intentions of the expresser (Baron-Cohen et al., 1997, 2001; Du et al., 2014) and cultural variance in their interpretation and emergence (Aviezer et al., 2012; Elfenbein & Ambady, 2003; Marsh et al., 2003; Fridlund, 1997; Jack et al., 2012; Russell & Barrett, 1999).

Increasing evidence suggests that emotions influence the central nervous system at multiple levels to alter perception (e.g., Krusemark & Li, 2011; Li, Howard, Parrish, & Gottfried, 2008; Sherman et al., 2012; Todd, Talmi, Schmitz, Susskind, & Anderson, 2012). The collective evidence here shows that emotional expressions can exert potent effects at the earliest stage of sensory encoding. These effects are consistent with the theorized functions of fear and disgust (Chapman & Anderson, 2012; Öhman & Mineka, 2001; Rozin et al., 2000; Sherman et al., 2012; Whalen, 1998) and the distinct processing dynamics proposed for fear and disgust (Anderson et al., 2003), as the opposing sensory and perceptual effects discussed in this chapter shed light on why these two negatively valenced and avoidance action-related emotions are associated with opposing facial actions (Susskind et al., 2008) and opposing effects on the autonomic nervous system (de Jong, van Overveld, & Peters, 2011; Levenson, 1992). For example, specific to the eyes, the functions of their expressive widening and narrowing may converge with the sympathetic dilation and parasympathetic constriction of the pupil (Beatty & Lucero-Wagoner, 2000), potentially acting as the initial filters toward the magnocellular (dorsal) and parvocellular (ventral) visual streams (Ungerleider & Mishkin, 1982).

It is important to note that the expressive effects here are attributable to direct sensory differences rather than indirect effects of facial feedback (e.g., Strack, Martin, & Stepper, 1988) or emotional embodiment (Niedenthal, 2007). In the sensitivity experiment, measurement of pupil size found no differences during posing expressions (indicating a lack of autonomic feedback) and no differences in behavioral tendency, measured by fixations away from center to peripheral targets (Lee et al., 2014). However, in full-fledged emotional expressions, we would expect these egocentric sensory functions to be further augmented—for instance, in fear, its eye-widening light sensitivity may be amplified by an increase in sympathetic autonomic tone (Levenson, 1992) that dilates the pupils, and the further conjunctive retracting of the eyelids through the involuntary, sympathetically innervated Müller's muscle (Brunton, 1938).

While expressive forms may have been functionally shaped to modulate the expresser's sensory intake, the modern utility of our expressions extends beyond the self to serve as social signals. We next examine evidence on how such allocentric function may have been co-opted from egocentric functional forms.

Allocentric Function

To examine how expressions' interpersonal function may have been co-opted from personal function, we focused on the eyes. The eyes are an important source of social information (e.g., Marsh, Adams, & Kleck, 2005; Smith, Cottrell, Gosselin, & Schyns, 2005), with the capacity to communicate a wide variety of complex mental states (Baron-Cohen et al., 1997, 2001). Indeed, circumscribed brain regions in the superior temporal sulcus and gyrus, which are responsive to eye information (Allison, Puce, & McCarthy, 2000; Calder et al., 2007), neighbor regions supporting how we read the mental states of others (in the temporoparietal junction; Saxe & Powell, 2006). Convergently, increasing failure to use the information conveyed by the eyes has been positively related with degrees of autism, a disorder tied to failures in the ability to understand the expresser's mental states (Baron-Cohen, 1995).

Prior work has also examined how emotional expressions influence processing of eye gazes. For instance, fear expressions facilitate faster judgments of averted gaze compared with direct gaze (Adams & Franklin, 2009) and, inversely, that averted gaze enhances the perceived intensity of fear (Adams & Kleck, 2005). Fear expressions' directional eye gazes have also been shown to deploy additional attention in the context of an attentional cueing paradigm (Putman, Hermans, & van Honk, 2006; Tipples, 2006). These eye gaze effects are hinged to the communicated emotion and illustrate a congruent social utility of eye gazes with fear expressions in facilitating a state of vigilance in the observer as well as fear's expresser—the state of alarm whose reverberation in the observer acts as the catalyst (e.g., Harrison, Singer, Rotshtein, Dolan, & Critchley, 2006).

Physical Signal

In our examination, we tested the benefits of fear expressions on the eye gaze signal at a more basic, physical signal level. We predicted that wider fear eyes would capitalize on the morphology of our eyes, such as the additional contrast provided by our white sclera thought to have coevolved with our social nature (Kobayashi & Kohshima, 1997). The enhancement of this physical signal in expressive eye widening would serve as the most expedient social signal of a significant event's location by way of a clearer "look here" gaze signal. Thus, the potential personal sensory benefit of eye widening would be directly conferred interpersonally prior to, or independent from, the need for the communicated emotion of the expresser.

We created schematic eye stimuli using modeled (Cootes et al., 2001) expressions of fear and disgust, and removed the rest of the face, which reduced their emotional perception (Lee et al., 2013) in order to impoverish any emotional influence of the full expressions while retaining the basic physical features. We then created four different eye sizes, from narrowest disgust to widest fear (Figure 29.4a), of which participants judged the gaze directions. We found accuracy of gaze direction judgment linearly increased with increased eye widening (Figure 29.4b).

Given that mere greater exposure of eye whites can activate the amygdala (Adams, Gordon, Baird, Ambady, & Kleck, 2003; Whalen et al., 2004) and widened eyes are sufficient to recognize fear (Smith et al., 2005), the recruitment of emotional circuitry as well as some degree of emotion contagion (Harrison et al., 2006) in modulating these effects was possible. To control for this, we used the same eyes inverted, as inverted fear expressions have demonstrated reduced fear perceptions (McKelvie, 1995), reductions in amygdalar activity (Sato, Kochiyama, & Yoshikawa, 2011), and attentional orienting (Bocanegra & Zeelenberg, 2009; Phelps, Ling, & Carrasco, 2006; although they have been shown to retain some of their affective influences; Lipp, Price, & Tellegen, 2009). Indeed, the inverted schematic eyes reduced the perception of fear but provided the identical physical gaze signal and retained the same enhancement in gaze

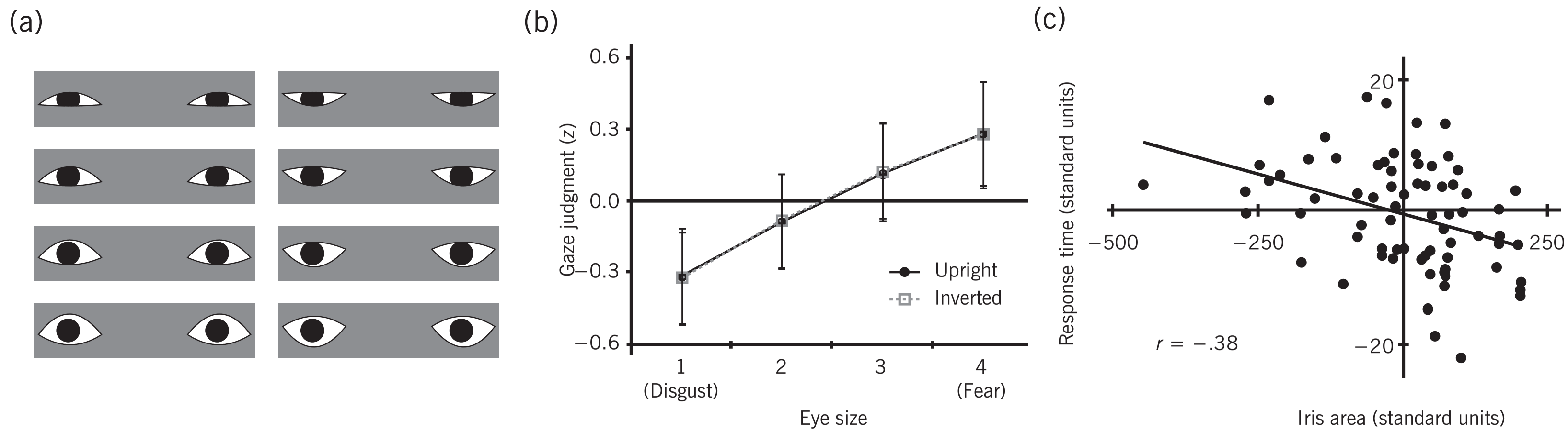

FIGURE 29.4. Allocentric physical signaling effects of eye widening. (a) Schematic eyes were modeled from participants who posed disgust expressions (top images; Size 1) and fear expressions (bottom images; Size 4). Intermediate Sizes 2 and 3 were interpolated linearly from Size 1 to 4 in equal steps of vertical aperture. Eyes in the right column are inverted versions of eyes in the left column. All eyes are gazing the same degree, slightly left of center. (b) Plot shows standardized scores of logistic regression slopes for each eye size for upright and inverted eyes. Accuracy of gaze direction judgments increased with eye widening, but not eye inversion. Error bars represent SEM. (c) Plot shows response time negatively correlated to visible iris information. Participants responded faster to peripheral targets cued by wider eye gazes that revealed more iris. Adapted from Lee et al. (2013).

judgment accuracy for wider eyes (Figure 29.4b; Lee et al., 2013).

Separately, we examined whether fear eye widening would directly facilitate observer responsiveness in locating peripheral targets (i.e., to “look here”). In a gaze-cueing experiment, we used the same schematic eyes and found that participants responded faster to cued peripheral targets, with response speed related to key physical features of the eyes, contrast, and amount of visible iris (Figure 29.4c; Lee et al., 2013). Further, we found no attentional biasing effect of wider eyes, which further suggested that the effects of the emotionally impoverished gaze stimuli were not due to the communicated emotion, as full fear expressions and their gazes have been shown to bias attention (Vuilleumier et al., 2001; Putman et al., 2006; Tipples, 2006).

The importance of the physical signal of our eye gazes is highlighted in the features that are enhanced in fear’s eye widening, which provide no direct function for the expresser. For example, the additional exposure of our physically salient white sclera, unique among primates (Kobayashi & Kohshima, 1997), suggests an additional social function supported by expressive eye widening. Thus the egocentric sensory benefits of fear may have had a direct influence in shaping their allocentric benefits—by the single expressive action of eye widening that augments its physical saliency, fear’s sensory function may be directly linked with that of the observer. In this way, the functional benefit of expressive fear at its basic sensory level in locating potential threat is passed on to the observer through transmission of a clearer “look here” gaze signal, highlighting the coevolution of egocentric and allocentric sensory functions of expressions.

Retracting the eyelids and eyebrows has likely resulted from multiple selective pressures. One such pressure may be the coevolution of an enhanced processing of events in the visual field of the expresser passed on to the observer. The basic, physical utility of this function may have been selected prior to expression’s modern utility of communicating a particular emotion or mental state (Shariff & Tracy, 2011). Convergent evidence also suggests the interaction of these pressures toward a congruent social function, such as the emotionality of full fear expressions enhancing averted gaze direction processing (Adams & Franklin, 2009). Further linking allocentric to egocentric function, fear expressions have also shown to improve early vision for observers (Phelps et al., 2006), specifically along lower spatial frequency channels (Bocanegra & Zeelenberg, 2009), which is aligned with fear expressions’ prioritized perception and action via the low-spatial-frequency-tuned-magnocellular pathway, projecting to the dorsal stream (Vuilleumier, Armony, Driver, & Dolan, 2003; West, Anderson, Bedwell, & Pratt, 2010).

Summary

The purpose of this chapter was to bridge a gap in our understanding of facial expressions: why they look the way do and how they were shaped to be the varied social communicative signals of today. Our thesis is that of Darwin (1872/1998), who posited that our facial expressions originated for sensory function to provide egocentric benefits to the expresser, which were then socially co-opted for allocentric function to the expressions’ observers.

In the broader context of facial expression research, this egocentric-to-allocentric functional perspective supports an integration of categorical and dimensional views. It holds the categorical view of expressions (Ekman, 1999; Izard, 1994) to the degree that basic expressions such as fear and disgust represent higher-order probabilities organized by lower, adaptive actions as opposites along a dimension of an expressive continuum (Oosterhof & Todorov, 2008; Russell & Barrett, 1999; Susskind et al., 2008). Thus, basic expressions are not considered strong universal categories, but the evidence for their functional origins provides a parsimonious, empirical account of their cultural consistency (Ekman et al., 1969; Ekman & Friesen, 1971). Then, rather than the emergence of new and variant sets of expressive forms across different cultures, it is likely that these invariant, adaptive action tendencies were socially co-opted for communication (Andrew, 1963; Shariff & Tracy, 2011), serving as anchoring sources of invariance in expression perception across cultures and contexts.

The facial actions we tested for egocentric function fell on a sensory regulatory dimension of widening versus narrowing expressive form. The variance afforded by this dimension makes available a variety of facial expressions that can be interpretable as signals of different mental states (Baron-Cohen et al., 1997, 2001; Du et al., 2014) and cultural dialects of expressive communications (Elfenbein, 2013). This perspective accommodates the constructivist view in that the labels that define specific facial actions and their degrees of expressivity (i.e., what the expressions are) is left up to social interpretation and context (e.g., Aviezer et al., 2012; Fridlund, 1997; Jack et al., 2012; Russell & Barrett, 1999). However, an important consequence of this functional perspective is how it may provide guiding constraints for understanding why our expressions as social signals look the way they do. While features could be arbitrarily mapped for communication, they cannot be arbitrarily mapped for function (Darwin, 1872/1998; Susskind et al., 2008). For example, from a strictly constructivist perspective (Barrett, 2006a, 2006b), widening and narrowing of the eyes may not universally characterize fear and disgust expressions, especially given the powerful influences of culture (Jack et al., 2012) and social context (Aviezer et al., 2008, 2012) on perception of facial expressions. So if fear and disgust expressive forms were swapped, they would serve equally well as social signals of mental states but have misaligned functional consequences (e.g., reducing acuity in disgust, or making it harder to tell where someone is gazing during fear). Evidence that these functionally driven features serve as guides for social interpretation is supported by the fact that powerful contextual effects do not cause narrow-eyed expressions to be judged similarly to wide-eyed ones, and vice versa (Aviezer et al., 2008).

We found adaptive sensory effects for both fear-widening and disgust-narrowing expressions, aligned with their theorized emotion functions. However, despite symmetrical opposing form, they did not necessarily exhibit symmetry in function. For example, in contrast to a visual field enhancement in fear, its reduction in disgust arguably confers no functional benefit. And anatomically, while a sympathetically innervated Müller's muscle may further retract the eyes, there is also no opposing, parasympathetically innervated muscle that further closes the eyes. This asymmetry in functional needs was also seen in the utility of these expressions to their receivers, as only wider fear eyes conferred the benefit of enhanced gaze judgment. Physically speaking, fear and disgust both communicate negative emotional states, thus being equal potential targets for attention, but the salience of the signal transmitted by their eyes is biased toward fear. This asymmetric salience of eye widening may also enhance detection of these expressions from afar (Smith & Schyns, 2009), in addition to transmitting a clearer "look here" signal, both aligned with fear's selective pressures toward rapid processing of distal, moving threats, as compared with disgust that tracks proximal, stationary ones (Anderson et al., 2003). That is, fear and disgust are both threat responses of different kinds, with the former more appropriate for a potential predator or looming threat and the latter for a potential disease vector (Chapman et al., 2009; Chapman & Anderson, 2012; Rozin & Fallon, 1987; Rozin et al., 2000). Further social exaptation of fear's association with sensitivity and immediacy in action is evidenced in fear expressions' relationship with the magnocellular system, in their perceptual prioritization (West et al., 2010), and low-spatial-frequency tuning (Bocanegra & Zeelenberg, 2009; Vuilleumier et al., 2003). In contrast, we predict that encoding of disgust expressions would be slower and more attentionally gated (Anderson et al., 2003), dependent on the ventral parvocellular system and high-spatial-frequency analysis.

Looking forward, this functional perspective of expression form may further serve as a useful guide for navigating the complex ways that facial information can interact with our social nature. For instance, neuroimaging evidence has shown that amygdala activations toward fear expressions are enhanced for members of one's own culture, suggesting greater saliency attributed to potential threats toward ingroup members (Chiao et al., 2008). Also, the pedomorphic features of fear's wide eyes have been shown to solicit more socially sympathetic responses from neighbors (Marsh, Ambady, & Kleck, 2005), thereby reciprocating the signaling function transmitted by the expresser. The overlearning of these socially coopted expressive facial features (Zebrowitz, 1997) can also convey traits that are more enduring than transient mental states, such as sexual orientation (Rule, Ambady, Adams, & Macrae, 2008) and political affiliation (Rule & Ambady, 2010). These overlearned features combined with how our social nature feeds back on itself may explain the self-fulfilling prophecies of how faces that communicate competence can predict election outcomes (Todorov, Mandisodza, Goren, & Hall, 2005) and financial measures of success (Rule & Ambady, 2008).

Notes

1. It is worth noting that Darwin (1872/1998) stated that these opposing forms sometimes may not serve any function.
2. Using 20 facial action coding units, bilaterally where applicable, each of which may contract independently at five different levels of intensity.

3. The odds of winning the jackpot is one in 2.9×10^8. Winning two jackpots is the number squared: one in 8.5×10^{16}.
4. An immediate physical utility distinguishes itself from the more distant social utility. Expression forms selected for social utility could also be considered "evolutionary" and functionally "egocentric." However, purely symbolic associated forms for social utility need not have any physical utility.
5. For some visual experiments, we left out the facial actions of the lower face in fear and disgust, to maintain fixation and head stability on the chin rest (Lee et al., 2014).

References

Adams, R. B., Jr., & Franklin, R. G., Jr. (2009). Influence of emotional expression on the processing of gaze direction. *Motivation and Emotion, 33*, 106–112.

Adams, R. B., Jr., Gordon, H. L., Baird, A. A., Ambady, N., & Kleck, R. E. (2003). Effects of gaze on amygdala sensitivity to anger and fear faces. *Science, 300*, 1536.

Adams, R. B., Jr., & Kleck, R. E. (2005). Effects of direct and averted gaze on the perception of facially communicated emotion. *Emotion, 5*, 3–11.

Allison, T., Puce, A., & McCarthy, G. (2000). Social perception from visual cues: Role of the STS region. *Trends in Cognitive Sciences, 4*, 267–278.

Anderson, A. K., Christoff, K., Panitz, D. A., De Rosa, E., & Gabrieli, J. D. E. (2003). Neural correlates of the automatic processing of threat facial signals. *Journal of Neuroscience, 23*, 5627–5633.

Andrew, R. J. (1963). Evolution of facial expression. *Science, 142*, 1034–1041.

Aviezer, H., Hassin, R. R., Ryan, J., Grady, C., Susskind, J. M., Anderson, A. K., et al. (2008). Angry, disgusted, or afraid? Studies on the malleability of emotion perception. *Psychological Science, 19*, 724–732.

Aviezer, H., Trope, Y., & Todorov, A. (2012). Body cues, not facial expressions, discriminate between intense positive and negative emotions. *Science, 338*, 1225–1229.

Bailey, I. L., & Lovie, J. E. (1976). New design principles for visual acuity letter charts. *American Journal of Optometry and Physiological Optics, 53*, 740–745.

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind*. Boston: MIT Press/Bradford Books.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "Reading the Mind in the Eyes" Test–Revised Version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry, 42*, 241–251.

Baron-Cohen, S., Wheelwright, S., & Jollifee, T. (1997). Is there a "language of the eyes"? Evidence from normal adults, and adults with autism or Asperger syndrome. *Visual Cognition, 4*, 311–331.

Barrett, L. F. (2006a). Are emotions natural kinds? *Perspectives on Psychological Science, 1*, 28–58.

Barrett, L. F. (2006b). Solving the emotion paradox: Categorization and the experience of emotion. *Personality and Social Psychology Review, 10*, 20–46.

Beatty, J., & Lucero-Wagoner, B. (2000). The pupillary system. In J. T. Cacioppo, G. Berntson, & L. G. Tassinary (Eds.), *Handbook of psychophysiology* (pp. 142–162). Cambridge, UK: Cambridge University Press.

Bocanegra, B. R., & Zeelenberg, R. (2009). Emotion improves and impairs early vision. *Psychological Science, 20*, 707–713.

Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion, 1*, 276–298.

Bruce, V., & Young, A. (1986). Understanding face recognition. *British Journal of Psychology, 77*, 305–327.

Brunton, C. E. (1938). Smooth muscle of the periorbita and the mechanism of exophthalmos. *British Journal of Ophthalmology, 22*, 257–268.

Cacioppo, J. T., & Berntson, G. G. (1994). Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates. *Psychological Bulletin, 115*, 401–423.

Calder, A. J., Beaver, J. D., Winston, J. S., Dolan, R. J., Jenkins, R., Eger, E., et al. (2007). Separate coding of different gaze directions in the superior temporal sulcus and inferior parietal lobule. *Current Biology, 17*, 20–25.

Calder, A. J., & Young, A. (2005). Understanding the recognition of facial identity and facial expression. *Nature Reviews Neuroscience, 6*, 641–651.

Chapman, H. A., & Anderson, A. K. (2012). Understanding disgust. *Annals of the New York Academy of Sciences: The Year in Cognitive Neuroscience, 1251*, 62–76.

Chapman, H. A., Kim, D. A., Susskind, J. M., & Anderson, A. K. (2009). In bad taste: Evidence for the oral origins of moral disgust. *Science, 323*, 1222–1226.

Chiao, J. Y., Iidaka, T., Gordon, H. L., Nogawa, J., Bar, M., Aminoff, E., et al. (2008). Cultural specificity in amygdala response to fear faces. *Journal of Cognitive Neuroscience, 20*, 2167–2174.

Cootes, T., Edwards, G., & Taylor, C. (2001). Active appearance models. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 23*, 681–685.

Dailey, M. N., Cottrell, G. W., Padgett, C. & Adolphs, R. (2002). EMPATH: A neural network that categorizes facial expressions. *Journal of Cognitive Neuroscience, 14*, 1158–1173.

Darwin, C. (1998). *The expression of the emotions in man and animals*. New York: Oxford University Press. (Original work published 1872)

de Jong, P. J., van Overveld, M., & Peters, M. L. (2011). Sympathetic and parasympathetic responses to a core disgust video clip as a function of disgust propensity and disgust sensitivity. *Biological Psychology, 88*, 174–179.

Du, S., Tao, Y., & Martinez, A. M. (2014). Compound facial expressions of emotion. *Proceedings of the National Academy of Sciences, USA, 111*, E1454–E1462.

Duke-Elder, S., & Abrams, D. (1970). Ophthalmic optics and refraction. In S. Duke-Elder (Ed.), *System of ophthalmology* (Vol. 5, pp. 487–501). London: Kimpton.

Ekman, P. (1973). *Darwin and facial expression: A century of research in review*. New York: Academic Press.

Ekman, P. (1999). Basic emotions. In T. Dalgleish & T. Power (Eds.), *The handbook of cognition and emotion* (pp. 45–60). Sussex, UK: Wiley.

Ekman, P. & Friesen, W. (1971). Constants across cultures in the face and emotion. Journal of *Personality and Social Psychology, 17*, 124–129.

Ekman, P., Friesen, W. V., & Hager, J. C. (1978). *Facial Action Coding System*. Salt Lake City, UT: Research Nexus.

Ekman, P., Sorenson, E. R., & Friesen, W. V. (1969). Pancultural elements in facial displays of emotion. *Science, 164*, 86–88.

Elfenbein, H. A. (2013). Nonverbal dialects and accents in facial expressions of emotion. *Emotion Review, 5*, 90–96.

Elfenbein, H. A., & Ambady, N. (2002). On the universality and cultural specificity of emotion recognition: A meta-analysis. *Psychological Bulletin, 128*, 203–235.

Elfenbein, H. A., & Ambady, N. (2003). When familiarity breeds accuracy: Cultural exposure and facial emotion recognition. *Journal of Personality and Social Psychology, 85*, 276–290.

Etcoff, N. L., & Magee, J. J. (1992). Categorical perception of facial expressions. *Cognition, 44*, 227–240.

Fridlund, A. J. (1994). *Human facial expression: An evolutionary view*. San Diego, CA: Academic Press.

Fridlund, A. J. (1997). The new ethology of human facial expressions. In J. A. Russell & J. Fernandez-Dols (Eds.), *The psychology of facial expression* (pp. 103–129). Cambridge, UK: Cambridge University Press.

Harrison, N., Singer, T., Rotshtein, P., Dolan, R. J., & Critchley, H. D. (2006). Pupillary contagion: Central mechanisms engaged in sadness processing. *Social Cognitive and Affective Neuroscience, 1*, 5–17.

Izard, C. E. (1977). *Human emotions*. New York: Plenum Press.

Izard, C. E. (1994). Innate and universal facial expressions: Evidence from developmental and cross-cultural research. *Psychological Bulletin, 115*, 288–299.

Jack, R. E., Garrod, O. G. B., Yu, H., Caldara, R., & Schyns, P. (2012). Facial expressions of emotion are not culturally universal. *Proceedings of the National Academy of Sciences, USA, 109*, 7241–7244.

Kobayashi, H., & Kohshima, S. (1997). Unique morphology of the human eye. *Nature, 387*, 767–768.

Krusemark, E., & Li, W. (2011). Do all threats work the same way?: Divergent effects of fear and disgust on sensory perception and attention. *Journal of Neuroscience, 31*, 3429–3434.

Lee, D. H., Mirza, R., Flanagan, J. G., & Anderson, A. K. (2014). Optical origins of opposing facial expression actions. *Psychological Science, 25*, 745–752.

Lee, D. H., Susskind, J. M., & Anderson, A. K. (2013). Social transmission of the sensory benefits of fear eye-widening. *Psychological Science, 24*, 957–965.

Levenson, R. W. (1992). Autonomic nervous system differences among emotions. *Psychological Science, 3*, 23–27.

Li, W., Howard, J. D., Parrish, T. B., & Gottfried, J. A. (2008). Aversive learning enhances perceptual and cortical discrimination of indiscriminable odor cues. *Science, 319*, 1842–1845.

Lipp, O. V., Price, S. M., & Tellegen, C. S. (2009). No effect of inversion on attentional and affective processing of facial expressions. *Emotion, 9*, 248–259.

Livingstone, M. S., & Hubel, D. H. (1987). Psychophysical evidence for separate channels for the perception of form, color, movement, and depth. *Journal of Neuroscience, 7*, 3416–3468.

Marsh, A. A., Adams, R. B., Jr., & Kleck, R. E. (2005). Why do fear and anger look the way they do?: Form and social function in facial expressions. *Personality and Social Psychology Bulletin, 31*, 73–86.

Marsh, A. A., Ambady, N., & Kleck, R. E. (2005). The effects of fear and anger facial expressions on approach- and avoidance-related behaviors. *Emotion, 5*, 118–124.

Marsh, A. A., Elfenbein, H. A., & Ambady, N. (2003). Nonverbal "accents": Cultural differences in facial expressions of emotion. *Current Directions in Psychological Science, 12*, 159–164.

Matsumoto, D., & Ekman, P. (1988). *Japanese and Caucasian facial expressions of emotion (JACFEE)* [Slides]. San Francisco: San Francisco State University, Department of Psychology, Intercultural and Emotion Research Laboratory.

McKelvie, S. J. (1995). Emotional expression in upside-down faces: Evidence for configurational and componential processing. *British Journal of Social Psychology, 34*, 325–334.

Niedenthal, P. M. (2007). Embodying emotion. *Science, 316*, 1002–1005.

Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review, 3*, 483–522.

Oosterhof, N. N., & Todorov, A. (2008). The functional basis of face evaluation. *Proceedings of the National Academy of Sciences, USA, 105*, 11087–11092.

Phelps, E. A., Ling, S., & Carrasco, M. (2006). Emotion facilitates perception and potentiates the perceptual benefits of attention. *Psychological Science, 17*, 292–299.

Plutchik, R. (1980). *Emotion: Theory, research, and experience: Vol. 1. Theories of emotion*. New York: Academic Press.

Putman, P., Hermans, E., & van Honk, J. (2006). Anxiety meets fear in perception of dynamic expressive gaze. *Emotion, 6*, 94–102.

Rolls, E. T. (1990). A theory of emotion, and its application to understanding the neural basis of emotion. *Cognition and Emotion, 4*, 161–190.

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94*, 23–41.

Rozin, P., Haidt, J., & McCauley, C. (2000). Disgust. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (pp. 637–653). New York: Guilford Press.

Rule, N. O., & Ambady, N. (2008). The face of success: Inferences from chief executive officers' appearance predict company profits. *Psychological Science, 19*, 109–111.

Rule, N. O., & Ambady, N. (2010). Democrats and Republicans can be differentiated from their faces. *PLoS ONE, 5*, e8733.

Rule, N. O., Ambady, N., Adams, R. B., Jr., & Macrae, C. N. (2008). Accuracy and awareness in the perception and categorization of male sexual orientation. *Journal of Personality and Social Psychology, 95*, 1019–1028.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39*, 1161–1178.

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology, 76*, 805–819.

Sato, W., Kochiyama, T., & Yoshikawa, S. (2011). The inversion effect for neutral and emotional facial expressions on amygdala activity. *Brain Research, 1378*, 84–90.

Saxe, R., & Powell, L. J. (2006). It's the thought that counts: Specific brain regions for one component of theory of mind. *Psychological Science, 17*, 692–699.

Scherer, K. R., & Wallbott, H. G. (1994). Evidence for universality and cultural variation of differential emotion response patterning. *Journal of Personality and Social Psychology, 66*, 310–328.

Shariff, A., & Tracy, J. (2011). What are emotion expressions for? *Current Directions in Psychological Science, 20*, 395–399.

Sherman, G. D., Haidt, J., & Clore, G. L. (2012). The faintest speck of dirt: Disgust enhances the detection of impurity. *Psychological Science, 23*, 1506–1514.

Smith, F. W., & Schyns, P. G. (2009). Smile through your fear and sadness: transmitting and identifying facial expression signals over a range of viewing distances. *Psychological Science, 20*, 1202–1208.

Smith, M. L., Cottrell, G. W., Gosselin, F., & Schyns, P. G. (2005). Transmitting and decoding facial expressions. *Psychological Science, 16*, 184–189.

Strack, F., Martin, L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: a nonobtrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology, 54*, 768–777.

Susskind, J. M., & Anderson, A. K. (2008). Facial expression form and function. *Communicative and Integrative Biology, 1*, 148–149.

Susskind, J. M., Lee, D. H., Cusi, A., Feiman, R., Grabski, W., & Anderson, A. K. (2008). Expressing fear enhances sensory acquisition. *Nature Neuroscience, 11*, 843–850.

Susskind, J. M., Littlewort, G., Bartlett, M. S., Movellan, J., & Anderson, A. K. (2007). Human and computer recognition of facial expressions of emotion. *Neuropsychologia, 45*, 152–162.

Tipples, J. (2006). Fear and fearfulness potentiate automatic orienting to eye gaze. *Cognition and Emotion, 20*, 309–320.

Todd, R. M., Talmi, D., Schmitz, T. W., Susskind, J. M., & Anderson, A. K. (2012). Psychophysical and neural evidence for emotion-enhanced perceptual vividness. *Journal of Neuroscience, 32*, 11201–11212.

Todorov, A., Mandisodza, A. N., Goren, A., & Hall, C. C. (2005). Inference of competence from faces predict election outcomes. *Science, 308*, 1623–1626.

Tomkins, S. S., & McCarter, R. (1964). What and where are the primary affects?: Some evidence for a theory. *Perceptual and Motor Skills, 18*, 119–158.

Ungerleider, L. G., & Mishkin, M. (1982). Two cortical visual systems. In D. J. Ingle, M. A. Goodale, & R. J. Mansfield (Eds.), *Analysis of visual behavior* (pp. 549–586). Cambridge, MA: MIT Press.

Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2001). Effects of attention and emotion on face processing in the human brain: An event-related fMRI study. *Neuron, 30*, 829–841.

Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2003). Distinct spatial frequency sensitivities for processing faces and emotional expressions. *Nature Neuroscience, 6*, 624–631.

Watson, D., & Tellegen, A. (1985). Toward a consensual structure of mood. *Psychological Bulletin, 98*, 219–235.

West, G. L., Anderson, A. K., Bedwell, J. S., & Pratt, J. (2010). Red diffuse light suppresses the accelerated perception of fear. *Psychological Science, 21*, 992–999.

Whalen, P. J. (1998). Fear, vigilance, and ambiguity: Initial neuroimaging studies of the human amygdala. *Current Directions in Psychological Science, 7*, 177–188.

Whalen, P. J., Kagan, J., Cook, R. G., Davis, F. C., Kim, H., Polis, S., et al. (2004). Human amygdala responsivity to masked feaful eye whites. *Science, 306*, 2061.

Young, A. W., Rowland, D., Calder, A. J., Etcoff, N. L., Seth, A., & Perrett, D. I. (1997). Facial expression megamix: Tests of dimensional and category accounts of emotion recognition. *Cognition, 63*, 271–313.

Zebrowitz, L. A. (1997). *Reading faces: Window to the soul?* Boulder, CO: Westview.

PART V

Cognitive Perspectives

CHAPTER 30

Emotional Intelligence

Marc A. Brackett, Susan E. Rivers, Michelle C. Bertoli, and Peter Salovey

A quarter of a century has passed since Salovey and Mayer (1990) introduced the first formal model of emotional intelligence into the scientific literature and demonstrated how aspects of it might be measured (Mayer, DiPaolo, & Salovey, 1990). Synthesizing research from developmental and social psychology with an emerging literature on mental abilities, they defined emotional intelligence as "the ability to monitor one's own and others' feelings and emotions, to discriminate among them and to use this information to guide one's thinking and actions" (Salovey & Mayer, 1990, p. 189). Today, several thousand publications have cited that article. Research on emotional intelligence, its correlates, and its applications has flourished, and efforts to enhance individuals' emotional intelligence have proliferated across the globe. Former British Prime Minister Tony Blair recently asserted that "one big change in what kids should learn is the need to nurture creative thinking and emotional intelligence" (Global Ed & Skills, 2014). High-ranking business schools have added emotional intelligence screenings to their battery of entrance assessments to help determine which students are likely to be top performers (Korn, 2013). The University of Málaga in Spain now offers a master's degree in emotional intelligence.

These developments belie the construct's initial reception. At first, the concept that individuals might differ in their ability to reason adaptively with and about emotions did not sway many within academia; in fact, it elicited criticism (see Mayer & Salovey, 1993). For one thing, as emotion researcher Joseph LeDoux (2000, p. 156) noted, "emotion research was a victim of the cognitive revolution" of the mid-20th century. For some time, the cognitive psychological approach to explaining human behavior overshadowed interest in emotion (Neisser, 1967). The 1980s and 1990s saw a surge of interest in affective science (Barsade, Brief, & Spataro, 2003), but even then, the idea of an emotional intelligence—with its emphasis on individual differences—ran counter to existing trends in emotion research. Only within the last decade, roughly, have neuroscientists increasingly begun to appreciate the value of individual neurobiological differences in emotion processing (e.g., Eugène et al., 2003; Hamann & Canli, 2004). Prior to that, neuroscience tended to focus on universal processing trends, considering individual differences to be statistical "noise" (Hamann & Canli, 2004; Plomin & Kosslyn, 2001). Such "noise" distracted from a century-long endeavor to first agree upon the provenance of emotions within the human organism (i.e., the brain as opposed to visceral organs) and then to map the general neural circuitry underlying emotional experience in animals and humans (see Davidson, Jackson, & Kalin, 2000, for a concise historical summary). Moreover, theories and measures of intelligence had long been concerned mainly with the *g* factor (Spearman, 1904), general intelligence conceptualized as interrelated cognitive capacities like abstract and mathematical reasoning (e.g., Sattler, 1982; Spearman, 1927; Wechsler, 1939). Finally, emotional intelligence had to overcome an entrenched view of emotions as destabilizing, disorganized forces that prevent logical reasoning (e.g., Lefford, 1946; Young, 1943). That mistrust of emotions has roots in Stoic philosophy, which presumed that the self-centeredness of emotional experience precluded its leading people to act in rational (i.e., moral, altruistic) ways (see Lyons, 1999).

However, an undercurrent of insight into the possible existence of distinct intelligences, including social intelligence (Thorndike, 1920), gained momentum as the latter part of the 20th century drew to a close. It manifested in the proposal of a "cognitive loop" among mood and judgment (Isen, Shalker, Clark, & Karp, 1978), Gardner's (1983/1993) theory of multiple intelligences, and Sternberg's (1985) triarchic theory of intelligence. By questioning the view that IQ was the prime determinant of success in life, these and other investigations into the link between emotion and cognition (e.g., Damasio, 1994) laid the groundwork for the "affective revolution" some argue is now under way (Barsade et al., 2003).

The book *The Bell Curve* (Herrnstein & Murray, 1994) may have pushed the tipping point; it lent a particularly controversial voice to the argument that IQ is preeminently predictive. The authors linked IQ to social class and race in a manner that sparked considerable backlash (see Lynn, 1999) and prompted the American Psychological Association to assemble a task force on the state of intelligence research (Neisser et al., 1996). One year after the publication of *The Bell Curve*, psychologist and reporter Daniel Goleman (1995) published a trade book—*Emotional Intelligence*—that provided a unique counterpoint to *The Bell Curve*'s polemic assertions (see Cartwright & Pappas, 2008; Matthews, Zeidner, & Roberts, 2002). Goleman presented a persuasive articulation of what audiences inflamed by *The Bell Curve* likely wanted acknowledged: that there are ways to be smart beyond what standardized intelligence tests measure (e.g., Mayer, Salovey, & Caruso, 2000). Indeed, some have remarked that "the EI construct gives hope for a more utopian, classless society" (Zeidner, Matthews, & Roberts, 2009, p. xii). Goleman's book quickly climbed the *New York Times* best-seller list and catapulted emotional intelligence to prominence on the international stage. It was then that the term "emotional intelligence" came into wide usage among the general public and researchers (for instance, a search on Google Scholar returns 32 results for publications with "emotional intelligence" in the title in the 20 years before Goleman's book was published, and over 10,000 results in the 20 years following). But along with that popularization came many misconceptions about the infant construct. Perhaps most problematic, as others have argued (e.g., Zeidner, Roberts, & Matthews, 2002), Goleman's (1995a) description of the construct encompassed a plethora of valued, nonintellectual human characteristics (e.g., motivation, persistence, willingness to delay gratification, hope; p. 34) that are beyond the scope of emotional intelligence, strictly defined. Thus, in the two decades that have followed, science has had to work to catch up to—and put into perspective—the hype.

In this chapter, we describe the four-branch ability model of emotional intelligence (Mayer & Salovey, 1997; Salovey & Mayer, 1990) and its measurement. We review the correlates of emotional intelligence in several domains of functioning and outline approaches to developing the four emotional intelligence abilities. We consider current limitations and areas of controversy in the field and conclude by proposing promising directions for expanding our understanding of the construct.

The Ability Model of Emotional Intelligence

Emotions are a critical source of information about the environment (e.g., Levenson, 1994; Schwarz, 1990; Schwarz & Clore, 1983) that can organize and direct cognitive activities and behaviors in adaptive ways (e.g., Darwin, 1872; Frijda, 1986; Izard, 1971; Leeper, 1948; Salovey & Mayer, 1990; Schwarz & Clore, 1983). Emotions may signal to us, among other things, that we are in harm's way (fear), have experienced something pleasurable and should strive to repeat it (happiness), our access to something we need or desire is being blocked (anger), or that we have lost something important (sadness). (See Ekman, 1992, 1994, for a discussion of basic emotions and their common antecedent events.) The functional utility of emotions has been established since Darwin's (1872) time, but what was novel about emotional intelligence theory when it was introduced was its assertion that individuals might *vary* in their ability to make advantageous use of the information emotions impart.

In 1997, Mayer and Salovey revised their original (Salovey & Mayer, 1990) definition of emotional intelligence to refine and outline more specifically the abilities the construct encompasses. They wrote:

> Emotional intelligence involves the ability to perceive accurately, appraise, and express emotion; the ability to access and/or generate feelings when they facilitate thought; the ability to understand emotion and emotional knowledge; and the ability to regulate emotions to promote emotional and intellectual growth. (p. 10)

The distinct but related mental aptitudes identified in this definition constitute the four-branch or ability model of emotional intelligence. Other models have emerged as the concept has gained traction (Cherniss, 2010) such as the Bar-On (1997, 2006) model, which includes intrapersonal and interpersonal skills, general mood, adaptability, and stress management; the Boyatzis–Goleman model (Boyatzis & Sala, 2004), concerned mainly with social and emotional competencies considered pertinent to performance in the workplace; and the trait emotional intelligence model (Petrides & Furnham, 2001; Petrides, Pita, & Kokkinaki, 2007), consisting of sociability, emotionality, well-being, and self-control. These models represent "mixed models" of emotional intelligence, so-called because they "mix" some skills from the ability model (e.g., perceiving emotion) with elements of personality and behavioral preferences such as assertiveness and self-esteem (see Mayer, Roberts, & Barsade, 2008; Mayer, Salovey, & Caruso, 2008). Trait emotional intelligence proponents posit that the construct "encompasses . . . empathy, impulsivity, and assertiveness as well as elements of social . . . and personal intelligence" (Petrides & Furnham, 2003, p. 278). Bar-On (1997) proposed that emotional intelligence includes, among other preferences and traits, optimism and the *perceived* ability to manage relationships.

Mayer and Salovey (1993) cautioned against confusing behavioral preferences with intelligence, writing, "Although a trait such as extraversion may depend on social skill, or result in it, a trait is a behavioral preference rather than an ability. Knowing what another person feels, in contrast, is a mental ability" (p. 435). When conceptualized as a set of mental abilities, emotional intelligence is not only a new, distinct psychological variable, it also meets the criteria for a standard intelligence (Carroll, 1993; Fancher, 1985). Specifically, ability emotional intelligence (1) is a set of mental abilities that (2) are distinct from but correlated with one another and with abilities included in other recognized intelligence frameworks, and that (3) increase with age and experience (Mayer, Caruso, & Salovey, 1999; Mayer, Salovey, Caruso, & Sitarenios, 2001; Rivers et al., 2012). In contrast, emotional intelligence conceptualized—as in mixed models—as a combination of personality traits, behavioral preferences, and perceived mental abilities overlaps with other variables. This makes discerning its unique impact on outcomes of interest complicated at best (Brackett & Mayer, 2003; Brackett, Rivers, Shiffman, Lerner, & Salovey, 2006). This is one reason researchers have criticized the use of "emotional intelligence" as a catchall term for valued noncognitive qualities (e.g., Daus & Ashkanasy, 2003; Joseph & Newman, 2010; Zeidner, Roberts, & Matthews, 2004). A construct that is defined too broadly risks becoming meaningless if the aim is to investigate its unique relationship to important life outcomes and to understand how it can be targeted via intervention. Emotional intelligence, understood and assessed as a discrete mental ability, incrementally predicts certain outcomes (e.g., social effectiveness) over and above general intelligence and personality (see Mayer, Salovey, et al., 2008). It is presumably for these reasons that the four-branch model has been called the "gold standard" in emotional intelligence research (Daus & Ashkanasy, 2003, p. 72). The remainder of this chapter focuses on the ability model and its measurement and correlates, beginning with a delineation of the model's four branches.

The Four Branches of the Ability Model

Mayer and Salovey's critical review of the literature on intelligence, emotion, and the relationship between the two resulted in the four-branch model of emotional intelligence, which encompasses perceiving emotion, using emotion to facilitate thought, understanding emotion, and regulating emotion (Mayer & Salovey, 1997; Salovey & Mayer, 1990). Each of these abilities is described here.

Perceiving Emotion

The first branch of emotional intelligence is the ability to accurately perceive and appraise emotions in the self and others. This ability supports humans' innate tendency to be social. As one prominent social psychologist has written, "Social living is only possible because humans possess an elaborate cognitive capacity to perceive and evaluate others, infer their intentions, and respond with sophisticated and highly adaptable interpersonal strategies" (Forgas, 2006, p. 270). Individuals skilled in emotion perception can identify emotions in their own physical states and thoughts as well as in others' facial expressions, vocalizations, postures, and movements. They can also discern emotion in cultural artifacts such as works of art. They are able to express their emotions and the needs related to them. A more advanced skill on this branch is the ability to determine whether or not an emotional expression is genuine. Individuals' ability to perceive emotions in others' faces, voices, and movements begins in infancy (e.g., Flom & Bahrick, 2007; Nelson & Dolgin, 1985; Schwartz, Izard, & Ansul, 1985; Walker-Andrews, 2005; Zieber, Kangas, Hock, & Bhatt, 2014) and forms the foundation for the other emotional skills. Once emotion perception abilities are established, using, understanding, and regulating emotions become possible (Joseph & Newman, 2010; Mayer et al., 1999; Mayer & Salovey, 1997).

Using Emotion to Facilitate Thought

Consistent with a foundational premise of emotional intelligence—that emotions can assist cognitive processing—the second branch of the ability model encompasses individuals' capacity to leverage emotions to facilitate cognitive activities like problem solving. Individuals equipped with this skill can determine which activities may benefit from the emotion they are currently experiencing, and can also generate the emotions most likely to facilitate tasks that need to be done. For instance, research supports a significant link between pleasant, high-arousal emotions (e.g., happiness) and creative, original thinking (Baas, De Dreu, & Nijstad, 2008; Fredrickson, 1998; Jamison, 2005; however, see also Hunsinger, Isbell, & Clore, 2012). In contrast, unpleasant, high-arousal emotions like fear are associated negatively with cognitive flexibility (Baas et al., 2008). However, unpleasant emotions do appear to be better suited than pleasant ones for deductive reasoning tasks (Palfai & Salovey, 1993) and making contingency judgments (Schwarz & Bless, 1991). According to the ability model, someone skilled in using emotions is more likely to take advantage of a pleasant, high-energy emotion to brainstorm or generate new approaches to a problem.

Understanding Emotion

The ability to understand the causes and consequences of emotions falls under the third branch of the framework. A basic skill on this branch is labeling emotions accurately and understanding that different emotion words are related (e.g., "joyful" and "elated" are nuanced experiences of "happy"). Individuals vary in their ability to label qualitatively distinct emotional experiences with different emotion words (Barrett, 1998; Barrett, Gross, Christensen, & Benvenuto, 2001; Feldman, 1995). For example, one person may report feeling "mad" or "bad" after any unpleasant event while another person specifies that one event caused "frustration" while another caused "despair." This phenomenon is referred to as emotion differentiation or emotion granularity (Barrett et al., 2001). Research has linked greater emotion differentiation—especially for unpleasant emotions—to lower levels of depression (Demiralp et al., 2012; Erbas, Ceulemans, Lee Pe, Koval, & Kuppens, 2014) as well as less neuroticism and higher self-esteem (Erbas et al., 2014). Theoretically, these findings can be attributed to high differentiators' greater understanding of the causes and consequences of a variety of emotions, which should allow them to respond to and regulate emotions more adaptively (Erbas et al., 2014; Schwarz, 1990). Individuals who label unpleasant emotions in a granular way tend to regulate unpleasant emotions more frequently, and by employing a larger repertoire of strategies, than those who describe their emotional experiences in broader strokes (Barrett et al., 2001).

Other skills on the third branch include recognizing why certain emotions occur (e.g., accomplishing a goal causes pride), foreseeing the trajectory of an emotion that goes unregulated (e.g., sadness can degrade into hopelessness), surmising what occurred to change one emotion into another (e.g., anger transitions to satisfaction when an injustice is righted), and understanding how multiple emotions can "blend" to form another emotion (e.g., disgust and anger combined become contempt). Although not made explicit in this model, to understand emotions fully one also should take into account the historical and cultural contexts in which they are experienced. For example, individuals displaying acedia (sloth) in the early Christian Church and modern-day sufferers of depression may share feelings of apathy. However, acedia was considered to be a cardinal sin, while depression is increasingly explained in terms of neurochemical imbalances that have no bearing on one's moral standing (Frevert, 2011). Thus,

> Even if there are signs of acedia . . . and depression that resemble each other, the labeling, framing and contextualising of those signs are vastly different. Relating the symptoms to diverse systems of reference (magic, religion, arts and sciences, neurobiology) affects the value attributed to them. This in turn affects the appraisal and experience of those states. (p. 36)

As emotional intelligence matures and is examined more thoroughly in light of cultural distinctions and shifts in societal values over time, the need to consider context when assessing the causes and consequences of emotions will only increase.

Regulating Emotion

Individuals' ability to manage their own and others' emotions is the scope of the fourth branch of emotional intelligence. This branch includes skills such as remaining open to experiencing both pleasant and unpleasant emotions, judging the usefulness of a particular emotion in a specific situation, and using effective emotion regulation strategies with consideration for the situational context and desired outcome. Emotion regulation strategies vary in effectiveness. For example, studies have examined the relative efficacy of cognitive reappraisal and expressive suppression. Individuals who reappraise (i.e., construe in a different way in their minds) an event that could potentially elicit a negative emotional response have been found to experience more pleasant and fewer unpleasant emotions and to function better interpersonally and experience greater well-being (Gross & John, 2003). Individuals who engage in expressive suppression (e.g., disguising how they feel) experience the opposite outcomes: more unpleasant and fewer pleasant emotions, less effective interpersonal functioning, and poorer well-being (Gross & John, 2003). In fact, deficits in emotion regulation ability are a hallmark of many psychological disorders—including but not limited to mood disorders—and addressing these deficits directly may significantly aid in the treatment of such conditions (Werner & Gross, 2010). The ability model of emotional intelligence posits that individuals with more refined emotion regulation skills are more likely to choose effective regulation strategies (i.e., those with fewer cognitive and social costs).

In order to demonstrate that these four abilities—perceiving, using, understanding, and regulating emotion—provide an adaptive advantage, we must be able to assess them validly in diverse samples and examine their relationship to domains that are important for successful, healthy functioning. Next, we consider how emotional intelligence is measured and review some of its established correlates.

Assessing Emotional Intelligence

Accumulating research demonstrates that emotional intelligence can be assessed reliably and validly with performance measures, which ask respondents to demonstrate emotional intelligence by completing carefully designed exercises and tasks. Performance measures contrast with self-report (e.g., Bar-On Emotional Quotient inventory [EQ-i]; Bar-On, 2006) and multirater (e.g., Emotional Competence Inventory [ECI]; Boyatzis & Sala, 2004) measures, which ask respondents to estimate and report on their own or others' capabilities rather than to demonstrate them. Although self-report measures offer practical advantages such as being relatively inexpensive, quick, and easy to administer (e.g., Riggio & Riggio, 2001), in most cases these advantages do not outweigh the limitations of this measurement approach. Self-report measures are problematic because they substantially overlap with existing personality measures (Brackett et al., 2006; Webb et al., 2013), capture perceived—not actual—abilities (Paulhus, Lysy, & Yik, 1998), and are susceptible to social desirability bias and faking (Day & Carroll, 2008; Tett, Freund, Christiansen, Fox, & Coaster, 2012). Multirater measures such as the ECI (Boyatzis & Sala, 2004) attenuate some of the limitations of self-report measures by requiring input from at least two different sources, which increases internal validity (Palmer & Stough, 2005). However, the psychometric properties of multirater measures of emotional intelligence are not well established (Cherniss, 2010). For these reasons, using performance measures of emotional intelligence, when feasible, is preferable to using other measurement approaches.

The Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT; Mayer, Salovey, & Caruso, 2002b) is the most commonly used performance measure of emotional intelligence in adults, and its validity has been demonstrated in multiple studies (e.g., Brackett & Mayer, 2003; Mayer, Salovey, & Caruso, 2012; Rossen & Kranzler, 2009). The MSCEIT can be completed in approximately 40 minutes, administered either via a computer or paper version of the test. The test assesses each of the four branches of the ability model via two tasks. For instance, the perceiving emotions branch of the test asks respondents to view photographs of human faces and works of art and to identify how much of each of a particular emotion is represented in each picture. The managing emotions branch of the test presents respondents with a series of emotion-laden scenarios and asks them to rate the effectiveness of various strategies for maintaining, reducing, or otherwise regulating the particular emotions highlighted in the vignettes. Five scores are generated for the MSCEIT: an overall emotional intelligence score and four branch scores. The MSCEIT can be scored in two ways (Mayer, Salovey, & Caruso, 2002a): responses are awarded a certain number of points based on the degree of their overlap with *either* responses provided by a large, normative sample (consensus scoring) or those provided by a panel of emotion experts (expert scoring). Consensus and expert scores are correlated highly (Brackett & Salovey, 2006). The Mayer–Salovey–Caruso Emotional Intelligence Test—Youth Version (MSCEIT-YV; Mayer, Caruso, & Salovey, 2005) is a valid performance measure of emotional intelligence in youth ages 10–17 years (Peters, Kranzler, & Rossen, 2009; Rivers et al., 2012). Its language, pictures, and vignettes have been adapted to the adolescent population (e.g., younger faces).

An important consideration when determining the usefulness of an emotional intelligence measure is its relationship to measures of other constructs that, theoretically, should or should not overlap with it. Emotional intelligence, as a cognitive ability, should overlap to some degree with existing intelligence paradigms while still demonstrating unique variance (Mayer et al., 1999). As a measure of mental ability, emotional intelligence theoretically should not overlap significantly with measures of personality or general well-being. A recent meta-analysis found that, indeed, MSCEIT scores correlate positively with measures of verbal, nonverbal, and overall intelligence (Kong, 2014). Conversely, MSCEIT scores are discriminable from measures of well-being and personality, such as the Big Five, while self-report measures such as the EQ-i are significantly less separable from such constructs (i.e., they overlap to a greater degree with personality measures; Brackett & Mayer, 2003). Furthermore, the MSCEIT and self-report measures of emotional intelligence are only minimally related (Brackett & Mayer, 2003). These associations, or lack thereof, lend support to the utility of the MSCEIT for measuring validly the distinct, mental ability to reason with and about emotions. A more thorough comparison of emotional intelligence measures can be found in Mayer, Roberts, et al. (2008).

The MSCEIT and MSCEIT-YV are not without limitations. The tests do not capture the real-time application of emotion knowledge. For example, when someone experiences a strong emotion, is that person able to regulate it effectively in the moment? The current versions of the MSCEIT cannot evaluate this. Additionally, a number of studies have questioned the four-factor structure of the tests (e.g., Maul, 2011). In particular, there is some evidence to support the potentially superior fit of a three-factor structure that does not include the second branch: using emotions to facilitate thought (e.g., Fan, Jackson, Yang, Tang, & Zhang, 2010; Maul, 2011; Palmer, Gignac, Manocha, & Stough, 2005). Despite these limitations, converging evidence suggests that, of the assessments currently available, the MSCEIT measures emotional intelligence most reliably (Jordan, Dasborough, Daus, & Ashkanasy, 2010). Next, we describe the correlates of emotional intelligence as assessed by the MSCEIT and the MSCEIT-YV.

Correlates of Emotional Intelligence as Measured by the MSCEIT

Due in part to the many disparate definitions of emotional intelligence that emerged after the concept was proposed (e.g., Cherniss, 2010), extraordinary claims have been made about its significance; for instance, that "a highly developed emotional intelligence will make you a candidate for CEO or a brilliant trial lawyer" (Goleman, 1997, p. 76). While being emotionally intelligent is no guarantee of achieving great success in any particular field, evidence accumulated over the last 25 years suggests that emotional intelligence—measured as an ability—is related to important outcomes in many domains: particularly, health, relationships, academic achievement, and work performance (see Brackett, Rivers, & Salovey, 2011; Mayer, Roberts, et al., 2008; Rivers et al., 2012, for reviews). We summarize some key associations with the MSCEIT and MSCEIT-YV here. For most of the associations described, correlations range from .15 to .40. Associations that are not statistically significant are not included in this summary.

Emotional Intelligence and Health

One of the ways emotional intelligence appears to facilitate adaptive living is through its relationship to health outcomes. A recent meta-analysis demonstrated that individuals higher in emotional intelligence experience better physical, mental, and psychosomatic health (Martins, Ramalho, & Morin, 2010). Among adolescents, emotional intelligence appears to predict mental health (i.e., higher scores correlate with less depression and fewer conduct problems) over and above personality and cognitive ability (Davis & Humphrey, 2012) and to protect against suicidal behavior (Cha & Nock, 2009). Additionally, it appears that emotional intelligence protects against engagement in health risk behaviors for both adults and adolescents. Adolescents higher in emotional intelligence are less likely to use alcohol (Trinidad & Johnson, 2002) or smoke cigarettes, and report lower intentions to smoke cigarettes (Duncan et al., 2013; Trinidad & Johnson, 2002; Trinidad, Unger, Chou, & Johnson, 2004). Among college students, higher emotional intelligence has been linked to lower rates of substance abuse, adjustment problems, and aggressive behaviors (Rivers, Brackett, Omori, et al., 2013). Among adult males, lower emotional intelligence has been linked to increased use of illegal drugs and alcohol (Brackett, Mayer, & Warner, 2004). While the relationship between emotional intelligence and broad health categories (i.e., physical, mental, and psychosomatic) is well established (Martins et al., 2010), more research is needed to expand knowledge of the associations between emotional intelligence and specific health difficulties and risky behaviors, as well as the mechanisms underlying the associations.

Emotional Intelligence and Interpersonal Functioning

Emotional intelligence is thought to contribute to successful interpersonal functioning by equipping individuals with the tools needed to assess and understand others' emotions and points of view, and to communicate about and manage their own and others' emotions more effectively. Individuals higher in emotional intelligence are perceived by peers to be more interpersonally sensitive than those with lower scores (Lopes, Salovey, Côté, Beers, & Petty, 2005). Such individuals also tend to report better relationships with friends, parents, members of the opposite sex, and romantic partners (Brackett, Warner, & Bosco, 2005; Lopes et al., 2004; Lopes, Salovey, & Straus, 2003) and to exhibit more secure attachment styles in adulthood (Kafetsios, 2004) as compared to their counterparts with lower MSCEIT scores. Among men, MSCEIT scores have been shown to predict social competence (Brackett et al., 2006). Adolescents who score higher on the MSCEIT-YV are rated both by themselves and by their teachers as being more socially competent than students with lower scores (Rivers et al., 2012). These and similar findings should not be interpreted, however, as indicating that emotionally intelligent individuals are merely more agreeable (although in some samples there is a modest correlation between the two variables; e.g., $r = .24$ in Brackett et al., 2004). For one thing, the results of most of these studies remain significant after controlling for personality variables (see Brackett, Rivers, et al., 2011). Moreover, it appears that individuals higher in emotional intelligence prefer to feel the emotions that are most useful for a given situation, whether those emotions are pleasant or not (Ford & Tamir, 2012). For example, a person high in emotional intelligence who needs to confront someone is more likely to prefer to feel anger than a more pleasant, but potentially less useful, emotion (Ford & Tamir, 2012). Similarly, a recent study indicates that individuals higher in emotional intelligence demonstrate flexibility when choosing interpersonal strategies (i.e., cooperating *or* competing as is beneficial, as opposed to always cooperating) in a way that maximizes their gains over the long term in a laboratory-based, socially interactive game (Fernández-Berrocal, Extremera, Lopes, & Ruiz-Aranda, 2014). It would appear, then, that individuals high in emotional intelligence may be more interpersonally successful because they are more flexible and responsive to their social circumstances—and the resultant emotions—at any given time. Future research could investigate whether this is the case.

Emotional Intelligence and Academic Achievement

Accumulating data suggest that emotional intelligence is related to academic performance through the former's impact on students' attention, self-regulation, and adaptation in school (Lopes & Salovey, 2004). Among a sample of college students, overall MSCEIT scores correlated with verbal SAT scores (Brackett et al., 2004). In one study, the managing emotions scores of high school students were found to be the best predictor of academic success (DiFabio & Palazzeschi, 2009), even more than grit (Ivcevic & Brackett, 2014), a construct that has taken center stage in the popular press on what children need to succeed (e.g., Tough, 2012). Studies show that measuring emotional intelligence as an ability, compared with self-reports, is a more efficacious method for predicting academic success, as measured by grade point average (GPA; DiFabio & Palazzeschi, 2009) and teacher ratings of academic performance (e.g., Mestre, Guil, Lopes, Salovey, & Gil-Olarte, 2006). The latter study was conducted among Spanish adolescents using the Spanish-language version of the MSCEIT (Extremera & Fernández-Berrocal, 2002), and the relationship between ability emotional intelligence remained significant for boys, but not girls, after controlling for personality and cognitive ability (Mestre et al., 2006). Furthermore, understanding and managing emotions scores were higher among academically gifted—as compared with average—Israeli high school students (Zeidner, Shani-Zinovich, Matthews, & Roberts, 2005). Efforts to teach emotional intelligence skills through evidence-based social and emotional learning (SEL) programs have also been linked to improved academic achievement (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011), including interventions that target the skills associated with the ability model (Brackett, Rivers, Reyes, & Salovey, 2012). These associations are discussed further in the section "Teaching Emotional Intelligence in the Classroom."

Emotional Intelligence and Professional Performance

Emotional intelligence has been a popular topic in organizational settings since its introduction, spurred in part by such claims as "For star performance in all jobs, in every field, emotional competence is twice as important as purely cognitive abilities" (Goleman, 1998, p. 34). Research *has* linked emotional intelligence to important workplace outcomes including performance and leadership ability, although the associations cannot be characterized as "twice as" predictive as those related to cognitive ability. Recent meta-analyses have found that individuals with higher emotional intelligence scores perform better on the job (Joseph & Newman, 2010; O'Boyle, Humphrey, Pollack, Hawver, & Story, 2011), particularly in the context of jobs requiring more emotional labor (e.g., displaying specific emotions, as would be expected of customer service workers; Côté, 2014; Joseph & Newman, 2010). In two studies, emotional intelligence correlated with leadership emergence, which is the extent to which someone not in an official leadership position exerts influence with his or her colleagues (Côté, Lopes, Salovey, & Miners, 2010). These associations remained significant after controlling for cognitive ability and personality (and no correlations were found between self-reported emotional intelligence and leadership emergence). While individual studies (e.g., Leban & Zulauf, 2004) have shown promising associations between emotional intelligence and transformational leadership—the leadership style in which leaders motivate and inspire their subordinates to work toward a common vision (Bass, 1985; Bass & Riggio, 2006)—a recent meta-analysis (Harms & Credé, 2010) found a relationship only when the same rater assessed both emotional intelligence and transformational leadership. When multiple rating sources were used (e.g., the leader assessed emotional intelligence and a peer or subordinate assessed leadership style), there was no significant relationship between the variables (Harms & Credé, 2010). Future investigations in this area might consider the possible role of emotional intelligence in leaders' decision-making styles, as well as observed leadership styles as opposed to self- or informant ratings of leadership styles. (See Brackett and colleagues, 2013, and Côté, 2014, for more detailed reviews of the literature on emotional intelligence in the workplace.)

Summary

Emotional intelligence, measured as an ability, correlates with important outcomes in the domains of health, relationships, academics, and the workplace, but more work should be done to ascertain the mechanisms by which such associations occur. Furthermore, as the MSCEIT-YV was developed more recently than the MSCEIT, additional investigations into the correlates of emotional intelligence among older children and adolescents should be undertaken. Given the link between emotional intelligence and important life outcomes, emotional intelligence appears to be a desirable set of abilities to possess, and individuals may wonder whether—and how—they can increase their emotional intelligence. We now turn to a consideration of how emotional intelligence might be developed.

Developing Emotional Intelligence

Mayer and Salovey (1997) observed early on that since "most skills can be improved through education . . . it is likely this will hold true for at least some of the skills related to emotional intelligence" (p. 19). Perhaps a less cautious endorsement of this concept is this statement from neuroscientists Davidson and McEwen (2012):

> Just as we as a society are learning to take more responsibility for our physical health by engaging in regular physical exercise, we can also take more responsibility for our minds and brains by engaging in certain mental exercises that can induce plastic changes in the brain and that may have enduring beneficial consequences for social and emotional behavior. This also invites the perspective that qualities such as well-being ought to be viewed, at least in part, as a product of trainable skills and that interventions explicitly designed to promote well-being may have beneficial behavioral and biological effects. (p. 690)

We propose that, as a set of mental abilities or skills that underlie adaptive social and emotional functioning and well-being, emotional intelligence and the training of its component skills may be understood from a similar perspective. Although empirical evidence of the potential for emotional intelligence skill growth has been slow to accumulate, that which does exist is promising. In this section, we review the existing evidence as well as overview the state of efforts to improve emotional intelligence in the home and at school. We also consider how burgeoning technological advancements might expand the reach and format of emotional skill-development endeavors across the lifespan.

Theoretical and Empirical Evidence Related to Developing Emotional Intelligence

Just as we would not expect a person's intelligence to change dramatically over time, it is unlikely that individuals experience *dramatic* shifts in their overall emotional intelligence beyond the natural increase that occurs with age and education. However, it is clear that people can and do learn information about emotions and related skills, and can acquire new emotion language and regulation strategies as they age and accumulate a wider range of life experiences. Indeed, neuroscientists have suggested that "social and emotional characteristics can be educated in ways that are not dissimilar from certain forms of cognitive learning" (Davidson & McEwen, 2012, p. 694). A recent review of the literature supports this assertion; emotional intelligence interventions show promise, with preliminary studies demonstrating a moderate effect size (Schutte, Malouff, & Thorsteinsson, 2013). This review, however, identified only two studies that both used a true experimental, random-assignment design and that assessed participants' emotional intelligence with ability assessments. For instance, one well-designed intervention study showed a significant increase in emotional intelligence among young adults in the treatment group and not the control group, with effects still measurable at a 6-month follow-up (Nelis, Quoidbach, Mikolajczak, & Hansenne, 2009). However, this study used measures of trait and not ability emotional intelligence, so results should be interpreted with caution. There is a need for additional, well-designed investigations into the impact of ability emotional intelligence training.

Despite their limitations, the existing studies Schutte and colleagues (2013) identified provide a foundation for further examinations into the development of emotional intelligence. One study found that athletes randomly assigned to participate in 10 three-hour emotional intelligence workshops had significantly higher MSCEIT scores at posttest than at baseline, and had significantly higher MSCEIT scores than their peers in the control group (Crombie, Lombard, & Noakes, 2011). A second study found similar results among business school students (Reuben, Sapienza, & Zingales, 2009). Participants assigned to a 16-hour, not-for-credit course in emotional intelligence showed a significant gain in overall MSCEIT performance upon course completion, while the pre- and posttest MSCEIT scores of their peers in an attention-control (i.e., business etiquette) course showed no significant change. Whether the effects of either intervention were lasting is unclear and future studies should attempt to replicate the findings and track retention of skills over time. As Lindebaum (2009) cautions, there is a significant difference between short-term training and comprehensive education where emotional intelligence is concerned.

Another well-established finding that bears on our consideration of the potential for teaching emotional intelligence is that individuals' *beliefs* about the malleability of intelligence are linked to achievement (e.g., Blackwell, Trzesniewski, & Dweck, 2007; Hong, Chiu, Dweck, Lin, & Wan, 1999; Stipek & Gralinski, 1996). Specifically, individuals who believe skills can be improved through attention and effort tend to perform better than those who believe intelligence is fixed and unchangeable. Furthermore, comprehensive, evidence-based efforts to shape children's social and emotional development early on in life have been shown to provide clear social, emotional, behavioral, and academic advantages (Durlak et al., 2011). It is for the reasons outlined in this section that we encourage individuals—particularly caregivers and educators—to adopt and promulgate an optimistic view of the potential for developing emotional intelligence. Promising avenues for developing these skills in the home, at school, and by leveraging new technologies are where we now turn.

Parents' Socialization of Children's Emotional Skills

Mayer and Salovey (1997) wrote that "emotional skills begin in the home with good parent–child interaction" (p. 19). Of course, children may be socialized by caregivers other than parents, but for ease of language we use the term "parents" for socializers in the home as opposed to those in the education system. Parents teach children (whether consciously or not) how to behave and interact around emotions through (1) their reactions to their children's expressions of emotion, (2) their discussion of emotions, and (3) their own emotional expressiveness (Eisenberg, Cumberland, & Spinrad, 1998). Children's observation of these modeled behaviors is a key component of emotional development (Bandura, 1977; Morris, Silk, Steinberg, Myers, & Robinson, 2007; Parke, 1994). Families' emotional climate—including the marital relationship and parenting styles—also has an impact on children's emotion socialization and, in particular, emotion regulation ability (Morris et al., 2007). The emotion socialization process is bidirectional; families influence the child's socialization process and the child (via gender, temperament, and other factors) influences the family's actions and responses related to emotion socialization (Eisenberg et al., 1998; Morris et al., 2007).

One prominent theoretical framework of emotion socialization in the home posits that parents' philosophies of emotion fall into two categories: emotion dismissing and emotion coaching (Gottman, 2011; Gottman, Katz, & Hooven, 1996; Katz, Maliken, & Stettler, 2012). According to this theory, called parental meta-emotion philosophy, parents with a dismissing philosophy tend to minimize or deny their children's negative emotions. In contrast, parents who coach emotions are more likely to engage in five behaviors: (1) being aware of children's emotions, even at a low intensity; (2) taking the perspective that emotional expression indicates an opportunity to connect and teach; (3) communicating to children that their emotions are acceptable; (4) helping children label their emotions; and (5) setting appropriate boundaries and/or facilitating emotional problem solving. While this theory is not explicitly based in the ability model of emotional intelligence, it does map on to three of the four branches: perceiving, understanding, and managing emotions. Parents' emotion philosophies appear to predict actual parenting behaviors as well as children's physiological ability to regulate emotions (Gottman et al., 1996). A recent review of the literature related to this theory found that parents' emotion socialization style was related to important child outcomes, including peer relationships and psychosocial adjustment (Katz et al., 2012).

Two interventions based in parental meta-emotion philosophy are Tuning in to Kids (Havighurst, Wilson, Harley, & Prior, 2009) and Tuning in to Toddlers (Lauw, Havighurst, Wilson, Harley, & Northam, 2014). Both programs aim to strengthen parent–child emotional connections by teaching the five-step model of emotion coaching described above via videos, group exercises (such as role plays and discussions), and home activities. A randomized control study of Tuning in to Kids found that after six group sessions and two booster sessions, parents in the intervention group showed improved awareness and regulation, more emotion labeling and coaching behavior, and less emotion dismissing behavior. Children of parents in the intervention group showed increased emotion knowledge (Havighurst, Wilson, Harley, Prior, & Kehoe, 2010). A pilot study of Tuning in to Toddlers revealed that after attending six sessions, parents were rated by themselves and by observers as using more emotion coaching behavior, less emotion dismissing behavior, and a higher level of emotion talk (Lauw et al., 2014). Future evaluations of the program designed for toddlers would be improved by the use of a control group.

As interventions with a basis in this model become more fully developed and available, additional research should be done to determine their impact on actual parenting behavior and child outcomes. Parent training programs and interventions more closely based in the four-branch model of emotional intelligence should also be developed, keeping in mind that it is critical to ensure that emotion socializers themselves are proficient in the perception, use, understanding, and managing of emotions before they can successfully cultivate emotional intelligence in children. This is true for parents or other caregivers in the home, and for teachers in the classroom, where we turn next.

Teaching Emotional Intelligence in the Classroom

Over the past couple of decades, it has become increasingly clear that emotions are central to students' academic, personal, and social success both in and outside of the classroom. In 1994 at a conference hosted by the Fetzer Institute, the term "social and emotional learning" (SEL) was introduced to describe efforts to promote skill building among youth that support positive relationships and well-being throughout life (Elbertson, Brackett, & Weissberg, 2010). The Collaborative for Academic, Social, and Emotional Learning (CASEL) was formed soon after with the mission of integrating SEL into existing academic curricula from early childhood through high school. With hundreds of programs now available that claim to teach social and emotional competencies to students, standards for what constitutes effective SEL programming have been adjusted throughout the years (e.g., Durlak et al., 2011; Elias et al., 1997; Payton et al., 2000). CASEL (*www.casel.org*) has begun to identify and endorse school-based SEL programs ("CASEL SELect" programs; see CASEL, 2012) that meet rigorous standards, including offering quality training and implementation support and being well designed, evidence based, and universal (i.e., implemented across the entire student body and not just select groups of at-risk students).

The positive impact of teaching SEL in schools using high-quality programming has been established empirically. A meta-analysis including over 200 studies of school-based SEL programs found that teachers delivered them successfully and that they significantly enhanced students' social and emotional skills, behavior, attitudes toward school, and academic performance (Durlak et al., 2011). The authors of the meta-analysis identified four components that are critical to successful SEL programs: they should be sequenced, active, focused, and explicit (SAFE; Durlak et al., 2011). Two SEL programs that are rooted in emotion science and meet these SAFE standards are RULER (an acronym for the five key skills of emotional intelligence: recognizing, understanding, labeling, expressing, and regulating emotion), and the promoting alternative thinking strategies (PATHS) curriculum. Here, we overview these programs briefly.

RULER is a schoolwide approach to developing children's emotional intelligence from prekindergarten through high school that was developed at the Yale Center for Emotional Intelligence (Brackett, Kremenitzer, et al., 2011). RULER is grounded in the ability model of emotional intelligence and is designed to enhance emotional skills and improve interactions between and among school leaders, teachers, students, and families. RULER supports educators in using new teaching practices to help children learn about emotions and refine their ability to be self-aware, acquire the language of emotions, and practice emotion regulation skills. For instance, using RULER's Mood Meter, teachers and students develop the skills of emotional intelligence by checking in with and labeling their emotions on a regular basis, examining and understanding the likely causes and consequences of those emotions, and expressing and regulating emotions using effective strategies. In addition to tools that foster empathy, emotional awareness, and effective emotion regulation, classrooms use RULER's Feeling Words Curriculum to support students' attainment of a large "emotions vocabulary" that is contextualized and integrated into routine academic instruction via shared personal stories, discussions of world events, and developmentally appropriate storybooks and literature.

Evidence is accumulating for RULER's positive impact. One quasi-experiment showed that students in middle school classrooms integrating RULER for one academic year had higher year-end grades and higher teacher ratings of social and emotional competence compared with students in the control group (Brackett et al., 2012). A randomized control trial in 62 schools found that classrooms randomly assigned to the RULER intervention had higher degrees of warmth and connectedness between teachers and students, more indicators of student autonomy and leadership, less bullying-related behaviors, and a greater focus on students' interests and motivations, as rated by independent observers of the classrooms (Rivers, Brackett, Reyes, Elbertson, & Salovey, 2013). These first-year shifts in the emotional qualities of classrooms were followed by other improvements: compared with classrooms randomized to the control, business-as-usual condition, independent observers rated classrooms in the RULER condition as exhibiting greater emotional support, better classroom organization, and better instructional support at the end of the second year (Hagelskamp, Brackett, Rivers, & Salovey, 2013). Higher emotional intelligence and more advanced social problem-solving skills were associated with greater fidelity of program implementation (Reyes, Brackett, Rivers, Elbertson, & Salovey, 2012).

The PATHS curriculum (Kusche & Greenberg, 1994) was designed to promote social and emotional development among students who are deaf or hearing impaired (Greenberg & Kusché, 1993) but has since expanded to include students in general education from prekindergarten through sixth grade (see *www.pathstraining.com*). PATHS has its theoretical basis in the affective–behavioral–cognitive–dynamic (ABCD) model of development (Greenberg & Kusché, 1993), which recognizes that children's emotional experience precedes their cognitive and linguistic development, and posits that these affective, cognitive, linguistic, and behavioral systems must be integrated strategically as children develop in order to nurture social and emotional competence. PATHS promotes emotional awareness, understanding, and regulation to help children choose adaptive approaches to interpersonal challenges. PATHS teachers deliver developmentally appropriate lessons at least two times per week throughout the school year. The lessons allow children to practice emotion regulation strategies, to label emotions, and to problem solve about their emotional experiences. PATHS has been shown to decrease students' externalizing and internalizing behaviors and depression, as well as to increase students' emotion recognition and understanding skills, teacher ratings of students' prosocial behavior, and students' social problem-solving skills (Domitrovich, Cortes, & Greenberg, 2007; Greenberg & Kusché, 1998; Greenberg, Kusche, Cook, & Quamma, 1995; Kam, Greenberg, & Kusche, 2004).

Because SEL, like emotional intelligence, has been defined in many ways, standardizing SEL efforts could help to illuminate their impact and moderators (Durlak et al., 2011). SEL is not synonymous with emotional intelligence, and so care should be taken in interpreting outcomes of SEL interventions as evidence for the effects of teaching emotional intelligence. Relatedly, there is currently no comprehensive measure of ability emotional intelligence for children 9 years and younger. This presents a major challenge to researchers' ability to evaluate home- and school-based efforts to enhance emotional intelligence in young children, even though individual measures of the specific subskills that make up emotional intelligence exist for this age range (e.g., the emotion perception "box task," which is not reliant on reading or verbal skills; Russell & Widen, 2002). The development of an omnibus measure-of-ability emotional intelligence in young children would constitute a groundbreaking contribution to the field; it would allow for more thorough and even evaluation of intervention attempts, and would inform our understanding of the timing and nature of the developmental milestones of emotional skill acquisition.

Leveraging Technology to Enhance Emotional Intelligence

Across domains (i.e., homes, schools, and even professional organizations), technology may pave new pathways to developing emotional skills, particularly as it becomes increasingly accessible, portable, and sophisticated. Rosalind Picard and colleagues, working in the Affective Computing Research Group at MIT, use biosensors and long-term measurements of autonomic nervous system function to increase self-awareness and improve emotion regulation in everyday life via a wearable device ("iCalm"; Hedman et al., 2009). RULER's Mood Meter, described above, now is available as an "app" that can be downloaded to mobile devices to allow (and remind) users of all ages to label and track their emotions over time to discover their emotional tendencies and triggers. Going a step further, virtual avatars and robots are increasingly employed to assess users' emotions and aid in emotion regulation (Klein, Moon, & Picard, 2002; Picard & Klein, 2002; Ring, Barry, Totzke, & Bickmore, 2013; Wada & Shibata, 2007). For example, one study found that virtual agents (avatars) that actively engaged isolated older adults and assessed their emotional states succeeded in reducing the users' feelings of loneliness (Ring et al., 2013). This type of interaction has the added benefit of modeling to adults that some unpleasant emotions may be reduced by engaging in social contact. In a similar vein, therapeutic robotic seals introduced into geriatric care settings were found to increase socialization and reduce stress among users, as assessed by video observations and the analysis of hormone levels, respectively (Wada & Shibata, 2007).

The technologies described here could theoretically be incorporated into settings such as schools using programs like RULER to bolster skill-building efforts, and may be particularly helpful for reaching individuals who are less comfortable sharing their emotions via traditional conversation and group discussion. Teachers could prompt students to interact with a social robot or avatar placed in the classroom, out of earshot of other students. The agent could prompt students to indicate how pleasant or unpleasant they feel and how high or low their energy is, and then could help students to label their emotions and determine what activities might benefit from them. The agent could also recommend strategies for reducing negative emotions or maintaining positive ones. A similar, adult-centered interface could be used in workplaces in relatively private places to encourage self-awareness and reflection. Data could be shared immediately with individual users or could be collected and considered in the aggregate to determine general emotional states and whether particular days of the week or specific events generally trigger more unpleasant or pleasant emotions. Results could guide shifts in schedules or activities and could inform more individualized emotional intelligence interventions for specific settings and groups.

Limitations and Future Directions for Emotional Intelligence

Even after 25 years of research, much about emotional intelligence remains to be learned and refined. Perhaps most pressing to address, the current approach to measuring the construct is far from perfect. As discussed above, there is some debate regarding the fitness of the four-factor structure of the MSCEIT, and there should be continued attempts to replicate the proposed structure or to present and test alternatives. The challenges of measuring the real-time application of emotional knowledge must also be addressed with innovative approaches—for example, by finding cost- and time-effective ways to induce emotions and assess regulation strategies as they are actually employed. The fact that the majority of ability emotional intelligence research uses the MSCEIT increases the likelihood that test effects have become confounded with construct effects (MacCann & Roberts, 2008). Researchers have developed new measurement approaches in an effort to address this concern (e.g., the Situational Test of Emotional Understanding and the Situational Test of Emotion Management; MacCann & Roberts, 2008), and these merit further exploration. Finally, there is a need for a comprehensive performance assessment of emotional intelligence for children under the age of 10. The success of such a measure will depend on its sensitivity to developmental milestones (cognitive, emotional, and linguistic) across childhood.

Other considerations for future research have to do with the generalizability of conclusions about emotional intelligence across genders and cultures. It has been established meta-analytically that females score significantly higher on performance measures of emotional intelligence than do males (Joseph & Newman, 2010). It would be interesting to examine whether interventions are differentially effective across sexes, and whether skill-development efforts could or should be tailored to gender differences to help close this gap. In terms of cultural context, there is reason to believe that global variance in emotion display rules and other cultural norms around emotions would impact the fit of the construct and related scales across cultural groups. It is only recently that cross-cultural investigations of ability emotional intelligence have been undertaken, but there is limited evidence that the MSCEIT is generalizable across Eastern (Pakistani) and Western (French) student samples (Karim & Weisz, 2010). Thus, the question of cultural generalizability begs further exploration.

Finally, while it is natural to frame emotional intelligence in terms of its adaptive and positive consequences for individuals and society, some researchers have also begun to explore the construct's relationship to social deviance and Machiavellianism—in other words, its "dark side" (Austin, Farrelly, Black, & Moore, 2007; Côté, DeCelles, McCarthy, Van Kleef, & Hideg, 2011; Winkel, Wyland, Shaffer, & Clason, 2011). Are individuals who are better at perceiving and regulating emotions in themselves and others also better able to manipulate others' emotions toward selfish or even immoral ends? While empirical evidence is limited and mixed, there is some indication that higher emotional intelligence may be related to deviant behavior in some contexts (Winkel et al., 2011). Future research could endeavor to identify the conditions that make the "misuse" of emotional intelligence less likely.

Conclusion

Emotions permeate every aspect of our lives. They provide us invaluable information about our environment and the people in it, and they become adaptive when they are attended to and leveraged with skill. For the past quarter-century, emotional intelligence research has helped to illuminate what it means to apply skill to our emotional experience. While multiple perspectives still abound on what emotional intelligence is, what it should be expected to predict, and how it should be measured, a picture of the construct as a set of specific mental abilities best measured via performance assessments is beginning to emerge as the accepted standard. The exact extent to which the enhancement of these abilities in individuals is possible remains to be seen, but it is clear that well-designed efforts to enhance emotional intelligence show promise for improving functioning and well-being in many domains.

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References

Austin, E. J., Farrelly, D., Black, C., & Moore, H. (2007). Emotional intelligence, Machiavellianism and emotional manipulation: Does EI have a dark side? *Personality and Individual Differences, 43*, 179–189.

Baas, M., De Dreu, C. K. W., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin, 134*, 779–806.

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bar-On, R. (1997). *Bar-On Emotional Quotient inventory: Technical manual.* Toronto, Canada: Multi-Health Systems.

Bar-On, R. (2006). The Bar-On model of emotional–social intelligence (ESI). *Psicothema, 18*(Suppl.), 13–25.

Barrett, L. F. (1998). Discrete emotions or dimensions?: The role of valence focus and arousal focus. *Cognition and Emotion, 12*, 579–599.

Barrett, L. F., Gross, J., Christensen, T. C., & Benvenuto, M. (2001). Knowing what you're feeling and knowing what to do about it: Mapping the relation between emotion differentiation and emotion regulation. *Cognition and Emotion, 15*, 713–724.

Barsade, S. G., Brief, A. P., & Spataro, S. E. (2003). The affective revolution in organizational behavior: The emergence of a paradigm. *Organizational Behavior: The State of the Science, 2*, 3–52.

Bass, B. M. (1985). *Leadership and performance beyond expectations*. New York: Free Press.

Bass, B. M., & Riggio, R. E. (2006). *Transformational leadership* (2nd ed.). Mahwah, NJ: Erlbaum.

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78*, 246–263.

Boyatzis, R., & Sala, F. (2004). The Emotional Competency Inventory (ECI). In G. Geher (Ed.), *Measuring emotional intelligence: Common ground and controversy* (pp. 143–178). Hauppauge, NY: Nova Science.

Brackett, M. A., Bertoli, M. C., Elbertson, N. A., Bausseron, E., Castillo-Gualda, R., & Salovey, P. (2013). Emotional intelligence: Reconceptualizing the cognition–emotion link. In M. D. Robinson, E. R. Watkins, & E. Harmon-Jones (Eds.), *Handbook of cognition and emotion* (pp. 365–382). New York: Guilford Press.

Brackett, M. A., Kremenitzer, J. P., Maurer, M., Rivers, S. E., Elberston, N. A., & Carpenter, M. D. (Eds.). (2011). *Creating emotionally literate classrooms: An introduction to the RULER approach to social and emotional learning.* Port Chester, NY: National Professional Resources.

Brackett, M. A., & Mayer, J. D. (2003). Convergent, discriminant, and incremental validity of competing measures of emotional intelligence. *Personality and Social Psychology Bulletin, 29*, 1147–1158.

Brackett, M. A., Mayer, J. D., & Warner, R. M. (2004). Emotional intelligence and its relation to everyday behaviour. *Personality and Individual Differences, 36*, 1387–1402.

Brackett, M. A., Rivers, S. E., Reyes, M. R., & Salovey, P. (2012). Enhancing academic performance and social and emotional competence with the RULER Feeling Words Curriculum. *Learning and Individual Differences, 22*, 218–224.

Brackett, M. A., Rivers, S. E., & Salovey, P. (2011). Emotional intelligence: Implications for personal, social, academic, and workplace success. *Social and Personality Compass, 5*, 88–103.

Brackett, M. A., Rivers, S. E., Shiffman, S., Lerner, N., & Salovey, P. (2006). Relating emotional abilities to social functioning: A comparison of self-report and performance measures of emotional intelligence. *Journal of Personality and Social Psychology, 91*, 780–795.

Brackett, M. A., & Salovey, P. (2006). Measuring emotional intelligence with the Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT). *Psicothema, 18*, 34–41.

Brackett, M. A., Warner, R. M., & Bosco, J. S. (2005). Emotional intelligence and relationship quality among couples. *Personal Relationships, 12*, 197–212.

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies.* New York: Cambridge University Press.

Cartwright, S., & Pappas, C. (2008). Emotional intelligence, its measurement and implications for the workplace. *International Journal of Management Reviews, 10*, 149–171.

CASEL. (2012). *2013 CASEL guide: Effective social and* *emotional learning programs—preschool and elementary school edition*. Chicago: Author.

Cha, C., & Nock, M. (2009). Emotional intelligence is a protective factor for suicidal behavior. *Journal of the American Academy of Child and Adolescent Psychiatry, 48*, 422–430.

Cherniss, C. (2010). Emotional intelligence: Toward clarification of a concept. *Industrial and Organizational Psychology: Perspectives on Science and Practice, 3*, 110–126.

Côté, S. (2014). Emotional intelligence in organizations. *Annual Review of Organizational Psychology and Organizational Behavior, 1*, 459–488.

Côté, S., DeCelles, K. A., McCarthy, J. M., Van Kleef, G. A., & Hideg, I. (2011). The Jekyll and Hyde of emotional intelligence: Emotion-regulation knowledge facilitates both prosocial and interpersonally deviant behavior. *Psychological Science, 22*, 1073–1080.

Côté, S., Lopes, P. N., Salovey, P., & Miners, C. T. H. (2010). Emotional intelligence and leadership emergence in small groups. *Leadership Quarterly, 21*, 496–508.

Crombie, D., Lombard, C., & Noakes, T. (2011). Increasing emotional intelligence in cricketers: An intervention study. *International Journal of Sports Science and Coaching, 6*, 69–86.

Damasio, A. R. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York: Grosset/Putnam.

Darwin, C. (1872). *The expression of the emotions in man and animals with photographic and other illustrations*. London: Murray.

Daus, C. S., & Ashkanasy, N. M. (2003). Will the real emotional intelligence please stand up?: On deconstructing the emotional intelligence "debate." *The Industrial–Organizational Psychologist, 41*, 69–72.

Davidson, R. J., Jackson, D. C., & Kalin, N. H. (2000). Emotion, plasticity, context, and regulation: Perspectives from affective neuroscience. *Psychological Bulletin, 126*, 890–909.

Davidson, R. J., & McEwen, B. S. (2012). Social influences on neuroplasticity: Stress and interventions to promote well-being. *Nature Neuroscience, 15*, 689–695.

Davis, S. K., & Humphrey, N. (2012). Emotional intelligence predicts adolescent mental health beyond personality and cognitive ability. *Personality and Individual Differences, 52*, 144–149.

Day, A. L., & Carroll, S. A. (2008). Faking emotional intelligence (EI): Comparing response distortion on ability and trait-based EI measures. *Journal of Organizational Behavior, 29*, 761–784.

Demiralp, E., Thompson, R. J., Mata, J., Jaeggi, S. M., Buschkuehl, M., Barrett, L. F., et al. (2012). Feeling blue or turquoise?: Emotional differentiation in major depressive disorder. *Psychological Science, 23*, 1410–1416.

DiFabio, A., & Palazzeschi, L. (2009). An in-depth look at scholastic success: Fluid intelligence, personality traits or emotional intelligence? *Personality and Individual Differences, 46*, 581–585.

Domitrovich, C. E., Cortes, R. C., & Greenberg, M. T. (2007). Improving young children's social and emotional competence: A randomized trial of the preschool "PATHS" curriculum. *Journal of Primary Prevention, 28*(2), 67–91.

Duncan, L. R., Bertoli, M. C., Latimer-Cheung, A. E., Rivers, S. E., Brackett, M. A., & Salovey, P. (2013). Mapping the protective pathway of emotional intelligence in youth: From social cognition to smoking intentions. *Personality and Individual Differences, 54*, 542–544.

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., & Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: A meta-analysis of school-based universal interventions. *Child Development, 82*, 405–432.

Eisenberg, N., Cumberland, A., & Spinrad, T. L. (1998). Parental socialization of emotion. *Psychological Inquiry, 9*, 241–273.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion, 6*, 169–200.

Ekman, P. (1994). All emotions are basic. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 15–19). New York: Oxford University Press.

Elbertson, N. A., Brackett, M. A., & Weissberg, R. P. (2010). School-based social and emotional (SEL) programming: Current perspectives. In A. Hargreaves, M. Fullan, D. Hopkins, & A. Lieberman (Eds.), *The second international handbook of educational change* (pp. 1017–1032). New York: Springer.

Elias, M. J., Zins, J. E., Weissberg, R. P., Frey, K. S., Greenberg, M. T., Haynes, N. M., et al. (1997). *Promoting social and emotional learning: Guidelines for educators*. Alexandria, VA: Association for Supervision and Curriculum Development.

Erbas, Y., Ceulemans, E., Lee Pe, M., Koval, P., & Kuppens, P. (2014). Negative emotion differentiation: Its personality and well-being correlates and a comparison of different assessment methods. *Cognition and Emotion, 28*(7), 1–18.

Eugène, F., Lévesque, J., Mensour, B., Leroux, J. M., Beaudoin, G., Bourgouin, P., et al. (2003). The impact of individual differences on the neural circuitry underlying sadness. *NeuroImage, 19*, 354–364.

Extremera, N., & Fernández-Berrocal, P. (2002). *Cuestionario MSCEIT* (versión española 2.0) de Mayer, Salovey y Caruso. Toronto, Canada: Multi-Health Systems.

Fan, H., Jackson, T., Yang, X., Tang, W., & Zhang, J. (2010). The factor structure of the Mayer–Salovey–Caruso Emotional Intelligence Test V 2.0 (MSCEIT): A meta-analytic structural equation modeling approach. *Personality and Individual Differences, 48*, 781–785.

Fancher, R. E. (1985). *The intelligence men: Makers of the IQ controversy*. New York: Norton.

Feldman, L. A. (1995). Valence focus and arousal focus: Individual differences in the structure of affective experience. *Journal of Personality and Social Psychology, 69*, 153.

Fernández-Berrocal, P., Extremera, N., Lopes, P. N., & Ruiz-Aranda, D. (2014). When to cooperate and when to compete: Emotional intelligence in interpersonal decision-making. *Journal of Research in Personality, 49*, 21–24.

Flom, R., & Bahrick, L. E. (2007). The development of infant discrimination of affect in multimodal and unimodal stimulation: The role of intersensory redundancy. *Developmental Psychology, 43*, 238.

Ford, B. Q., & Tamir, M. (2012). When getting angry is smart: Emotional preferences and emotional intelligence. *Emotion, 12*, 685.

Forgas, J. P. (2006). Affective influences on interpersonal behavior: Towards understanding the role of affect in everyday interactions. In J. P. Forgas (Ed.), *Affect in social thinking and behavior* (pp. 269–290). New York: Psychology Press.

Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology, 2*, 300–319.

Frevert, U. (2011). *Emotions in history: Lost and found*. Budapest: Central European University Press.

Frijda, N. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.

Gardner, H. (1993). *Frames of mind: The theory of multiple intelligences* (10th anniv. ed.). New York: Basic Books. (Original work published 1983)

Global Ed & Skills. (2014, March 15). Tony Blair on skills: "One big change in what kids should learn is the need to nurture creative thinking and emotional intelligence." Twitter post. Retrieved from *https://twitter.com/GESForum/status/444861219199918080.*

Goleman, D. (1995). *Emotional intelligence: Why it can matter more than IQ*. New York: Bantam Books.

Goleman, D. (1998). *Working with emotional intelligence*. New York: Bantam Books.

Gottman, J. M. (2011). *Raising an emotionally intelligent child*. New York: Simon & Schuster.

Gottman, J. M., Katz, L. F., & Hooven, C. (1996). Parental meta-emotion philosophy and the emotional life of families: Theoretical models and preliminary data. *Journal of Family Psychology, 10*, 243–268.

Greenberg, M. T., & Kusché, C. A. (1993). *Promoting social and emotional development in deaf children: The PATHS project*. Seattle: University of Washington Press.

Greenberg, M. T., & Kusché, C. A. (1998). Preventive interventions for school-age deaf children: The PATHS curriculum. *Journal of Deaf Studies and Deaf Education, 3*, 49–63.

Greenberg, M. T., Kusche, C. A., Cook, E. T., & Quamma, J. P. (1995). Promoting emotional competence in school-aged children: The effects of the PATHS curriculum. *Development and Psychopathology, 7*, 117–136.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*, 348–362.

Hagelskamp, C., Brackett, M. A., Rivers, S. E., & Salovey, P. (2013). Improving classroom quality with the RULER approach to social and emotional learning: Proximal and distal outcomes. *American Journal of Community Psychology, 51*, 530–543.

Hamann, S., & Canli, T. (2004). Individual differences in emotion processing. *Current Opinion in Neurobiology, 14*, 233–238.

Harms, P. D., & Credé, M. (2010). Emotional intelligence and transformational and transactional leadership: A meta-analysis. *Journal of Leadership and Organizational Studies, 17*, 5–17.

Havighurst, S. S., Wilson, K. R., Harley, A. E., & Prior, M. R. (2009). Tuning in to Kids: An emotion-focused parenting program—Initial findings from a community trial. *Journal of Community Psychology, 37*, 1008–1023.

Havighurst, S. S., Wilson, K. R., Harley, A. E., Prior, M. R., & Kehoe, C. (2010). Tuning in to Kids: Improving emotion socialization practices in parents of preschool children—findings from a community trial. *Journal of Child Psychology and Psychiatry, 51*, 1342–1350.

Hedman, E., Wilder-Smith, O., Goodwin, M. S., Poh, M.-Z., Fletcher, R., & Picard, R. (2009). *iCalm: Measuring electrodermal activity in almost any setting*. Amsterdam: IEEE: Third International Conference on Affective Computing and Intelligent Interaction.

Herrnstein, R. J., & Murray, C. A. (1994). *The bell curve: Intelligence and class structure in American life*: New York: Free Press.

Hong, Y., Chiu, C., Dweck, C. S., Lin, D. M., & Wan, W. (1999). Implicit theories, attributions, and coping: A meaning system approach. *Journal of Personality and Social Psychology, 77*, 588–599.

Hunsinger, M., Isbell, L. M., & Clore, G. L. (2012). Sometimes happy people focus on the trees and sad people focus on the forest: Context-dependent effects of mood in impression formation. *Personality and Social Psychology Bulletin, 38*, 220–232.

Isen, A. M., Shalker, T. E., Clark, M., & Karp, L. (1978). Affect, accessibility of material in memory, and behavior: A cognitive loop? *Journal of Personality and Social Psychology, 36*, 1–12.

Ivcevic, Z., & Brackett, M. A. (2014). Predicting school success: Comparing conscientiousness, grit, and emotion regulation ability. *Journal of Research in Personality, 52*, 29–36.

Izard, C. E. (1971). *The face of emotion*. East Norwalk, CT: Appleton-Century-Crofts.

Jamison, K. R. (2005). *Exuberance: The passion for life*. New York: Knopf.

Jordan, P. J., Dasborough, M. T., Daus, C. S., & Ashkanasy, N. M. (2010). A call to context. *Industrial and Organizational Psychology, 3*, 145–148.

Joseph, D. L., & Newman, D. A. (2010). Emotional intelligence: An integrative meta-analysis and cascading model. *Journal of Applied Psychology, 95*, 54–78.

Kafetsios, K. (2004). Attachment and emotional intelligence abilities across the life course. *Personality and Individual Differences, 37*, 129–145.

Kam, C.-M., Greenberg, M. T., & Kusche, C. A. (2004). Sustained effects of the PATHS curriculum on the social and psychological adjustment of children in special education. *Journal of Emotional and Behavioral Disorders, 12*, 66–78.

Karim, J., & Weisz, R. (2010). Cross-cultural research on the reliability and validity of the Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT). *Cross-Cultural Research, 44*(4), 374–404.

Katz, L. F., Maliken, A. C., & Stettler, N. M. (2012). Parental meta-emotion philosophy: A review of research and theoretical framework. *Child Development Perspectives, 6*, 417–422.

Klein, J., Moon, Y., & Picard, R. W. (2002). This computer responds to user frustration: Theory, design, and results. *Interacting with Computers, 14*, 119–140.

Kong, D. T. (2014). Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT/MEIS) and overall, verbal, and nonverbal intelligence: Meta-analytic evidence and critical contingencies. *Personality and Individual Differences, 66*, 171–175.

Korn, M. (2013, May 1). B-schools know how you think, but how do you feel? *The Wall Street Journal*. Retrieved from *http://online.wsj.com/news/articles/SB1000142412788732 4582004578456770420379966*.

Kusche, C. A., & Greenberg, M. T. (1994). *The PATHS (promoting alternative thinking strategies) curriculum*. South Deerfield, MA: Channing-Bete Co.

Lauw, M. S. M., Havighurst, S. S., Wilson, K. R., Harley, A. E., & Northam, E. A. (2014). Improving parenting of toddlers' emotions using an emotion coaching parenting program: A pilot study of Tuning in to Toddlers. *Journal of Community Psychology, 42*, 169–175.

Leban, W., & Zulauf, C. (2004). Linking emotional intelligence abilities and transformational leadership styles. *Leadership Organization Development Journal, 25*, 554–564.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience, 23*, 155–184.

Leeper, R. W. (1948). A motivational theory of emotion to replace emotion as disorganized response. *Psychological Review, 55*, 5–21.

Lefford, A. (1946). The influence of emotional subject matter on logical reasoning. *Journal of General Psychology, 34*, 127–151.

Levenson, R. W. (1994). Human emotion: A functional view. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 123–126). New York: Oxford University Press.

Lindebaum, D. (2009). Rhetoric or remedy?: A critique on developing emotional intelligence. *Academy of Management Learning Education, 8*, 225–237.

Lopes, P. N., Brackett, M. A., Nezlek, J. B., Schütz, A., Sellin, I., & Salovey, P. (2004). Emotional intelligence and social interaction. *Personality and Social Psychology Bulletin, 30*, 1018–1034.

Lopes, P. N., & Salovey, P. (2004). Toward a broader education: Social, emotional and practical skills. In J. E. Zins, R. P. Weissberg, M. C. Wang, & H. J. Walberg (Eds.), *Building academic success on social and emotional learning: What does the research say?* (pp. 76–93). New York: Teachers College Press.

Lopes, P. N., Salovey, P., Côté, S., Beers, M., & Petty, R. E. (2005). Emotion regulation abilities and the quality of social interaction. *Emotion, 5*, 113.

Lopes, P. N., Salovey, P., & Straus, R. (2003). Emotional intelligence, personality, and the perceived quality of social relationships. *Personality and Individual Differences, 35*, 641–658.

Lynn, R. (1999). Special review: The attack on The Bell Curve. *Personality and Individual Differences, 26*, 761–765.

Lyons, W. (1999). The philosophy of emotion and cognition. In T. Dalgleish & M. J. Power (Eds.), *Handbook of cognition and emotion* (pp. 21–44). Chichester, UK: Wiley.

MacCann, C., & Roberts, R. D. (2008). New paradigms for assessing emotional intelligence: Theory and data. *Emotion, 8*, 540.

Martins, A., Ramalho, N., & Morin, E. (2010). A comprehensive meta-analysis of the relationship between emotional intelligence and health. *Personality and Individual Differences, 49*, 554–564.

Matthews, G., Zeidner, M., & Roberts, R. D. (2002). *Emotional intelligence: Science and myth*. Cambridge, MA: MIT Press.

Maul, A. (2011). The factor structure and cross-test convergence of the Mayer–Salovey–Caruso model of emotional intelligence. *Personality and Individual Differences, 50*, 457–463.

Mayer, J. D., Caruso, D. R., & Salovey, P. (1999). Emotional intelligence meets traditional standards for an intelligence. *Intelligence, 27*, 267–298.

Mayer, J. D., Caruso, D. R., & Salovey, P. (2005). *The Mayer–Salovey–Caruso Emotional Intelligence Test—Youth Version (MSCEIT-YV), Research Version*. Toronto, Canada: Multi Health Systems.

Mayer, J. D., DiPaolo, M., & Salovey, P. (1990). Perceiving affective content in ambiguous visual stimuli: A component of emotional intelligence. *Journal of Personality Assessment, 54*, 772–781.

Mayer, J. D., Roberts, R. D., & Barsade, S. G. (2008). Human abilities: Emotional intelligence. *Annual Review of Psychology, 59*, 507–536.

Mayer, J. D., & Salovey, P. (1993). The intelligence of emotional intelligence. *Intelligence, 17*, 433–442.

Mayer, J. D., & Salovey, P. (1997). What is emotional intelligence? In P. Salovey & D. J. Sluyter (Eds.), *Emotional development and emotional intelligence: Educational implications* (pp. 3–34). New York: Basic Books.

Mayer, J. D., Salovey, P., & Caruso, D. R. (2000). Emotional intelligence as zeitgeist, as personality, and as a mental ability. In R. Bar-On & J. D. A. Parker (Eds.), *The handbook of emotional intelligence: Theory, development, assessment, and application at home, school, and in the workplace* (pp. 92–117). San Francisco: Jossey-Bass.

Mayer, J. D., Salovey, P., & Caruso, D. R. (2002a). *Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT): User's manual*. North Tonawanda, NY: Multi-Health Systems.

Mayer, J. D., Salovey, P., & Caruso, D. R. (2002b). *The Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT), Version 2.0*. Toronto, Canada: Multi Health Systems.

Mayer, J. D., Salovey, P., & Caruso, D. R. (2008). Emotional intelligence: New ability or eclectic traits? *American Psychologist, 63*, 503–517.

Mayer, J. D., Salovey, P., & Caruso, D. R. (2012). The validity of the MSCEIT: Additional analyses and evidence. *Emotion Review, 4*, 403–408.

Mayer, J. D., Salovey, P., Caruso, D. R., & Sitarenios, G. (2001). Emotional intelligence as a standard intelligence. *Emotion, 1*, 232–242.

Mestre, J. M., Guil, R., Lopes, P. N., Salovey, P., & Gil-Olarte, P. (2006). Emotional intelligence and social and academic adaptation to school. *Psicothema, 18*, 112–117.

Morris, A. S., Silk, J. S., Steinberg, L., Myers, S. S., & Robinson, L. R. (2007). The role of the family context in the development of emotion regulation. *Social Development, 16*, 361–388.

Neisser, U. (1967). *Cognitive psychology*. New York: Appleton-Century-Crofts.

Neisser, U., Boodoo, G., Bouchard, T. J., Jr., Boykin, A., Brody, N., Ceci, S. J., et al. (1996). Intelligence: Knowns and unknowns. *American Psychologist, 51*, 77–101.

Nelis, D., Quoidbach, J., Mikolajczak, M., & Hansenne, M. (2009). Increasing emotional intelligence: (How) is it possible? *Personality and Individual Differences, 47*, 36–41.

Nelson, C. A., & Dolgin, K. G. (1985). The generalized discrimination of facial expressions by seven-month-old infants. *Child Development, 56*, 58–61.

O'Boyle, E. H., Humphrey, R. H., Pollack, J. M., Hawver, T. H., & Story, P. A. (2011). The relation between emotional intelligence and job performance: A meta-analysis. *Journal of Organizational Behavior, 32*, 788–818.

Palfai, T., & Salovey, P. (1993). The influence of depressed and elated mood on deductive and inductive reasoning. *Imagination Cognition and Perception, 19*, 57–71.

Palmer, B. R., Gignac, G., Manocha, R., & Stough, C. (2005). A psychometric evaluation of the Mayer–Salovey–Caruso Emotional Intelligence Test Version 2.0. *Intelligence, 33*, 285–305.

Palmer, B. R., & Stough, C. (2005). Multi-rater or 360-degree emotional intelligence assessment. *Europe's Journal of Psychology, 1*.

Parke, R. D. (1994). Progress, paradigms, and unresolved problems: A commentary on recent advances in our understanding of children's emotions. *Merrill-Palmer Quarterly, 40*, 157–169.

Paulhus, D. L., Lysy, D. C., & Yik, M. S. M. (1998). Self-report measures of intelligence: Are they useful as proxy IQ tests? *Journal of Personality, 66*, 525–554.

Payton, J. W., Graczyk, P. A., Wardlaw, D. M., Bloodworth, M. R., Tompsett, C. J., & Weissberg, R. P. (2000). Social and emotional learning: A framework for promoting mental health and reducing risk behavior in children and youth. *Journal of Social Health, 70*, 179–185.

Peters, C., Kranzler, J. H., & Rossen, E. (2009). Validity of the Mayer–Salovey–Caruso Emotional Intelligence Test—Youth Version, Research Edition. *Canadian Journal of School Psychology, 24*, 76–81.

Petrides, K. V., & Furnham, A. (2001). Trait emotional intelligence: Psychometric investigation with reference to established trait taxonomies. *European Journal of Personality, 15*, 425–448.

Petrides, K. V., & Furnham, A. (2003). Trait emotional intelligence: Behavioural validation in two studies of emotion recognition and reactivity to mood induction. *European Journal of Personality, 17*, 39–57.

Petrides, K. V., Pita, R., & Kokkinaki, F. (2007). The location of trait emotional intelligence in personality factor space. *British Journal of Psychology, 98*, 273–289.

Picard, R. W., & Klein, J. (2002). Computers that recognise and respond to user emotion: Theoretical and practical implications. *Interacting with Computers, 14*, 141–169.

Plomin, R., & Kosslyn, S. M. (2001). Genes, brain and cognition. *Nature Neuroscience, 4*, 1153–1154.

Reuben, E., Sapienza, P., & Zingales, L. (2009). *Can we teach emotional intelligence?* Unpublished manuscript, Columbia Business Schoo, New York.

Reyes, M. R., Brackett, M. A., Rivers, S. E., Elbertson, N. A., & Salovey, P. (2012). The interaction effects of program training, dosage, and implementation quality on targeted student outcomes for the RULER approach to social and emotional learning. *School Psychology Review, 41*, 82–99.

Riggio, R. E., & Riggio, H. R. (2001). Self-report measurement of interpersonal sensitivity. In J. A. Hall & F. J. Bernieri (Eds.), *Interpersonal sensitivity: Theory and measurement* (pp. 127–144). Mahwah, NJ: Erlbaum.

Ring, L., Barry, B., Totzke, K., & Bickmore, T. (2013). *Addressing loneliness and isolation in older adults: Proactive affective agents provide better support*. Geneva: IEEE: 2013. Humaine Association Conference on Affective Computing and Intelligent Interaction.

Rivers, S. E., Brackett, M. A., Omori, M., Sickler, C., Bertoli, M. C., & Salovey, P. (2013). Emotion skills as a protective factor for risky behaviors among college students. *Journal of College Student Development, 54*, 172–183.

Rivers, S. E., Brackett, M. A., Reyes, M. R., Elbertson, N. A., & Salovey, P. (2013). Improving the social and emotional climate of classrooms: A clustered randomized controlled trial testing the RULER approach. *Prevention Science, 14*, 77–87.

Rivers, S. E., Brackett, M. A., Reyes, M. R., Mayer, J. D., Caruso, D. R., & Salovey, P. (2012). Measuring emotional intelligence in early adolescence with the MSCEIT-YV: Psychometric properties and relationship with academic performance and psychosocial functioning. *Journal of Psychoeducational Assessment, 30*, 344–366.

Rossen, E., & Kranzler, J. H. (2009). Incremental validity of the Mayer–Salovey–Caruso Emotional Intelligence Test Version 2.0 (MSCEIT) after controlling for personality and intelligence. *Journal of Research in Personality, 43*, 60–65.

Russell, J. A., & Widen, S. C. (2002). A label superiority effect in children's categorization of facial expressions. *Social Development, 11*, 30–52.

Salovey, P., & Mayer, J. D. (1990). Emotional intelligence. *Imagination, Cognition and Personality, 9*, 185–211.

Sattler, J. M. (1982). *Assessment of children's intelligence and special abilities*. Boston: Allyn & Bacon.

Schutte, N. S., Malouff, J. M., & Thorsteinsson, E. B. (2013). Increasing emotional intelligence through training: Current status and future directions. *International Journal of Emotional Education, 5*, 56–72.

Schwartz, G. M., Izard, C. E., & Ansul, S. E. (1985). The 5-month-old's ability to discriminate facial expressions of emotion. *Infant Behavior and Development, 8*, 65–77.

Schwarz, N. (1990). Feelings as information: Informational and motivational functions of affective states. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 527–561). New York: Guilford Press.

Schwarz, N., & Bless, H. (1991). Happy and mindless, but sad and smart?: The impact of affective states on analytic reasoning. In J. P. Forgas (Ed.), *Emotion and social judgments* (pp. 55–71). Elmsford, NY: Pergamon Press.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology, 45*, 513–523.

Spearman, C. (1904). "General intelligence," objectively determined and measured. *American Journal of Psychology, 15*, 201–292.

Spearman, C. (1927). *The abilities of man: Their nature and measurement*. New York: Macmillan.

Sternberg, R. J. (1985). *The triarchic mind: A new theory of human intelligence*. New York: Penguin.

Stipek, D. J., & Gralinski, J. H. (1996). Children's beliefs about intelligence and school performance. *Journal of Educational Psychology, 88*, 397.

Tett, R. P., Freund, K. A., Christiansen, N. D., Fox, K. E., & Coaster, J. (2012). Faking on self-report emotional intelligence and personality tests: Effects of faking opportunity, cognitive ability, and job type. *Personality and Individual Differences, 52*, 195–201.

Thorndike, R. K. (1920). Intelligence and its uses. *Harper's Magazine, 140*, 227–235.

Tough, P. (2012). *How children succeed: Grit, curiosity, and the hidden power of character.* New York: Random House.

Trinidad, D. R., & Johnson, C. A. (2002). The association between emotional intelligence and early adolescent tobacco and alcohol use. *Personality and Individual Differences, 32*, 95–105.

Trinidad, D. R., Unger, J. B., Chou, C. P., & Johnson, C. A. (2004). The protective association between emotional intelligence with psychosocial smoking risk factors for adolescents. *Personality and Individual Differences, 36*, 945–954.

Wada, K., & Shibata, T. (2007). Living with seal robots: Its sociopsychological and physiological influences on the elderly at a care house. *Robotics, IEEE Transactions On, 23*, 972–980.

Walker-Andrews, A. (2005). Perceiving social affordances: The development of emotional understanding. In B. D. Homer & C. S. Tamis-LeMonda (Eds.), *The development of social cognition and communication* (pp. 93–116). Mahwah, NJ: Erlbaum.

Webb, C. A., Schwab, Z. J., Weber, M., DelDonno, S., Kipman, M., Weiner, M. R., et al. (2013). Convergent and divergent validity of integrative versus mixed model measures of emotional intelligence. *Intelligence, 41*, 149–156.

Wechsler, D. (1939). *The measurement of adult intelligence.* Baltimore: Williams & Wilkins.

Werner, K., & Gross, J. J. (2010). Emotion regulation and psychopathology: A conceptual framework. In A. M. Kring & D. M. Sloan (Eds.), *Emotion regulation and psychopathology: A transdiagnostic approach to etiology and treatment* (pp. 13–37). New York: Guilford Press.

Winkel, D. E., Wyland, R. L., Shaffer, M. A., & Clason, P. (2011). A new perspective on psychological resources: Unanticipated consequences of impulsivity and emotional intelligence. *Journal of Occupational and Organizational Psychology, 84*, 78–94.

Young, P. T. (1943). *Emotion in man and in animal: Its nature and relation to attitude and motive.* New York: Wiley.

Zeidner, M., Matthews, G., & Roberts, R. D. (2009). *What we know about emotional intelligence: How it affects learning, work, relationships, and our mental health*. Cambridge, MA: MIT Press.

Zeidner, M., Roberts, R. D., & Matthews, G. (2002). Can emotional intelligence be schooled?: A critical review. *Educational Psychologist, 37*, 215–231.

Zeidner, M., Roberts, R. D., & Matthews, G. (2004). The emotional intelligence bandwagon: Too fast to live, too young to die? *Psychological Inquiry, 15*, 239–248.

Zeidner, M., Shani-Zinovich, I., Matthews, G., & Roberts, R. D. (2005). Assessing emotional intelligence in gifted and non-gifted high school students: Outcomes depend on the measure. *Intelligence, 33*, 369–391.

Zieber, N., Kangas, A., Hock, A., & Bhatt, R. S. (2014). Infants' perception of emotion from body movements. *Child Development, 85*, 675–684.

CHAPTER 31

New Light on the Affect–Cognition Connection

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Human adaptability requires continually anticipating and preparing for what is likely to happen next. As this process unfolds, the relevance, value, and importance of anticipated events are appraised along with accessible responses. If done consciously and deliberately, this process would be costly and slow, leaving the individual depleted and lost in thought. Instead, affective appraisals occur automatically and unconsciously, generating feelings that vary in pleasantness and activation. These two attributes of affective feelings act as information about value and urgency. They can therefore confer value on associated thoughts, plans, people, and possibilities, making some things depressing and awful but others exciting and wonderful. We discuss how this happens from the perspective of the *affect-as-information* approach, which holds that affect confers value on whatever is in mind at the time (Clore, Gasper, & Garvin, 2001; Schwarz & Clore, 1983, 2007).

In recent research extending this model, we have discovered that affect can confer value on one's own thoughts and inclinations as well as on objects in the environment (Huntsinger, Isbell, & Clore, 2014; Schiller & Clore, 2015). In this chapter, we examine several key concepts, review research on how affect influences concepts, and review research on how affect influences judgment and regulates thought. In each case, we focus on how affect can serve as information about the value of one's own opinions, thoughts, and inclinations.

Key Concepts

Evaluation

Evaluating the environment is one of the mind's most important tasks. All living things continually evaluate that which they encounter. In humans, familiarity activates the smiling muscles of the face (Winkielman & Cacioppo, 2001), whereas unfamiliarity almost universally elicits vigilance (Creswell, Quinn, Whittingham, & Butler, 2003; Welp, Rushen, Kramer, Festa-Bianchet & de Passillé, 2004). This occurs even at the level of the immune system, as unfamiliarity leads lymphocytes to attack and kill other cells. Somewhat surprisingly, even plants evaluate stimuli in their environments, reacting to the presence of alien plants by increasing their own root profusion (Casper & Jackson, 1997), and reacting to the vibrations of chewing caterpillars by secreting toxins (Appel & Cocroft, 2014).

Extensive data show that people's everyday verbal descriptions are overwhelmingly evaluative. In their classic work on the connotative meaning of words, Osgood, Suci, and Tannenbaum (1957) concluded that the connotative meaning of all words in all languages is dominated by evaluation. In addition, analyses of almost any interpersonal rating data by factor analysis show that the first and largest factor is invariably one of evaluation.

This evaluative inclination is also evident in human moods and emotions, which are kinds of affective reactions. Rather than the fixed responses of lower animals and plants, affective reactions provide a kind of mental way station between stimuli and responses, which allows humans to respond in a flexible manner to the situations in which they find themselves (Scherer, 1984).

Affect

"Affect" refers to evaluation at any level and in any modality, including affective feelings, thoughts, expressions, and so on. The term "affect" is frequently used in psychology, but seldom defined. Although a noun, it functions as an adjective, because, like light, affect is seen only in reflection, when it illuminates something else. Zajonc (1980) illustrated this adjectival aspect of affect when he wrote:

> perhaps all perceptions contain some affect. We do not just see "a house": we see "a handsome house," "an ugly house," or "a pretentious house." We do not just read an article. . . . We read an "exciting" . . . "important" . . . or a "trivial" article. . . . And the same goes for a sunset, a lightning flash, a flower, a dimple, a hangnail, a cockroach, the taste of quinine, . . . the color of earth in Umbria, the sound of traffic on 42nd Street, and . . . the sight of the letter Q. (p. 154)

In this poetic rendition of his view, Zajonc was saying that affect illuminates our experience and gives meaning to the wide variety of events, actions, and objects that we encounter.

As implied by Zajonc's (1980) treatment, affect provides a common currency for evaluating the variety of otherwise incommensurate objects that people encounter. It confers value on objects of perception and thought, reflecting a versatile hedonic rule, which is that "If it feels good, it is good." Thus, pain feels bad, relief from hunger, thirst, cold, and heat feels good, as does sex, contact with conspecifics, and so on. To prevent excess, the pleasure of continuing to eat, for example, decreases along with the decrease in the biological value of further food intake.

The hypersociality of humans complicates matters, requiring behavior regulation not only for individual survival but for the survival of the groups on which they depend. If one lists the human emotions—including anger, jealousy, pity, gratitude, love, contempt, and so on—most are social emotions. Such emotions mark in memory the recurring problems that arise in human interaction and motivate behavior through the patterns of feeling that are involved. Thus, in shame situations, pain is attached both to one's action and one's motivation, whereas in anger situations, pain is attached to the actions of others, but righteous pleasure to one's own motivation. Each kind of social situation may be marked with a different pattern of valence and arousal attached to different aspects of the situation, including outcomes, actions, and objects (Ortony, Clore, & Collins, 1988).

Information

According to the affect-as-information model (Schwarz & Clore, 1983, 2007), however, the key to affective influence is not the affect or emotion itself, but the compelling information it provides. The approach is summarized in a set of principles (Clore, Wyer, et al., 2001). For example, the *affective information principle* is that *affective feelings are conscious registrations of unconscious appraisals of something as good or bad in some way.* That is, affective feelings provide embodied value information as experiences *of* goodness or badness, rather than as indirect information *about* value. The valence and arousal of "core affect" (Russell, 2003) provide value and urgency information. Surprising or arousing things, for example, attract attention, get priority treatment (Simon, 1967), and tend to be remembered (Cahill & McGaugh, 1998).

Mood Inductions

The research reviewed in this chapter often employs mood inductions and we refer to "mood effects," but moods themselves are of interest really only as a source of affective cues that last long enough to observe how they influence subsequent judgment and performance. Editors often want investigators to rule out mood as a potential explanation for findings, but since most affective influences do not involve full-blown moods or emotions, the utility of such checks is unclear.

Popular methods for inducing affect include having participants write about emotional experiences, see emotional films, hear emotionally evocative music, or pose emotional facial expressions (see Coan & Allen, 2007, for a review; Westermann, Spies, Stahl, & Hesse, 1996, for a meta-analysis). A recent comparison of common methods found them all to be effective, especially in combination (Zhang, Yu, & Barrett, 2014). Although reliance on irrelevant mood inductions as a tool has led some to assume that the affect-as-information model applies only to moods and misattributions, in fact, the same attributional processes apply to all affective reactions, not just to incidental ones.

Success in getting irrelevant moods to affect judgment and thought depends on multiple factors (see Greifeneder, Bless, & Pham, 2011, for a review). These include individual differences (e.g., attending to emotion; Gasper & Clore, 2000) and whether inductions are involving but sufficiently subtle that they can be misattributed to the object of interest. However, even obvious manipulations can be effective if participants are occupied with a secondary task (Martin, Seta, & Crelia, 1990).

A common error made in unsuccessful replications of mood studies comes, paradoxically, from efforts to be especially rigorous. Such efforts often involve the inclusion of premeasures of mood or of manipulation checks that ask about feelings before measures of the dependent variable. These focus participants on their feelings, making them an object of perception, thus losing their ability to modify other entities—for example, some failures to replicate (e.g., Van Damme & Seynaeve, 2013) ask about mood at the beginning and again before the dependent measure. One failure to replicate included seven mood assessments spread throughout the procedure (Bruyneel et al., 2013). Successful studies generally delay assessment until the end of the experiment. Any preliminary mood measurement should be minimal and embedded in other, nonmood questions, since a focus directly on feelings often eliminates mood effects (Hunsinger, Isbell, & Clore, 2011; Schwarz & Clore, 1983).

Affect and Judgment

Two recent discoveries merit special attention; one concerns affect and judgment. Before describing that discovery, however, we review the basic affect and judgment phenomenon to provide some background (see also Isbell & Lair, 2013). The question is "How do affective reactions influence evaluative judgments?"

Feelings as Information

In the spring of 1983, a simple experiment surveyed life satisfaction, varying whether people were interviewed on warm and sunny or cold and rainy spring days (Schwarz & Clore, 1983). The results showed that foul weather dampened people's moods, resulting in less positive judgments of life satisfaction. That effect vanished, however, when experimenters asked the participants questions about the weather *before* asking them about life satisfaction. Nasty weather still lowered mood, but happy or sad feelings were not experienced as information about life satisfaction once linked to the weather—their true source.

According to these results, the impact of affect depends on its object. Thus, affect influences judgment when experienced as a reaction to an object of judgment, but not otherwise. Relevant principles (Clore, Wyer, et al., 2001) include:

1. The *affective judgment principle: When focused on an object of judgment, a person may experience a concurrent affective reaction as an evaluation of that object.*
2. The *affective attribution principle*: *The information value of affect, and hence its consequences, depend on the object to which the affect is attributed.*

Recent research has further tested these affect-as-information principles by presenting pictures of fear faces (or frowns or spiders) outside of awareness. In the continuous flash-suppression paradigm, a flashing image in one eye captures attention, suppressing conscious experience of an emotional image in the other eye (e.g., Anderson, Siegel, White, & Barrett, 2012). In one such study, a fear face was presented out of awareness to participants' nondominant eye (Lapate, Rokers, Li, & Davidson, 2014). In the aware control condition, fear faces appeared in both eyes so that participants were fully conscious of them. Measuring skin conductance indicated that the level of negative affect was the same in the two conditions. However, responses to a neutral face presented immediately afterward were different. As long as participants remained unaware of the source of their negative affect, greater skin conductance was associated with greater dislike. But when they were aware and could correctly attribute their reactions to having seen the fear face, negative affect had no influence on their judgments of the neutral face.

The results conceptually replicate those of Schwarz and Clore's (1983) weather study described earlier. In both, unassigned negative affect (from mood or unconscious fear faces) was experienced as a negative reaction to whatever was in mind at the time (life satisfaction or a neutral face). But negative affect had no influence on ratings of life satisfaction or faces when participants attributed their affect to its true (irrelevant) source.

Generality

The processes described in these experiments are potentially at work in any situation in which new judgments are required. For example, in one study, students were asked to judge the adequacy of a scientific experiment (Munro, Stansbury, & Tsai, 2012). When confronted with findings that challenged their personal views, students experienced negative feelings, which made them think something must be wrong with the research. However, when unpleasant aspects of the experimental room were made the focus, negative affect had no effect on judgments of scientific validity. The same result occurred in a replication when participants were told that they might feel tense because a beverage they had consumed had been caffeinated. Those participants felt just as negatively, but their feelings were not experienced as reactions to the objectionable research findings.

Other research suggests that affect can also influence jury decisions. In a study of a mock trial, accountancy students served as jurors in a suit brought against an accounting firm in a corporate bankruptcy case (Kadous, 2001). Three versions of the testimony that the participants heard differed in the degree of emphasis that was placed on distressing outcomes of the bankruptcy for investors, workers, and the community. Despite the fact that the accounting practices were the same in each version of the case, jurors were increasingly likely to see the firm as negligent the more the version they read mentioned distressing consequences of the bankruptcy. The results were very different, however, for jurors who had earlier been asked to indicate how distressed they felt about serving on the jury. Answering that question first made their negative feelings seem like reactions to jury duty rather than like reactions to wrongdoing. As predicted, those jurors tended to find the accounting firm not guilty. These studies illustrate that affect and its object are separable, and that the meaning of affect is not self-announcing but reflects the context in which it is experienced. Thus, as indicated earlier, the impact of affect depends on its object, and its object depends on what is in mind at the time.

Specific Emotions

The studies reviewed thus far all involve induced moods as sources of affect, but what about specific emotions? Like moods, emotions are affective reactions, but their influence is constrained by their specificity or by the kinds of situations to which they are relevant.

According to appraisal theory (e.g., Ortony et al., 1988), the emotion of sadness concerns certain *undesirable outcomes*, whereas fear is about *the prospect of* undesirable outcomes, and anger is about undesirable outcomes *caused by others' blameworthy actions*. All are negative emotions, but the particulars that differentiate them limit the range of objects about which they are informative.

A test of the idea involved a comparison of anger and sadness (Keltner, Ellsworth, & Edwards, 1993). The results showed that sadness (which concerns negative outcomes) increased the judged likelihood of situationally caused events, whereas anger (which is about blameworthy agency) increased the judged likelihood of human-caused events. Thus, the influences of specific emotions depended on the similarity between their appraisal patterns and the judgments to be made.

Another study involved the "endowment effect," which refers to the fact that merely owning something makes it seem more valuable, hence elevating the price for which one is willing to sell it relative to the price at which one would be willing to buy a comparable article. The negative emotion of disgust, because it concerns the distastefulness of objects, can alter the endowment effect by decreasing the selling price of an owned object (Lerner, Small, & Loewenstein, 2004). But, whereas disgust is about unappealing objects, sadness signals undesirable outcomes (Ortony et al., 1988). By highlighting the possibility of negative outcomes, sadness reversed the endowment effect. Rather than following their inclinations, sadness led participants to decrease their selling price and increase their buying prices. Thus, the two negative emotions influenced the same phenomenon differently: one signaled that the object was unappealing, the other that outcomes might be undesirable.

Disgust can also increase the severity of moral judgments under some conditions (e.g., Wheatley & Haidt, 2005). For example, morally ambiguous actions were judged to be immoral after smelling a disgusting odor, working in a disgusting workspace, remembering disgusting experiences, or seeing a disgusting film. For individuals who scored high in private body consciousness, the negative emotion of disgust was found to affect judgments of morality (Schnall, Haidt, Clore, & Jordan, 2008). The same results did not occur for the negative emotion of sadness. Further, electromyography (EMG) measures of facial muscles indicating disgust have also been found to relate to moral judgments (Cannon, Schnall, & White, 2011) and hand washing to lead to less severe judgments (Schnall, Benton, & Harvey, 2008).

These and many other studies have been stimulated by Haidt's (2001) intuitionist account of moral judgment. The high profile of that work has made related research a target of critics. A paper reporting a meta-analysis of 50 relevant studies (Landy & Goodwin, 2015) found many confirmations of the hypothesis, the strongest resulting from gustatory/olfactory modes of disgust induction. The authors argued, however, that the effect was small if averaged with studies not showing the effect, and proposed a return to the rationalist model of moral judgment. They focused, however, only on whether disgust was induced, but not also on whether conditions favored misattribution of disgust to the objects of moral judgment (Schnall, Haidt, Clore, & Jordan, 2015).

Fear and anxiety involve displeasure about the prospect of undesirable outcomes of events, and accordingly, they can lead to pessimism about future outcomes and to risk-averse decisions (Lerner & Keltner, 2000), as well as to heightened risk judgments (e.g., Constans & Mathews, 1993; Gasper & Clore, 1998). Fear and anxiety have also been found to increase the perceived risk of terrorism (Lerner, Gonzalez, Small, & Fischhoff, 2003) and to an emphasis on the safety of consumer products (Raghunathan, Pham, & Corfman, 2006). When looking down from a tall balcony, fearful individuals have been found to overestimate the height of the balcony (Stefanucci & Storbeck, 2009). Similarly, when research participants estimated the slant of a hill while standing on a skateboard at the top, fear made the hill look steeper (Stefanucci, Proffitt, Clore, & Parekh, 2008). In contrast, when they stood at the bottom, sadness made the hill seem steeper (Riener, Stefanucci, Proffitt, & Clore, 2011). These differences in effects reflect differences in the focus of the different emotions. Presumably, fear exaggerated the risk of steepness when viewed from the top, whereas sadness exaggerated the effort of ascending the hill when viewed from the bottom.

This sample of research on emotion and judgment shows that, whereas negative emotions do lead to some kind of negative judgment, their specific effects are constrained by the particular kinds of negative situations of concern for a given emotion (see Lerner & Keltner, 2001, for an elaboration of this idea).

Affect in the Construction of Reality

These affective influences on judgment are examples of constructive processes in everyday perception. In the domain of sensory perception, the brain integrates inputs from different modalities so that from seeing, hearing, smelling, tasting, and touching, that which is sensed emerges as a multifaceted object. The research on affect suggests that affective reactions play a similarly constructive role, as indicated in the earlier quote from Zajonc (1980), "We do not just see 'a house': we see 'a handsome house,' 'an ugly house,' or 'a pretentious house'" (p. 154).

Although we believe this to be an accurate account, bottom-up processes in constructing perceptions and judgments are costly in terms of attentional and processing resources. Therefore, rather than constantly starting over, the brain acts as a Bayesian prediction device using existing knowledge and prior values to anticipate incoming information. If anticipations are accurate, little accommodation or incorporation of new information is required. Accordingly, when making judgments about something familiar, one may simply retrieve a prior judgment, rather than start from scratch to form a new one. As a consequence, affect may confer its value not on the nominal object of judgment, but on the person's own provisional opinion of that object. This is the insight driving the research reviewed next.

Affect and Judgment: A New View

Interesting results have come from recent research examining how affect influences judgments of things that are disliked. One experiment concerned reactions to cycling champion Lance Armstrong (Schiller & Clore, 2015). Armstrong had become a symbol of courage by overcoming cancer to win seven Tour de France cycling titles. Just before the study, however, a scandal emerged, leading him to confess that his victories had been aided by performance-enhancing drugs, ensuring that most research participants would see him in a negative light. They were then asked how much they would like to have one of what had been highly popular "Livestrong" bracelets, sold by Armstrong's foundation for cancer research. The results were interesting because rather than the usual "rose-colored glasses" effect (positive mood leading to positive judgments), positive mood led participants to judge the bracelets more negatively than did negative moods.

To determine the reliability of this result, a second study conducted a year later (Schiller & Clore, 2015) focused on another disgraced athlete. It produced an even stronger version of the same effect. Participants rated how much they would like a poster picturing Alex Rodriguez (“A-Rod”), the New York Yankees third baseman who at the time was said by some to be the greatest athlete ever to play baseball. Just before the study, rumors that illicit drugs had enhanced his exceptional performance were confirmed. Again, rather than a rose-colored-glasses effect, happy moods led participants to rate a poster of A-Rod more negatively than did sad moods.

In these experiments, people in positive moods did not give the benefit of the doubt to Armstrong or Rodriguez, as one might have expected. Rather, they were more confident in the negative judgments they already held. In contrast, negative moods made participants more tentative about their negative judgments. Apparently, affect served, not as information about the target athletes, but as information about the participant’s own provisional opinions of them.

What are we to make of these seemingly anomalous findings? Why has this pattern not appeared in prior research? The reason is that the phenomenon can be detected only when provisional opinions are negative, as in these experiments. In the negative case, if positive affect leads to greater confidence in one’s opinion, it should lead to a more extreme negative judgment, as we observed. But if the initial opinion had been positive, a positive judgment in positive mood would have been indistinguishable from the usual prediction in which positive affect simply enhances the value of any associated object.

As a further test of this idea, an experiment examining mood effects on ratings of subjective well-being was conducted (Schiller & Clore, 2015). The usual rose-colored-glasses effect was found to be significant (i.e., positive moods leading to more positive judgments). However, when we analyzed rating extremity rather than the rating means, it was apparent that positive mood had also made ratings significantly more extreme. The mean and variance effects were comparable in size, with the extremity effect being slightly larger. The data do not allow us to determine if both processes or only the confidence effect was operating.

We believe that the most plausible general account of mood and judgment, including these recent results, involves the *affective immediacy principle*, which is that *affect is always experienced as being about whatever is in mind at the time* (Clore, Wyer, et al., 2001). If so, would directing judges’ attention to the object of judgment in the world create rose-colored-glasses effects and directing attention to participants themselves create extremity effects? That research remains to be conducted.

For the present, we conclude simply that affective reactions are *sometimes* self-reflective, providing information about one’s own inclinations. A set of results with similar implications comes from five experiments on judgments of trustworthiness done by Lount (2010). He found that positive affect served as feedback about the judge’s own potential responses, rather than as information about the object of judgment (the other person)—that is, rather than simply increasing trust, positive mood led to increased trust only when the faces to be judged did in fact look trustworthy. In contrast, positive mood decreased trust judgments when the faces looked untrustworthy. The results thus further support the idea that positive affect empowers whatever responses and inclinations are currently most accessible.

In summary, in our review of studies examining affect and judgment, we focused on recent findings showing that the evaluative information conveyed by affective reactions can be self-referential. The conditions under which this is likely are not yet fully clear, including whether this is always or only sometimes the case. But in those studies in which self-referential effects were found, initial opinions were made salient. If self-referential effects require a focus on initial inclinations, then such self-relevancy effects are special cases of the affective immediacy principle that the object of affect is always whatever is perceptually salient or cognitively accessible at the time.

Affect and Thinking

We turn next to the question of how affect regulates cognitive processing or thinking (as opposed to judgment). There is now considerable evidence that affect is routinely self-directed (Huntsinger et al., 2014). We review this research and the elaboration of the affect-as-information model that it suggests.

Early studies of mood and persuasion showed that moods influence not only judgments but also modes of cognitive processing (Schwarz, 1990; Worth & Mackie, 1987). One might have expected on the basis of judgment research that positive affect would simply increase the evaluation and persuasiveness of attitude messages. However, the results showed that was not the case. Happy moods led to moderate persuasion regardless of argument quality, whereas sad moods led participants to reject weak arguments and to be persuaded only by strong ones. Being sad apparently made people think systematically, whereas being happy led people to rely on judgment heuristics. Results across studies were consistent with such a dual-process account in which happy moods elicit peripheral, heuristic, or "system-one" processing, whereas sad moods lead to central, systematic, or "system-two" processing (see Schwarz, Bless, & Bohner, 1991; Schwarz & Clore, 2007, for reviews).

The hypothesis that happy and sad affect are linked to particular styles of cognitive processing has been a very productive one, leading to strong predictions about the emotion–cognition connection. For example, compared with negative affect, positive affect leads to a global focus (Gasper & Clore, 2002), creativity (Isen, 1984), broadened attention (Rowe, Hirsch, & Anderson, 2007), semantic and affective priming (Storbeck & Clore, 2008b), stereotyping (Bodenhausen, 1993), false memories (Forgas, Laham, & Vargas, 2005; Storbeck & Clore, 2005), schema-guided memory (Bless et al., 1996), part-list cueing effects (Bäuml & Kuhbandner, 2007), fundamental attribution errors (Forgas, 1998), judgment heuristics (Gasper, 1999), ease-of-retrieval effects (Ruder & Bless, 2003), and implicit–explicit attitude correspondence (Huntsinger & Smith, 2009).

Extensive research thus leads to the strong expectation that positive affect promotes global (relational, category-level, substantive, top-down) processing, and that negative affect promotes greater local (referential, item-level, bottom-up) processing. Such effects have been found in many different labs using various affect inductions and a variety of cognitive tasks. There is some variation, of course, but overall, the data present a very consistent picture (see Greifeneder et al., 2011; Schwarz & Clore, 2007, for reviews).

A variety of explanations for these consistent patterns have been offered, including mood-congruent priming (Forgas, 1995; Isen, 1984), resource depletion (Mackie & Worth, 1989), affect infusion (Forgas, 1995), assimilation–contrast (Fiedler, 2001), broaden-and-build processes (Fredrickson, 2001), dopamine (Ashby, Isen, & Turken, 1999), motivation (Gable & Harmon-Jones, 2010), and affect regulation (Tice, Bratslavsky, & Baumeister, 2001). These differ from one another in various ways, but they are similar in one way: they all assume that positive and negative affect do activate particular styles of thought.

In contrast, an affect-as-information approach has assumed only that affect provides information about situations, which allows cognitive processing to be regulated adaptively (Schwarz & Clore, 2007). Recent research from this perspective suggests ways in which it might be usefully elaborated, as we see next.

Affect as Feedback

We now turn to review recent work on seven phenomena concerning affective influences on thinking. This research casts new light on the consistent patterns uncovered over the past 25 years or so. These phenomena have generally been understood as direct and more or less fixed consequences of affect. But the most recent research provides a simpler interpretation (Clore & Huntsinger, 2007; Huntsinger, 2013; Huntsinger et al., 2014; Isbell, Lair, & Rovenpor, 2013), as shown by research on mood and global–local focus.

Global–Local Focus

In 1959, Easterbrook published an often-cited paper indicating that emotional arousal narrows attention. The hypothesis came from his memory of what had happened to him years earlier during an awkward parachute landing. After hitting his head, he was distressed, and noted that his spatial and temporal focus seemed to shrink (Easterbrook, 1982). In time, it became an accepted principle that stress and emotion lead to restricted attention.

The hypothesis that emotion narrows attention turned out to apply primarily to negative emotions, such as sadness and anxiety, rather than to emotion generally. Many studies show that fear and anxiety are associated with vigilance and restricted attention (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007, for a meta-analysis). However, mood studies find that happy feelings broaden attention (e.g., Basso, Shefft, Ris, & Dember, 1996; Derryberry & Reed, 1998; Fredrickson & Branigan, 2005; Gasper & Clore, 2002).

Various explanations for the association between affect and global–local focus have been offered. Some accounts stress neural connections (Anderson, 2009) and the role of dopamine in the brain (Ashby et al., 1999). Other accounts have stressed psychological processes. For example, the broadened attentional focus of positive affect is adaptive because it results in "undoing" the narrow focus engendered by threats and other stressors (Fredrickson, 2001). Similarly, to the extent that positive affect signals a benign situation, it allows one to think expansively, resulting in a global focus, heuristic thinking, and creativity (Schwarz & Clore, 2007). All of these processes seem likely to be involved, but recent research indicates that an additional process is also important. It is summarized in the *affective processing principle* (Clore, Wyer, et al., 2001; Clore, Gasper, et al., 2001), which says that *when one is task oriented, affective reactions may be experienced as confidence or doubt about cognitively accessible information, so that positive and negative affect lead to greater and lesser reliance on one's beliefs, expectations, and inclinations.* In this affect-as-feedback approach, positive and negative affective reactions are viewed as "go" and "stop" signals, respectively, for engaging in or inhibiting whatever response is currently most accessible (Clore & Huntsinger, 2007; Huntsinger et al., 2014). It explains the effect of mood on global–local focus, for example, by noting that people generally adopt a moderately global focus anyway—the global superiority effect (Navon, 1977; Wegner & Vallacher, 1986). Positive affect may therefore be associated with broad attention simply because it says "Go" to that existing inclination. If so, what would happen if a local focus were made more accessible?

To answer that question, experiments varied mood and the accessibility of global versus local orientations (Huntsinger, Clore, & Bar-Anan, 2010). To alter response accessibility, global or local responses were primed using the Navon task (Experiment 1) and global or local *concepts* were primed in a lexical decision task (Experiment 2). Participants then wrote either about happy or sad events or listened to happy or sad music. Global–local focus was assessed on a separate task (Kimchi, 1992). The results showed that the effect of mood on global–local focus depended on which focus had been made most accessible through priming. Positive mood promoted a global focus when a global orientation had been made most accessible, but a local focus when a local orientation had been made most accessible. By contrast, sad mood inhibited (and tended to reverse) adoption of the orientation that had been primed, which is consistent with its hypothesized role of stopping dominant responses.

These results suggest that positive affect promoted whatever focus was most accessible. When a local focus was accessible, happy moods led to a local orientation and sad moods to a focus on the big picture. The results, therefore, are consistent with the affective processing principle that, in task situations, affect serves as self-directed or response-focused feedback, rather than as information about the world.

Stereotyping

Many studies have reported a tendency for individuals in positive as opposed to negative moods to rely on stereotypes when forming impressions of others (see Bless, Schwarz, & Kemmelmeier, 1996; Schwarz & Clore, 2007, for reviews). For example, when judging a defendant's guilt, people in happy moods rely more on stereotypes than those in sad or neutral moods (Bodenhausen, 1993). This relationship has been interpreted as a by-product of the tendency of positive moods to promote global or category-level processing. Indeed, in studies of consumer behavior, happy moods are associated with a focus on brand names, whereas sad moods are associated with a focus on the specific attributes of products (Adaval, 2001).

This relationship between positive affect and stereotyping provided a second opportunity to test the "go and stop" interpretation of mood effects on processing. If positive affect says "Go" to the most accessible response, then for "chronic egalitarians" (Moskowitz, Gollwitzer, Wasel, & Schaal, 1999) positive affect should not increase stereotyping. Indeed, the results of a relevant study showed that among those individuals with a chronically accessible goal to be egalitarian, being in a positive mood reduced rather than increased their tendency to use gender stereotypes (Huntsinger, Sinclair, Dunn, & Clore, 2010; see also Hunsinger et al., 2011). In addition, across four experiments that used multiple methods, multiple stereotypes, and measured stereotyping with both explicit and implicit measures, positive affect showed no fixed tendency to increase the use of stereotypes, but rather enhanced whatever set of cognitions had been made most salient—sometimes a stereotype and sometimes a counterstereotype (Huntsinger, Sinclair, et al., 2010).

Broadened Attention

Rowe et al. (2007) reported that positive mood broadened attentional scope on a flanker task, and from functional magnetic resonance imaging (fMRI) data, Anderson (2009) concluded that happy mood influences basic visual–cortical encoding processes that underlie perception. In contrast, the alternative affect-as-feedback interpretation is that happy mood leads to broadened attention only because adoption of a relatively broad attentional scope is already the dominant response.

To test this hypothesis, Huntsinger (2012) repeated the experiment by Rowe et al. (2007) but first varied the relative accessibility of a global or a local focus. That manipulation consisted of varying the letters to be detected on the Navon (1977) task to require a global focus, a local focus, or half and half. The results showed that the impact of positive mood varied with the focus that had been primed. Priming a global focus led positive affect to elicit larger flanker effects, whereas priming a local focus led to the opposite: smaller flanker effects. Especially interesting were the results of the 50–50 priming group. When global and local perceptual orientations were equally accessible, no mood effects appeared, because there was no dominant response for positive and negative affect to empower or inhibit.

Persuasion

The most prominent paradigm for studying persuasion involves presenting participants with strong or weak persuasive messages for a position of personal relevance to participants (Petty & Cacioppo, 1986). As indicated earlier, the standard mood and persuasion finding is that people in sad moods differentiate strong and weak persuasive arguments (suggesting systematic processing), whereas those in happy moods tend not to distinguish strong and weak arguments, being moderately persuaded by both. That pattern was seen when affect was introduced *before* exposure to persuasive arguments. However, the pattern reversed when affect was introduced *after* exposure to the persuasive arguments (Bless, Mackie, & Schwarz, 1992).

This change of order had such dramatic effects, we believe, because it changed the object of affect from the persuasive arguments to the participants' thoughts about the arguments. When positive affect was induced after arguments had been presented, it led them to be more convinced by strong than weak arguments. Positive affect presumably validated the positive thoughts participants had about strong arguments, as well as the negative thoughts they had about weak arguments. In contrast, negative affect invalidated both, leading sad participants not to distinguish strong from weak arguments and hence to be moderately convinced by either. This "self-validation" explanation (Briñol & Petty, 2003) has proven to be powerful and has stimulated extensive research (see Briñol & Petty, 2009, for a review).

The results and the self-validation account are consistent with the affect-as-information approach. Recall that according to the affective immediacy principle (Clore, Wyer, et al., 2001), *the object of affect is experienced as whatever is in mind at the time*. In the method used in the self-validation studies, participants' thoughts were made especially accessible by having them write down their thoughts in response to strong or weak persuasive arguments immediately after reading them. The "yes" or "no" information conveyed by affect was therefore directed at these *thoughts* rather than at the arguments, so that people in happy moods felt more confident and people in sad moods less confident in their thoughts about the arguments.

Support for this new perspective on affect and persuasion came from an experiment by Briñol, Petty, and Barden (2007) employing a measure of need for cognition (Cacioppo & Petty, 1982). Individuals high in need for cognition generally report more thoughts than do those low in need for cognition. This greater accessibility of thoughts should make the thoughts likely objects of affect. Positive affect should then be experienced as confidence and negative affect as lack of confidence in them. As expected, the results showed that happy moods did indeed lead high-need-for-cognition individuals to distinguish strong from weak arguments. But among low-need-for-cognition participants, for whom thoughts are believed to be less accessible, the persuasive arguments rather than their thoughts became the object of affect. As a result, happy moods simply led participants to like the arguments more and to be more persuaded by them than sad moods did. The results thus suggest that, contrary to widespread assumptions of a fixed relationship between affect and processing style, affect operates on whatever cognition or inclination is most accessible at the time.

Creativity

As reviewed earlier, the idea that feeling happy stimulates creativity is well known and well supported (see Baas, De Dreu, & Nijstad, 2008; Davis, 2009, for meta-analyses). Such findings have led to assumptions of a direct connection between positive affect and creativity (e.g., Isen, 2008). Recent research, however, indicates that the connection is not fixed but malleable (Huntsinger & Ray, 2014). In two experiments, either a global or a local thinking style was primed by giving numerous global or local practice trials on the Navon letter task. Then mood was induced and creativity was assessed. The results showed that creativity was greater in happy than in sad moods only when the usually dominant global focus was most accessible. In contrast, when a local focus had been primed, sad mood enhanced creativity. These reversals were apparent on several measures of creativity, including the Unusual Uses Test, the Remote Associates Test, and other insight problems, and they appeared on both quantitative and qualitative indices of creativity (Mednick & Mednick, 1967).

The most surprising result was that sad participants primed with a local focus showed enhanced creativity. However, that result is consistent with the model in that whereas a local focus usually limits creativity, the stop signal of negative affect resulted in a more global focus, which in turn enhanced creativity. Conversely, the "go" signal of positive affect resulted in reliance on the primed local focus, which inhibits creativity. Hunstinger and Ray (2014) thus discovered that even the time-honored relationship between positive affect and creativity is variable rather than fixed. The key, again, is that the influence of affect on cognition depends—not on the affect, mood, or emotion itself—but on the information conveyed, which in turn depends on its object.

Note that such findings do not invalidate the wealth of data showing an association between positive affect and creativity, but they do undermine the inferences usually drawn from such results. Positive affect does tend to enhance creativity, but only because, independently of affect, a global focus is dominant for most people most of the time (Navon, 1977; Wegner & Vallacher, 1986). What these experiments suggest is that heightened creativity came from the enhanced global focus, not from happiness, because the same positive affect reduced creativity when a local focus was made dominant. Thus, it appears that nothing about positive affect itself leads to creativity; its role is simply to say "Yes" or "No" to whatever is the dominant focus.

Judgment Heuristics

Positive affect leads to the use of some judgment heuristics and negative affect leads to the use of others. For example, positive affect was found to lead people to commit the conjunction fallacy on Tversky and Kahneman's (1974) Linda problem (Gasper, 1999), and negative affect led to increased use of anchoring and adjustment on other judgment tasks (Bodenhausen, Gabriel, & Lineberger, 2000). Recent results, however, indicate that whether someone commits the conjunction fallacy or relies on anchors to make quantitative judgments depends not only on mood, but on what thinking style was already most accessible before the mood induction (Huntsinger & Ray, 2014). To vary that accessibility, the experimenters primed either heuristic or systematic thought styles by having participants supply a missing letter for each of a series of words, including either heuristic primes (e.g., intuitive, spontaneous, impulsive) or systematic primes (e.g., analytical, reasoned, methodical).

In studies using this priming methodology, when heuristic processing was made especially accessible, more individuals in the happy mood condition committed the conjunction fallacy, as in prior studies. But when systematic processing was primed, that effect disappeared. Again, rather than having fixed effects on thought, the influence of affect depended on what thinking style was most accessible at the time.

In a study of anchoring effects in judgment (Huntsinger & Ray, 2014), the same priming procedure was used, and greater anchoring effects were found in sad than happy moods, as in prior research. This result, however, held only as long as heuristic processing was the more accessible style. When systematic processing was primed, the results were reversed, with anchoring occurring more in happy than in sad moods. Again, rather than activating a particular style of thinking, the role of affect was to say "Go" or "Stop" to whatever response inclination was most accessible at the time. These data again indicate that the impact of affect depends on its object (Clore & Huntsinger, 2009).

Implicit–Explicit Attitude Correspondence

Research indicates that two of the factors that influence implicit–explicit attitude correspondence are mood (Huntsinger & Smith, 2009) and trust in one's intuitions (Jordan, Whitfield, & Zeigler-Hill, 2007). Happy moods presumably increase correspondence by promoting the inclusion of contextual information, including internal contextual information in the form of expectations, primes, and intuitions.

However, if positive affect serves as feedback about the value of the most accessible processing orientation, then varying which orientation is most accessible should change whether positive or negative affect promotes attitude correspondence. As a test of this idea, Huntsinger (2011) measured trust in intuition in one experiment and primed high or low levels of trust in other experiments. He found that when trust in intuitions was high, positive affect maintained that trust and led to higher implicit–explicit attitude correspondence, as in previous research. But when people's trust in intuition was low, positive affect empowered that lack of trust, which led to lower implicit–explicit correspondence. Comparable results occurred in four studies with multiple attitudes, modes of priming, and mood inductions. These results again indicate that affective reactions regulate thinking styles by saying "Yes" or "No" to current cognitions and inclinations, consistent with the affective processing principle (Clore, Wyer, et al., 2001).

Summary and Conclusions

Although affect may provide information about one's external situation (Frijda, 1988), the research we have reviewed indicates that it often serves as information about one's own current cognitions and inclinations—that is, as feedback. From this feedback perspective, positive and negative affect is seen to influence thinking by conferring positive or negative value on current mental content. That conclusion is consistent with the affective processing principle (Clore, Wyer, et al., 2001), the self-validation model of affect in persuasion (Briñol & Petty, 2003), the performance feedback model (Wyer, Clore, & Isbell, 1999), and the mood-as-input model (Martin, Ward, Achee, & Wyer, 1993). It is also consistent with the cognitive tuning hypothesis (Schwarz, 1990; Schwarz & Clore, 2007), which is that affect regulates processing to fit task demands. To varying degrees, there is also much in common with other proposals for explaining the influences of affect on styles of information processing, including Forgas's (1995) substantive processing formulation, Fiedler's (2001) assimilation–accommodation model, and Bless's (2001) emphasis on general knowledge structures.

The proposed view is also consistent with the current emphasis in the field on prospection. Friston (2010) has proposed that a primary job of the brain is to anticipate the next moment in order to waste as little effort as possible. It is useful, then, to see the information provided by affect as anticipatory and as providing feedback, not so much about what one has already done but about what one is prepared to do. The information it provides is directed toward cognitions, inclinations, and anticipated actions (Baumeister, Vohs, DeWall, & Zhang, 2007).

A number of other feelings have effects on processing similar to those of affective valence, including the experience of power, arousal, and certainty. For example, feelings of power should act very much like positive affect in that they should empower individuals to rely on their own cognitions and inclinations (Overbeck & Droutman, 2013). Similarly, a long line of research shows that elevated arousal increases dominant responses, so that arousal should also promote reliance on currently accessible inclinations (Corson & Verrier, 2007). In addition, some research shows that the degree to which a given emotion involves feelings of certainty can increase the processing effects typical of positive affect (Tiedens & Linton, 2001). Indeed, a role for feelings of certainty is quite compatible with the role for feelings of confidence that we have emphasized in the current approach. The effectiveness of all of these factors in regulating cognitive processing is compatible with the affect-as-information model and with its central proposition that the various phenomena we have reviewed result, not from affect per se but from the compelling information that affect and other feelings provide when processed with information from the context.

The key to the current view, however, is the observation that the various affective influences on information processing or thinking are malleable rather than fixed. Instead of having direct effects on cognitive processes, affective reactions serve as embodied evaluations of current thoughts and inclinations. The influences of affect, then, can be as varied as the thoughts and inclinations on which affective reactions confer positive or negative value.

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References

Adaval, R. (2001). Sometimes it just feels right: The differential weighting of affect consistent and affect-inconsistent product information. *Journal of Consumer Research, 28*, 117.

Anderson, A. K. (2009, July). Seeing positive: Positive mood enhances visual cortical encoding. *Psychological Science Agenda, Science Briefs*. Washington, DC: American Psychological Association. Retrieved from *www.apa.org/science/about/psa/2009/07/sci-brief.aspx*.

Anderson, E., Siegel, E., White, D., & Barrett, L. F. (2012). Out of sight but not out of mind: Unseen affective faces influence evaluations and social impressions. *Emotion, 12*, 1210–1221.

Appel, H. M., & Cocroft, R. B. (2014). Plants respond to leaf vibrations caused by insect herbivore chewing. *Oecologia, 175*, 1257–1266.

Ashby, F. G., Isen, A. M., & Turken, U. (1999). A neuropsychological theory of positive affect and its influence on cognition. *Psychological Review, 106*, 529–550.

Baas, M., De Dreu, C. K. W., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood–creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin, 134*, 779–806.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta analytic study. *Psychological Bulletin, 133*, 1–24.

Basso, M. R., Schefft, B. K., Ris, M. D., & Dember, W. N. (1996). Mood and global–local visual processing. *Journal of the International Neuropsychological Society, 2*, 249–255.

Baumeister, R. F., Vohs, K. D., DeWall, N., & Zhang, L. (2007). How emotion shapes behavior: Feedback, anticipation, and reflection, rather than direct causation. *Personality and Social Psychology Review, 11*, 167–203.

Bäuml, K. H., & Kuhbandner, C. (2007). Remembering can cause forgetting—but not in negative moods. *Psychological Science, 18*, 111–115.

Bless, H. (2001). Mood and the use of general knowledge structures. In L. L. Martin (Ed.), *Theories of mood and cognition: A user's guidebook* (pp. 9–26). Mahwah, NJ: Erlbaum.

Bless, H., Clore, G. L., Schwarz, N., Golisano, V., Rabe, C., & Wölk, M. (1996). Mood and the use of scripts: Do happy moods really make people mindless? *Journal of Personality and Social Psychology, 71*, 665–678.

Bless, H., Mackie, D. M., & Schwarz, N. (1992). Mood effects on encoding and judgmental processes in persuasion. *Journal of Personality and Social Psychology, 63*, 585–595.

Bless, H., Schwarz, N., & Kemmelmeier, M. (1996). Mood and stereotyping: The impact of moods on the use of general knowledge structures. *European Review of Social Psychology, 7*, 63–93.

Bodenhausen, G. V. (1993). Emotions, arousal, and stereotypic judgments: A heuristic model of affect and stereotyping. In D. M. Mackie & D. L. Hamilton (Eds.), *Affect, cognition, and stereotyping: Interactive processes in group perception* (pp. 13–37). San Diego, CA: Academic Press.

Bodenhausen, G. V., Gabriel, S., & Lineberger, M. (2000). Sadness and susceptibility to judgmental bias: The case of anchoring. *Psychological Science, 11*, 320–323.

Briñol, P., & Petty, R. (2003). Overt head movements and persuasion: A self-validation analysis. *Journal of Personality and Social Psychology, 84*, 1123–1139.

Briñol, P., Petty, R., & Barden, J. (2007). Happiness versus sadness as a determinant of thought confidence in persuasion: A self validation analysis. *Journal of Personality and Social Psychology, 93*, 711–727.

Briñol, P., & Petty, R. E. (2009). Persuasion: Insights from the self-validation hypothesis. *Advances in Experimental Social Psychology, 41*, 69–118.

Bruyneel, L., van Steenbergen, H., Hommel, B., Band, G. P. H., De Raedt, R., & Koster, E. H. W. (2013). Happy but still focused: Failures to find evidence for a mood-induced widening of visual attention. *Psychological Research, 77*, 320–332.

Cacioppo, J. T., & Petty, R. E. (1982). The need for cognition. *Journal of Personality and Social Psychology, 42*, 116–131.

Cahill, L., & McGaugh, J. L. (1998). Mechanisms of emotional arousal and lasting declarative memory. *Trends in Neurosciences, 21*, 294–299.

Cannon, P. R., Schnall, S., & White, M. (2011). Transgressions and expressions: Affective facial muscle activity predicts moral judgments. *Social Psychological and Personality Science, 2*, 325–331.

Casper B. B., & Jackson R. B. (1997). Plant competition underground. *Annual Review of Ecological Systems, 28*, 545–570.

Clore, G. L., Gasper, K., & Garvin, E. (2001). Affect as information. In J. P. Forgas (Ed.), *Handbook of affect and social cognition* (pp. 121–144). Mahwah, NJ: Erlbaum.

Clore, G. L., & Huntsinger, J. R. (2007). How emotions inform judgment and regulate thoughts. *Trends in Cognitive Sciences, 11*, 393–399.

Clore, G. L., & Huntsinger, J. R. (2009). How the object of affect guides its impact. *Emotion Review, 1*, 39–54.

Clore, G. L., Wyer, R. S., Dienes, B., Gasper, K., Gohm, C., & Isbell, L. M. (2001). Affective feelings as feedback: Some cognitive consequences. In L. L. Martin & G. L. Clore (Eds.), *Theories of mood and cognition: A user's guidebook* (pp. 27–62). Mahwah, NJ: Erlbaum.

Coan, J. A. & Allen, J. J. B. (2007). *The handbook of emotion elicitation and assessment*. New York: Oxford University Press.

Constans, J. I., & Mathews, A. M. (1993). Mood and the subjective risk of future events. *Cognition and Emotion, 7*, 545–560.

Corson, Y., & Verrier, N. (2007). Emotions and false memories: Valence or arousal? *Psychological Science, 18*, 208–211.

Creswell, W., Quinn, J. L., Whittingham, M. J., & Butler, S. (2003). Good foragers can also be good at detecting predators. *Proceedings of the Royal Society of London B, 270*, 1069–1076.

Davis, M. A. (2009). Understanding the relationship between mood and creativity: A meta-analysis. *Organi-*

zational Behavior and Human Decision Processes, 108, 25–38.

Derryberry, D., & Reed, M. A. (1998). Anxiety and attentional focusing: Trait, state and hemispheric influences. *Personality and Individual Differences, 25*, 745–761.

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review, 66*, 183–201.

Easterbrook, J. A. (1982). This week's citation classic. *Current Contents, 12*, 20.

Fiedler, K. (2001). Affective states trigger processes of assimilation and accommodation. In L. L. Martin & G. L. Clore (Eds.), *Theories of mood and cognition: A user's guidebook* (pp. 85–98). Mahwah, NJ: Erlbaum.

Forgas, J. P. (1995). Mood and judgment: The affect infusion model (AIM). *Psychological Bulletin, 116*, 39–66.

Forgas, J. P. (1998). Happy and mistaken?: Mood effects on the fundamental attribution error. *Journal of Personality and Social Psychology, 75*, 318–331.

Forgas, J. P., Laham, S., & Vargas, P. (2005). Mood effects on eyewitness memory: Affective influences on susceptibility to misinformation. *Journal of Experimental Social Psychology, 41*, 574–588.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist, 56*, 218–226.

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought–action repertoires. *Cognition and Emotion, 19*, 313–332.

Frijda, N. (1988). The laws of emotion. *American Psychologist, 43*, 349–358.

Friston, L. (2010). The free energy principle: A unified brain theory? *Nature Reviews Neuroscience, 11*, 127–138.

Gable, P. A., & Harmon-Jones, E. (2010). The motivational dimensional model of affect: Implications for breadth of attention, memory, and cognitive categorization. *Cognition and Emotion, 24*, 322–337.

Gasper, K. (1999). *How thought and emotional awareness influence the role of affect in processing: When attempts to be reasonable fail.* Unpublished doctoral dissertation, University of Illinois, Urbana-Champaign.

Gasper, K., & Clore, G. L. (1998). The persistent use of negative affect by anxious individuals to estimate risk. *Journal of Personality and Social Psychology, 74*, 1350–1363.

Gasper, K., & Clore, G. L. (2000). Do you have to pay attention to your feelings to be influenced by them? *Personality and Social Psychology Bulletin, 26*, 698–711.

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global vs. local mood and global vs. local processing of visual information. *Psychological Science, 13*, 34–40.

Greifeneder, R., Bless, H., & Pham, M. T. (2011). When do people rely on affective and cognitive feelings in judgment?: A review. *Personality and Social Psychology Review, 15*, 107–141.

Haidt, J. (2001). The emotional dog and its rational tail: A social intuitionist approach to moral judgment. *Psychological Review, 108*, 814–834.

Hunsinger, M., Isbell, L. M., & Clore, G. L. (2011). Sometimes happy people focus on the trees and sad people focus on the forest: Context-dependent effects of mood in impression formation. *Personality and Social Psychology Bulletin, 38*, 220–232.

Huntsinger, J. R. (2011). Mood and trust in intuition interactively orchestrate correspondence between implicit and explicit attitudes. *Personality and Social Psychology Bulletin, 37*, 1245–1258.

Huntsinger, J. R. (2012). Does positive affect broaden and negative affect narrow attentional scope?: A new answer to an old question. *Journal of Experimental Psychology: General, 141*, 595–600.

Huntsinger, J. R. (2013). Does emotion directly tune the scope of attention? *Current Directions in Psychological Science, 22*, 265–270.

Huntsinger, J. R., Clore, G. L., & Bar-Anan, Y. (2010). Mood and global–local focus: Priming a local focus reverses the link between mood and global–local processing. *Emotion, 10*, 722–726.

Huntsinger, J. R., Isbell, L. M., & Clore, G. L. (2014). The affective control of thought: Malleable, not fixed. *Psychological Review, 121*, 600–618.

Huntsinger, J. R., & Ray, C. (in press). A flexible influence of affective feelings on cognitive performance. *Emotion.*

Huntsinger, J. R., Sinclair, S., Dunn, E., & Clore, G. L. (2010). Affective regulation of stereotype activation: It's the (accessible) thought that counts. *Personality and Social Psychology Bulletin, 26*, 564–577.

Huntsinger, J. R., & Smith, C. T. (2009). First thought, best thought: Positive mood maintains and negative mood disrupts implicit–explicit attitude correspondence. *Personality and Social Psychology Bulletin, 35*, 187–197.

Isbell, L. M., & Lair, E. C. (2013). Moods, emotions, and evaluations as information. In D. Carlston (Ed.), *The Oxford handbook of social cognition* (pp. 435–462). New York: Oxford University Press.

Isbell, L. M., Lair, E. C., & Rovenpor, D. (2013). Affect-as-information about processing styles: A cognitive malleability approach. *Social and Personality Psychology Compass, 7*, 93–114.

Isen, A. M. (1984). Toward understanding the role of affect in cognition. In R. S. Wyer & T. K. Srull (Eds.), *Handbook of social cognition* (pp. 179–236). Hillsdale, NJ: Erlbaum.

Isen, A. M. (2008). Some ways in which positive affect influences decision making and problem solving. In M. Lewis, J. M. Haviland-Jones, & L. Feldman-Barrett (Eds.), *Handbook of emotions* (3rd ed., 548–573). New York: Guilford Press.

Jordan, C. H., Whitfield, M., & Zeigler-Hill, V. (2007). Intuition and the correspondence between implicit and explicit self-esteem. *Journal of Personality and Social Psychology, 93*, 1067–1079.

Kadous, K. (2001). Improving jurors' evaluations of auditors in negligence cases. *Contemporary Accounting Research, 18*, 425–444.

Keltner, D., Ellsworth, P., & Edwards, K. (1993). Beyond simple pessimism: Effects of sadness and anger on social perception. *Journal of Personality and Social Psychology, 64*, 740–752.

Kimchi, R. (1992). Primacy of holistic processing and global/local paradigm: A critical review. *Psychological Bulletin, 112*, 24–38.

Landy, J. F., & Goodwin, G. P. (2015). Does incidental disgust amplify moral judgment?: A meta-analytic review of experimental evidence. *Perspectives on Psychological Science, 10*, 518–536.

Lapate, R. C., Rokers, B., Li, T., & Davidson, R. J. (2014). Non-conscious emotional activation colors first impressions: A regulatory role for conscious awareness. *Psychological Science, 2*, 349–357.

Lerner, J. S., Gonzalez, R. M., Small, D. A., & Fischhoff, B. (2003). Effects of fear and anger on perceived risks of terrorism: A national field experiment. *Psychological Science, 14*, 144–150.

Lerner, J. S., & Keltner, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgement and choice. *Cognition and Emotion, 14*, 473–493.

Lerner, J. S., & Keltner, D. (2001). Fear, anger, and risk. *Journal of Personality and Social Psychology, 81*, 146–159.

Lerner, J. S., Small, D. A., & Loewenstein, G. (2004). Heart strings and purse strings: Carry-over effects of emotions on economic transactions. *Psychological Science, 15*, 337–341.

Lount, R. (2010). The impact of positive mood on trust in interpersonal and intergroup interactions. *Journal of Personality and Social Psychology, 98*, 420–433.

Mackie, D. M., & Worth, L. T. (1989). Cognitive deficits and the mediation of positive affect in persuasion. *Journal of Personality and Social Psychology, 57*, 27–40.

Martin, L. L., Seta, J. J., & Crelia, R. A. (1990). Assimilation and contrast as a function of people's willingness and ability to expend effort in forming an impression. *Journal of Personality and Social Psychology, 59*, 27–37.

Martin, L. L., Ward, D. W., Achee, J. W., & Wyer, R. S. (1993). Mood as input: People have to interpret the motivational implications of their moods. *Journal of Personality and Social Psychology, 64*, 317–326.

Mednick, S. A., & Mednick, M. T. (1967). *Remote Associates Test, College and Adult Forms 1 and 2*. Boston: Houghton Mifflin Company.

Moskowitz, G. B., Gollwitzer, P. M., Wasel, W., & Schaal, B. (1999). Preconscious control of stereotype activation through chronic egalitarian goals. *Journal of Personality and Social Psychology, 77*, 167–184.

Munro, G. D., Stansbury, J. A., & Tsai, J. (2012). A causal role for negative affect: Misattribution in biased evaluations of scientific information. *Self and Identity, 11*, 1–15.

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive Psychology, 9*, 441–474.

Ortony, A., Clore, G. L., & Collins, A. (1988). *The cognitive structure of emotions*. New York: Cambridge University Press.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning*. Urbana: University of Illinois Press.

Overbeck, J. R., & Droutman, V. (2013). One for all: Social power increases self-anchoring of traits, attitudes, and emotions. *Psychological Science, 24*, 1466–1476.

Petty, R. E., & Cacioppo, J. T. (1986). *Communication and persuasion: Central and peripheral routes to attitude change*. New York: Springer-Verlag.

Raghunathan, R., Pham, M. T., & Corfman, K. P. (2006). Informational properties of anxiety and sadness, and displaced coping. *Journal of Consumer Research, 32*, 596–601.

Riener, C. R., Stefanucci, J. K., Proffitt, D. R., & Clore, G. L. (2011). An effect of mood on the perception of geographical slant. *Cognition and Emotion, 25*, 174–182.

Rowe, G., Hirsch, J. B., & Anderson, A. K. (2007). Positive affect increases the breadth of attentional selection. *Proceedings of the National Academy of Sciences USA, 104*, 383–388.

Ruder, M., & Bless, H. (2003). Mood and the reliance on the ease of retrieval heuristic. *Journal of Personality and Social Psychology, 85*, 20–32.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*, 145–172.

Scherer, K. R. (1984). On the nature and function of emotion: A component process approach. In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 293–317). Hillsdale, NJ: Erlbaum.

Schiller, A. J., & Clore, G. L. (2015). *New light on mood and judgment*. Unpublished manuscript, University of Virginia, Charlottesville.

Schnall, S., Benton, J., & Harvey, S. (2008). With a clean conscience: Cleanliness reduces the severity of moral judgments. *Psychological Science, 12*, 1219–1222.

Schnall, S., Haidt, J., Clore, G. L., & Jordan, A. H. (2008). Disgust as embodied moral judgment. *Personality and Social Psychology Bulletin, 34*, 1096–1109.

Schnall, S., Haidt, J., Clore, G. L., & Jordan, A. H. (2015). Landy and Goodwin (2015) confirmed most of our findings then drew the wrong conclusions. *Perspectives in Psychological Science, 10*, 537–538.

Schwarz, N. (1990). Feelings as information: Informational and motivational functions of affective states. In R. M. Sorrentino & E. T. Higgins (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 527–561). New York: Guilford Press.

Schwarz, N. (2012). Feelings-as-information theory. In P. Van Lange, A. Kruglanski, & E. T. Higgins (Eds.), *Handbook of theories of social psychology* (pp. 289–308). Thousand Oaks, CA: Sage.

Schwarz, N., Bless, H., & Bohner, G. (1991). Mood and persuasion: Affective states influence the processing of persuasive communications. In M. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 24, pp. 161–197). New York: Academic Press.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology, 45*, 513–523.

Schwarz, N., & Clore, G. L. (2007). Feelings and phenomenal experiences. In A. Kruglanski & E. T. Higgins (Eds.), *Social psychology: Handbook of principles* (2nd ed., pp. 385–407). New York: Guilford Press.

Simon, H. A. (1967). Motivational and emotional controls of cognition. *Psychological Review, 74*, 29–39.

Stefanucci, J. K., Proffitt, D. R., Clore, G., & Parekh, N. (2008). Skating down a steeper slope: Fear influences the perception of geographical slant. *Perception, 37*, 321–323.

Stefanucci, J. K., & Storbeck, J. (2009). Don't look down: Emotional arousal elevates height perception. *Journal of Experiment Psychology: General, 138*, 131–145.

Storbeck, J., & Clore, G. L. (2005). With sadness comes accuracy, with happiness, false memory: Mood and the false memory effect. *Psychological Science, 16*, 785–791.

Storbeck, J., & Clore, G. L. (2008). Affective arousal as information: How affective arousal influences judgments, learning, and memory. *Social and Personality Psychology Compass, 2*, 1824–1843.

Storbeck, J., & Clore, G. L. (2008). The affective regulation of cognitive priming. *Emotion, 8*, 208–215.

Tice, D. M., Bratslavsky, E., & Baumeister, R. F. (2001). Emotional distress regulation takes precedence over impulse control: If you feel bad, do it! *Journal of Personality and Social Psychology, 80*, 53–67.

Tiedens, L. Z., & Linton, S. (2001). Judgment under emotional certainty and uncertainty: The effects of specific emotions on information processing. *Journal of Personality and Social Psychology, 81*, 973–988.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*, 1124–1131.

Van Damme, I., & Seynaeve, L. (2013). The effect of mood on confidence in false memories. *Journal of Cognitive Psychology, 25*, 309–318.

Wegner, D. M., & Vallacher, R. R. (1986). Action identification. In R. M. Sorrentino & E. T. Higgins (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (pp. 550–582). New York: Guilford Press.

Welp, T., Rushen, J., Kramer, D. L., Festa-Bianchet, M., & de Passillé, A. M. B. (2004). Vigilance as a measure of fear in dairy cattle. *Applied Animal Behaviour Science, 87*, 1–13.

Westermann, R., Spies, K., Stahl, G., & Hesse, F. W. (1996). Relative effectiveness and validity of mood induction procedures: A meta-analysis. *European Journal of Social Psychology, 26*, 557–580.

Wheatley, T., & Haidt, J. (2005). Hypnotically induced disgust makes moral judgments more severe. *Psychological Science, 16*, 780–784.

Winkielman, P., & Cacioppo, J. T. (2001). Mind at ease puts a smile on the face: Psychophysiological evidence that processing facilitation increases positive affect. *Journal of Personality and Social Psychology, 81*, 989–1000.

Worth, L. T., & Mackie, D. M. (1987). Cognitive mediation of positive affect in persuasion. *Social Cognition, 5*, 76–94.

Wyer, R. S., Clore, G. L., & Isbell, L. (1999). Affect and information processing. In M. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 31, pp. 1–77). New York: Academic Press.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist, 35*, 151–175.

Zhang, X., Yu, H. W., & Barrett, L. F. (2014). How does this make you feel?: A comparison of four affect induction procedures. *Frontiers in Psychology, 5*, 689.

CHAPTER 32

A Fundamental Role for Conceptual Processing in Emotion

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The idea that there are consistent and discriminable patterns for a small number of "basic" emotions (e.g., fear, anger, sad, happy, disgust) motivates a great deal of emotion research (see Tracy & Randles, 2011, for a recent review of these models). This view is also pervasive outside of the scientific arena, in education, government policy, industry, and entertainment. The logic is clear: If we could discover these emotion-specific patterns, we would unlock the mystery of human emotions, because these basic emotions are also the foundation of more complex emotions. As science has a tendency to do, however, the empirical evidence is forcing us to pause. A more complicated picture is emerging, one in which there is tremendous variability in the physiological, neural, behavioral, and subjective changes that occur during emotions like fear, anger, happiness, sadness, and disgust (Barrett, 2006; Barrett et al., 2007; Lindquist, Siegel, Quigley, & Barrett, 2013; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012; Ortony & Turner, 1990; Quigley & Barrett, 2014). Moreover, there are a great number of emotional experiences that do not fall into these categories. Perhaps, although elusive, some set of basic emotions is still the answer—the key to understanding this variability—and we should keep searching for them. But what if we could explain this variability without appealing to basic emotions? We suggest that conceptual processing offers a natural explanation of the variability in emotional life. Furthermore, conceptual processing offers a very different perspective on the functions of emotions than has traditionally been discussed in theories of emotion, and motivates a very different approach to studying them.

In this chapter, we explore possible roles that conceptual processing plays in emotion, drawing on both the cognitive and affective science literatures. In short, we suggest that concepts develop in memory for emotional experiences as they do for many other forms of experiences, shaped in large part by attention and learning and by the "niche" in which an individual operates, including internal bodily, external sensory, and sociocultural environments (Barrett, Wilson-Mendenhall, & Barsalou, 2015; Barsalou, 2009; Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011). The emotion literature often emphasizes the role of conceptual processing and language in explicitly remembering and communicating emotional experiences. We propose that conceptual processing also plays a role in the implicit generation of emotional experiences. Concepts develop so that previous experiences can be used to guide responding in the present situation (via prediction and inference; Barsalou, 2003b, 2009; Barsalou, Niedenthal, Barbey, & Ruppert, 2003). Our goal for this chapter is to illustrate how conceptual processing could play a fundamental role in emotion.

Concepts Develop for Prediction and Inference

Concepts work so seamlessly most of the time that we are not aware that they are functioning. Consider a typical start to a weekday morning: you hear your alarm clock sound. This may seem like a simple event, but let us break it down. In more simple terms, you hear a sound that arouses your nervous system somewhat automatically due to its acoustical properties.[1] Now, what do you do? If you did not know anything about alarm clocks, you might begin by orienting toward the sound and trying to find its source. You do not do this, however. Instead, prior experiences with alarm clocks that exist in memory, which are organized in your concept of alarm clock, shape how you respond to this sound. Information not only about the alarm clock object itself (e.g., its visual features, sounds it produces, how you act on it, co-occurring changes in your internal state), but also information contained in other related concepts that underlie the situations that involve alarm clocks (concepts like morning, bed, sleep, refreshed, exhausted, etc.) guide how you respond to this sound. You know that you can control the sound (stop or delay it) and that it is a signal to wake up. Unlike a rigid conditioned response, you can act flexibly based on the situational context, because concepts underlying the larger situation are also available in memory and are integrated with your concept of an alarm clock. If exhausted upon hearing the alarm, you press the snooze button; if well rested upon hearing the alarm, you press the off button. Perhaps you set the alarm extra early the night before, so you hit the snooze button twice. Perhaps you forgot to set the alarm, and wake up on your own instead of hearing an alarm, so you do not hit any button, and instead search for the time display. Thus, a concept like alarm clock refers to a set of patterns in memory that share various similarities and can flexibly be used to guide action. It refers to the aggregation of information about category instances into some kind of integrated representation (Barsalou, 2003a, 2005, 2012; Barsalou & Hale, 1993; Murphy, 2002). Concepts underlie our ability to interpret and engage in the situations that characterize everyday life.

The purpose of concepts, in other words, is prediction—going beyond the information that is present to *infer* what will happen next and to shift the biological system in ways appropriate to the situation (in the form of motor actions, perceptual sampling, attention shifts, visceromotor regulation, metabolic changes, etc.; Barsalou, 2009). In this way, concepts actively *interpret and construe* experience, dynamically shaping moment-to-moment "responding" in the form of perceiving, coordinating action, regulating the body, and organizing thoughts. Many theorists emphasize the value of prediction (and inference) in terms of filtering sensory information from the external environment, which allows us to act quickly and efficiently, and to allocate appropriate resources to novel stimuli (e.g., Clark, 2013). Prediction is also valuable in terms of filtering sensory information from the body and initiating efficient visceromotor responding (e.g., Barrett & Bar, 2009; Barrett & Simmons, 2015; Seth & Critchley, 2013). Prediction also plays central roles in internally oriented thought and reasoning, filtering and allocating attention to organize or redirect thoughts, plan for the future, generate new ideas, and so on (Barsalou, 2009).

Concepts develop to interpret virtually every aspect of the situations we experience—externally oriented experiences of objects and scenes in the world (e.g., violin, banana, mountain, statue), internally oriented experiences of our bodies (e.g., hunger, pain, itch, sweet), complex mental experiences that often involve how our internal and external worlds meet (e.g., anger, doubt, belief, analyze), and social experiences and institutions that involve many minds and bodies (e.g., government, protest, religion, concert). Simple and concrete concepts typically emerge earlier in the lifespan,[2] with more complex and abstract concepts, including many emotion concepts, developing later (Bretherton & Beeghly, 1982; Bretherton, Fritz, Zahn-Waxler, & Ridgeway, 1986; Gilhooly & Gilhooly, 1980; Kuperman, Stadthagen-Gonzalez, & Brysbaert, 2012; Ridgeway, Waters, & Kuczaj, 1985; Wellman, Harris, Banerjee, & Sinclair, 1995). As we will see, many different situational patterns accrue for each concept so prediction occurs as efficiently as possible at any given moment, in any given situation—guiding perception, action, regulation, and decision making. Furthermore, concepts are dynamic and flexible. Attention and learning support accruing many different patterns for a concept, and continually updating and expanding these patterns. Sometimes the changes in the patterns that underlie a concept are dramatic, as we see for emotion concepts later.

In the sections that follow, we focus on the characteristics of conceptual processing that are most relevant for understanding how concepts underlie emotional experiences. We propose that concepts develop to efficiently mobilize changes that characterize affective and emotional experiences.[3] Learning situated conceptualizations can explain the tremendous variability in emotional experiences within an individual and across different individuals.

Attention Is Integral to Establishing Concepts

A concept reflects a coherent aspect of experience that is represented by a set of patterns in memory. Attention is central to acquiring (and using) concepts because the brain's attention systems select specific aspects of the current experience, which often become integrated with similar schematic experiences in memory (Barsalou, 1999). In contrast to a "snapshot" or "recording" of experience like what a camera would produce, specific concepts develop from extracting aspects of experience than can be used to interpret similar experiences in the future (e.g., red, apple, hungry; Barsalou, 1999; Schyns, Goldstone, & Thibaut, 1998). Parsing experience into concepts is productive because, later, this enables constructing an infinite number of possible situated experiences from a finite number of concepts. Because no two situations are exactly the same, it is critical for the brain to organize information in memory so it is readily available for interpreting the situation at hand, which often involves the dynamic assembly of concepts. In this section, we discuss how attention operates in ways that are integral to establishing and using concepts to navigate situations.

Selecting Meaningful Units

Selection is a core function of attention and reflects efficient processing of what is most relevant to ongoing goals and behaviors (Chun, Golomb, & Turk-Browne, 2011; Johnson & Dark, 1986; Peelen & Kastner, 2014; Treisman, 1969). Selection can operate on properties of one modality (e.g., visual, auditory, gustatory) and on dimensions of space, time, or intensity that typically occur across modalities (Bahrick, Lickliter, & Flom, 2004). We assume that selective attention operates on interoceptive sensorimotor activity grounded in the body in a parallel way to how it operates on externally oriented sensorimotor activity.[4]

Selective attention establishes the meaningful units upon which concepts are built. For example, the spread of attention across multiple sensory modalities while allocated to a specific location in space serves to bind local sensory information into a multisensory object concept (Busse, Roberts, Crist, Weissman, & Woldorff, 2005; Treisman, 1998). Initially, intersensory redundancy appears to drive selective attention (e.g., temporal synchrony, rhythm, tempo, and changing intensity that a person's face and voice often express; Bahrick et al., 2004). As attentional skills develop, coordinated attention across modalities guided by time, space, and intensity dimensions is central to learning the relations (e.g., above, after, cause, intend) that are critical components of many concepts (e.g., Cohen & Amsel, 1998; Cohen, Chaput, & Cashon, 2002; Logan, 1994). Although people are sometimes aware of attending to a specific aspect of experience (e.g., when studying, when meditating), selection processes operate continually outside of awareness, which underlies accruing and integrating the many patterns underlying concepts in memory.[5]

Top-Down Processing Becomes Routine

As concepts develop in memory, top-down conceptual patterns and bottom-up sensory input often interact to direct selection processes (Chun et al., 2011; Corbetta, Patel, & Shulman, 2008) that include orienting, filtering, searching, and expecting (Plude, Enns, & Brodeur, 1994). This interaction supports the transition from the rigid stimulus–response responding present in early life to more adaptive, situated responding. The mechanisms underlying stimulus-driven attention are important because they bias attention toward novel features of experience (e.g., Klein, 2000) and disrupt top-down cognitive control to reorient attention. These kinds of disruptions tend to occur, for example, with a temporally abrupt onset, change in intensity, appearance of new objects, and moving or looming stimuli (especially as an interaction becomes more probable) (Chun et al., 2011). Evidence increasingly suggests, however, that bottom-up, sensory-driven processing occurs relatively infrequently, reflecting an interruption in routine top-down processing when it does occur (Clark, 2013; Vetter & Newen, 2014). Whether a stimulus is sufficiently novel to reorient attention is dependent on the concepts accessible in memory.

Top-Down Processing Interprets and Construes

Through attention operations, top-down conceptual processing dynamically shapes moment-to-moment perception, action, regulation, and decision making (Barrett & Bar, 2009; Barsalou, 2009). Extensive evidence in perception, for example, demonstrates that top-down conceptual predictions change and distort sensory information based on what is predicted to occur, shaping attention and perception through expectation (Barsalou, 2009; Vetter & Newen, 2014). The brain coordinates mental activity through internally driven interpretation and prediction, not through reflexive, externally driven responding (e.g., Raichle, 2010). Computationally, in predictive coding neuroscience models, information from memory does not merely modulate incoming sensory activity, it drives it, which means it can change how sensory information is being sampled (Bastos et al., 2012). It is more efficient to change perceptions of the environment to be consistent with patterns in memory (i.e., what a person already implicitly knows).[6]

Because it is unclear whether veridical perception even exists, recent proposals suggest that discussing levels of conceptual "penetration" or "construal" may be more productive (Vetter & Newen, 2014). The predictions driving construal penetrate very early perceptual processing (McCauley & Henrich, 2006). Top-down color knowledge, for example, can be decoded from patterns in primary visual cortex (V1) when participants view achromatic objects (Bannert & Bartels, 2013). The top-down penetration of early sensory processing is not specific to vision, occurring in other sensory modalities and during multisensory integration (Barsalou, 2009; Vetter & Newen, 2014). Initial evidence suggests that top-down processing of interoceptive activity also occurs (Barrett & Bar, 2009; Barrett & Simmons, 2015; Petersen, Schroijen, Molders, Zenker, & Van den Bergh, 2014; Seth & Critchley, 2013). In our view, then, attention and other systems are typically operating via conceptual processing, with predictions that distort perception, facilitate motor actions, regulate the viscera (and so on) continually occurring, and with updating occurring in novel situations. As we see next, top-down conceptual processing is what underlies efficiently engaging in situations, including the situations in which emotions emerge.

Learning Establishes Flexible, Situated Concepts

Learning grounded in attention establishes concepts that support interpreting and navigating experience in increasingly complex ways. Learning a concept involves accruing instances—patterns in memory—for an aspect of an experience (Allen & Brooks, 1991; Barsalou, 1987; Medin & Schaffer, 1978; Murphy, 2002). As we will see, the patterns that become organized in memory for a concept, the different instances, reflect the situations in which they occur (Barsalou, 2003b, 2008b; Barsalou, Breazeal, & Smith, 2007; Yeh & Barsalou, 2006). We refer to representing a concept in a situation, a situated instance, as a *situated conceptualization* (Barsalou, 2003b, 2009; Barsalou et al., 2003; Wilson-Mendenhall et al., 2011). Developing situated conceptualizations supports prediction and inference through efficiently assembling concepts to dynamically interpret and construe what is occurring based on prior experiences (Barsalou, 2009). More simple, concrete concepts that reflect *local* components of situations (e.g., apple conceptualizes part of an event in which a family bakes an apple pie together during a holiday) tend to develop as focal aspects of situated conceptualizations (Barsalou, 2003b, 2008b). As learning occurs in situations and attention operations become increasingly driven by top-down assemblies of concepts during situated conceptualization, more complex, abstract concepts emerge. These concepts, which typically integrate local components into *configural relational* structures (e.g., tradition integrates various parts of the event, including apples, baking, family, and holiday), tend to develop as entire situated conceptualizations (Barsalou, 1999; Barsalou & Weimer-Hastings, 2005; Wilson-Mendenhall, Simmons, Martin, & Barsalou, 2013). In this section, we build on our discussion of attention to examine how increasingly complex concepts, including the concepts underlying emotional experiences, are learned. We demonstrate how language underlies very different patterns, situated conceptualizations, becoming organized as instances of concepts. We first discuss our general theoretical approach and then apply it to emotional experiences.

Implicit Statistical Learning Is Occurring Early

Because aspects of situations tend to occur repeatedly, the brain organizes these regularities together as concepts in memory to facilitate interpreting similar situations in the future. Simple concepts can develop very early via implicit mechanisms in the brain that extract the organizational structural or "statistical regularity" across instances in the stream of situated activity filtered through attention (Aslin & Newport, 2012; Turk-Browne, 2012). Statistical learning is a powerful learning mechanism that is operating well before an infant is a year old (Kirkham, Slemmer, & Johnson, 2002; Saffran, Aslin, & Newport, 1996). Initially, the system easily extracts physical regularities that tend to be stable in the external environment (e.g., the boundary between earth and sky is consistently horizontal, not vertical), perhaps due to evolved biological scaffolding that needs minimal tuning (Turk-Browne, 2012). As selective attention becomes more sophisticated, statistical learning also operates on aspects of situations that tend to co-occur together and exhibit stable relations to one another (e.g., sky is above the horizon and ground is below it; Turk-Browne, 2012). The patterns underlying concepts at this point may be relatively rigid, with more flexibility introduced as language develops.

Words Support Flexible Learning in Different Situations

A word can further facilitate statistical learning through its redundancy with repeated sensorimotor patterns that are never exactly the same, strengthening the association (e.g., the word "apple" co-occurring with similar taste sensations and actions during eating; Smith, Suanda, & Yu, 2014; Smith & Yu, 2008; Yoshida & Smith, 2005). The redundancy provided by the word facilitates situated conceptualization. When the word "apple" is used in future, similar situations, for example, the brain mobilizes patterns in memory, generating top-down predictions that shape taste perception and guide actions (Barsalou, 2009). A word also provides a redundancy that can guide increasingly dissimilar experiential regularities—extracted via attention—to become established for a concept. Experiences of apple during a grocery shopping situation, for example, differ from experiences of apple during an afternoon snacking situation (e.g., involving searching for apples in produce bins, placing them in a cart, paying for them, and so forth in the shopping situation vs. involving grasping apple slices, inserting them in the mouth, tasting and chewing them, and so forth in the snacking situation). Whereas the patterns that accrue upon using the word "apple" when eating a snack support interpreting and engaging in future snacking situations, the patterns that accrue upon using the word "apple" when grocery shopping support interpreting and engaging in future shopping situations. Different perceptions, actions, regulation, and so on emerge in the two situations (Barsalou, 2003b, 2008b). As we return to later, regularities that are established across various instances of a concept using language and attention, and that are most useful for top-down prediction, are often driven by goal-oriented action in situations (e.g., eating apples as a healthy snack, selecting apples in the grocery store, picking apples as a leisure activity), which become richer and more varied with increasing cognitive capacities and novel experiences (Barsalou, 1991, 2003b). Throughout life and especially during childhood, implicit acquisition of these regularities is often structured through interactions with others (e.g., parents, siblings, caregivers, teachers; Akhtar & Tomasello, 2000; Tomasello, 1992).

Initially, words are important for establishing the patterns that underlie local aspects of situations—the more simple, concrete concepts upon which complex, abstract concepts are built. Because learning operates as continuous situated activity cascades across the brain,[7] the patterns that become organized in memory for a concept, the different instances, are each integrated within a situation (Barsalou, 2003b, 2008b; Barsalou et al., 2007; Yeh & Barsalou, 2006). Some instances of apple, for example, might become integrated within a situated conceptualization involving the concepts cutting board, kitchen, and knife; whereas other instances of apple might become integrated within a situated conceptualization involving the concepts tree, orchard, and autumn; and still other instances within a situated conceptualization involving the concepts pie, oven, and grandma. Many empirical studies demonstrate the extensive presence of situational information as people develop and use concepts (e.g., Bar, 2004; Barsalou & Weimer-Hastings, 2005; Chaigneau, Barsalou, & Zamani, 2009; Wu & Barsalou, 2009; see Yeh & Barsalou, 2006, for a review). Rather than the concept functioning in a rigid manner across situations, it is functioning flexibly in widely varying sets of concepts that contextualize it in each situation.

Language Supports Learning More Complex Concepts

As concepts develop in situations, words transition from operating as a co-occurring redundancy for establishing patterns to operating as top-down mobilizers that efficiently construct increasingly elaborate situated conceptualizations (Barsalou, Santos, Simmons, & Wilson, 2008; Vigliocco, Meteyard, Andrews, & Kousta, 2009). Words become especially important for coordinating concepts such that they are integrated into the configural, relational patterns in situated conceptualizations that underlie many abstract and emotion concepts. When this type of learning is occurring, language—typically in the form of sentences, not single words—guides attention to various aspects of a situation (Zwaan & Madden, 2004; Zwaan & Radvansky, 1998). Language supports productively assembling and combining concepts to establish more complex concepts, often through syntax that facilitates recursive embedding, mental time travel, and other configural, relational operations (Barsalou, 1999, 2008a; Clark, 2006; Schmid, 2000). Because language draws on internally oriented attention processes associated with working memory to assemble more elaborate situated conceptualizations, abstract concepts typically emerge later in development.

Consider, for example, a situation in which an individual tells her grandchildren that baking apple pie at this time every year is a holiday tradition as she places the pie in the oven. Language that situates the word "tradition" guides the top-down coordination and integration of concepts into a situated conceptualization underlying the concept of tradition. Assembling concepts into a situated conceptualization, linked to a specific word (e.g., the word "tradition"), supports efficient interpretation and engagement in future, similar situations. As we will see, it coordinates trajectories of moment-to-moment prediction and inference that guide perceiving, coordinating action, regulating the body, and organizing thought. It also supports efficient communication and interaction with others (Barrett, 2012). Learning concepts in this way often remains implicit in the sense that individuals are not aware of having learned a concept—they did not intend to learn a concept or remember how they learned it.

As the word "tradition" and supporting language is used in different situations, different situated conceptualizations develop that underlie the concept (e.g., for holiday traditions involving annual activities, for religious traditions involving weekly rituals, for vacation traditions involving travel with friends; Barsalou, 2003b, 2008b). Because the situated conceptualizations reflecting different instances of an abstract concept can vary dramatically, goals often represent what is regular and co-occurring across subsets of them (e.g., goals like sharing an enjoyable activity with family, teaching an important skill to others, and performing a valued duty in the community, for the abstract concept of tradition).[8] Importantly, though, goal-driven regularities are not particularly useful for interpreting and engaging in the situation without the situation-specific assembly of concepts embedded in the situated conceptualization (Wilson-Mendenhall et al., 2011).

Learning Concepts for Emotional Experiences

We assume that many emotion concepts develop like abstract concepts do (see also Vigliocco et al., 2009), with situated conceptualizations that assemble concepts developing as an emotion word and supporting language is used in different situations. These situated conceptualizations emerge out of the more simple concepts that develop for aspects of affective experiences, including internal states. Through a discussion that parallels that above, we highlight empirical examples from across the lifespan to illustrate how situated conceptualizations underlying emotions could be learned.

Learning Statistical Regularities Early

We assume statistical regularities in the body's internal environment (e.g., underlying hunger, arousal) could be learned in an analogous manner to those in the external environment. We further assume that regular situational co-occurences involving interoceptive activity could be learned in this manner. The simple reflexes that newborns display in response to the distress of overwhelming arousal (e.g., eye closing, head aversion, non-nutritive sucking) disappear quickly as more adaptive learned patterns become established in memory from experience (Kopp, 1989).[9] Infants learn situational co-occurrences among their internal states, their caregivers' actions, and their own actions as caregivers play an increasingly central role in regulating infants' arousal states (Kopp, 1989), which support interpreting and actively engaging in future, similar situations. Different cries, for example, can be used to signal hunger, pain, or boredom to a caregiver. The parent–infant synchrony that presumably supports statistical learning during the first year predicts conceptually driven capacities for symbolic play and internal state talk at 2–3 years of age (Feldman, 2007; Feldman & Greenbaum, 1997).

By 8 months of age, infants are establishing conceptual patterns that allow them to anticipate the affective changes that result from others' actions (e.g., cringing in anticipation of the physical discomfort involved in a vaccination, becoming distressed when an attachment figure prepares to leave; Bretherton et al., 1986).[10] The concepts infants are using, although rudimentary, appear to be increasingly flexible and situated (i.e., flexibly drawing on different instances of a concept). For example, 11-month-old infants express distress and increase attention when mom disappears into a closet, relative to when mom disappears through a doorway, suggesting that they are sensitive to the situation in which separation occurs (Littenberg, Tulkin, & Kagan, 1971).

Learning in Situations Using Words

We assume that initial word learning facilitates accruing patterns that underlie internal state concepts and other concepts in affective situations—an important precursor to developing more complex emotion concepts. Infants understand and begin to refer to the basic physiological and affective internal states that are central to daily routines and situations (e.g., sleepy, hungry, good, happy, tired, hot) as they learn words throughout the second year (Benedict, 1979; Bretherton & Beeghly, 1982; Ridgeway et al., 1985). We assume that different instances of these concepts accrue as they are named in different situations, and that they are increasingly integrated with other concepts as situated conceptualizations develop. We further assume that the concepts that are developing in affective situations during this time tend to be those that are useful for interpreting and engaging in the situations (and are heavily dependent on interactions with caregivers). When infants express distress or delight, for example, caregiver language tends to center around the eliciting situation and how to concretely resolve/maintain the affective state instead of labeling the entire situation using an emotion word (like “fear,” “anger,” “sadness,” “joy”; Bloom, 1993).

Only later, into their third year of life, do children begin to use words to name and understand discrete emotional experiences (e.g., “sad,” “afraid,” “scared,” “angry,” “mad”; Bretherton & Beeghly, 1982; Bretherton et al., 1986; Ridgeway et al., 1985; Wellman et al., 1995). Interestingly, the concepts that are developing in association with these words appear to initially be anchored on patterns of internal states underlying distress, paralleling the development of concrete, simpler concepts. Children often confuse emotions that feel unpleasant during this time (like anger and sadness), and it is not until later in the preschool years that children’s emotion concepts differentiate emotions of the same valence effectively (Widen & Russell, 2008, 2010). We assume that as language (i.e., phrases and sentences) and working memory operations develop, situated conceptualizations are constructed that support differentiating affective experiences using concepts like fear, anger, sadness, and so on.

Learning Integrated Situated Conceptualizations

As language and attention skills develop in a communicative context that supports learning, we assume that integrated situated conceptualizations underlying emotion concepts are learned (Barrett, 2009, 2013; Lindquist, Satpute, & Gendron, 2015). Assembling a configuration of concepts into a situated conceptualization through language, and linking the situated conceptualization to a specific emotion word (e.g., “fear,” “anger,” “sad”), supports efficiently interpreting and engaging in future, similar situations. The developmental literature provides many examples of parent–child interactions that involve discussing an emotion in the context of specific situations, including the events that preceded an affective state, the expressive actions that accompany an affective state, and subsequent coping actions (Bretherton & Beeghly, 1982; Bretherton et al., 1986). Discussing a child’s experience during a vaccination situation as involving fear (being scared, afraid), for example, might include talking about the restlessness and discomfort of anticipating the shot, the interactions with the doctor, the comforting presence of the parent (holding the child’s hand, etc.), the needle instrument and the actions involved in the injection, the pain experienced and expressive crying, and so on. Integrating concepts underlying these aspects of the experience into a situated conceptualization underlying fear supports later mobilizing them to efficiently generate series of implicit, top-down predictions during future vaccination situations (which drive changes in perception, action, and regulation that we explore in the section “Mobilizing Coordinated Concepts in Situations”). The constructive nature of this process suggests that the situated conceptualizations underlying emotions like fear, anger, sadness, and so on may change quite dramatically in the early years, becoming increasingly elaborate to the extent that such language-based interactions occur.

Across the lifespan, we assume that many different situated conceptualizations are developing for a given emotion concept. Situated conceptualizations underlying fear, for example, might develop in situations that involve undergoing a painful medical procedure, interacting with an intimidating stranger, disappointing a love one, riding a rollercoaster, being rejected by one's peers, injuring oneself in a car crash, starting a challenging new job, damaging one's reputation, and so on.[11] Empirical work increasingly demonstrates that by adulthood, varied situated conceptualizations—instances—underlie any given emotion concept (Barrett, 2009; Lebois, Wilson-Mendenhall, Simmons, Barrett, & Barsalou, 2016; Oosterwijk, Mackey, Wilson-Mendenhall, Winkielman, & Paulus, 2015; Wilson-Mendenhall et al., 2011). Adults can describe different instances of emotions like anger from their own life (Russell & Fehr, 1994). Moreover, they indicate that some of these instances are more typical than others, when instances are presented as specific words (e.g., "fury" is a more typical example of anger than "impatience" or "discontent"; Fehr & Russell, 1984, 1991; Russell, 1991; Russell & Fehr, 1994) or as different situational scenarios (Condon, Wilson-Mendenhall, & Barrett, 2014; Wilson-Mendenhall, Barrett, & Barsalou, 2015). Behavioral and neuroscience evidence suggest that these within-concept typicality ratings are meaningful, with atypical category instances of emotion concepts like fear, anger, and sadness processed less efficiently than typical instances (Russell & Fehr, 1994; Wilson-Mendenhall et al., 2015). Several recent studies provide further evidence that instances of emotion concepts vary, demonstrating that different forms of the same emotion produce different neutral patterns (e.g., oral, bodily, and moral disgust; Harrison, Gray, Gianaros, & Critchley, 2010; Moll et al., 2005; von dem Hagen et al., 2009), context shapes the experience of an emotion (e.g., fear during physical danger differs from fear during social evaluation; Wilson-Mendenhall et al., 2011), and individuals experience the same emotional situation differently (e.g., experiences of anger are dependent on a person's interpretation of an unpleasant situation; Kuppens, Van Mechelen, Smits, De Boeck, & Ceulemans, 2007).

We assume that the various situated conceptualizations underlying an emotion concept may tend to cluster around typical goals or motivations (e.g., avoiding anticipated harm/distress for fear) or emergent feelings (e.g., feeling unpleasant for fear), but that it is unlikely that these regularities are always present. The fear involved in riding a rollercoaster, for example, likely involves different goals (e.g., experiencing a thrill) and may even involve pleasant feelings. Moreover, as described above, goal-driven regularities are not particularly useful for interpreting and engaging in a situation without the situation-specific assembly of concepts embedded in the situated conceptualization (Wilson-Mendenhall et al., 2011).

Mobilizing Coordinated Concepts in Situations

Accruing situated conceptualizations supports the top-down coordination of concepts to efficiently navigate and learn in the situation at hand. Patterns of situated activity are continually interpreted through trajectories of situated conceptualization as a situation is experienced (either because it is presently occurring, or because it is occurring through reconstructing the past or planning/imagining the future; Barsalou, 2003b, 2008b; Barsalou et al., 2007; Yeh & Barsalou, 2006). As this occurs, the brain goes beyond the information present to infer what will happen next and to shift the biological system in ways appropriate to the situation (in the form of motor actions, perceptual sampling, attention shifts, visceromotor regulation, metabolic changes, etc.; Barsalou, 2009). Building on the empirical evidence presented in previous sections, we now address how dynamic situated conceptualization occurs for increasingly complex concepts, concluding with emotion concepts. We approach this theoretical discussion from the perspective of a typically functioning adult mind that developed the capacity for increasingly complex attention and learning as described above. At this point, we assume top-down prediction and inference is routine because concepts accumulated to interpret repeated situations (Barsalou, 2009; Vetter & Newen, 2014) and that the brain's neural architecture is, at many levels, organized for prediction (Barrett & Simmons, 2015; Bastos et al., 2012; Friston, 2012; Friston & Kiebel, 2009; Kroes & Fernandez, 2012; Shipp, Adams, & Friston, 2013). Because no two situations are exactly the same, we further assume that situated conceptualization is a dynamic process that reflects probabilistic activity and tuning, and when we refer to situated conceptualizations *mobilizing*, we are referring to this active, probabilistic processing (Barsalou, 2011).

Mobilizing Local (Often Concrete) Concepts in Situations

In familiar situations, situated conceptualizations can mobilize quickly and fluidly without explicit direction from language (although word forms are likely activated implicitly via pattern completion as an associated part of the situated conceptualization). Consider a situation in which an individual is searching for a healthy snack in the kitchen, and sees an apple. In this situation, with goal-directed conceptual processing of kitchen, healthy, snack, and hungry already occurring, visual processing of the apple provides the critical constituent of the pattern needed to mobilize a situated conceptualization that involves eating the apple. The brain quickly goes beyond the visual experience of the apple to initiate changes in the brain and body. Pattern completion inferences provide educated guesses about what is likely to occur next—inferring actions to execute (e.g., grasping, biting, chewing), external and internal sensations that will occur (e.g., sweet taste sensations, crunchy sound sensations, satiating body sensations), internal regulation to initiate (e.g., metabolic activities), affective feelings that will emerge (e.g., the pleasant satisfaction of choosing a healthy snack), and so forth. The rapid unfolding of top-down predictions prepares and *engages* the body and mind by initiating action and regulation involved in eating the apple (Barrett & Bar, 2009; Papies & Barsalou, 2015). Top-down predictions drive attention and perceptual sampling in the situation, changing the way it is experienced. Because this particular situated conceptualization is driving perception, for example, the apple may appear a more appetizing shade of red than it would otherwise (e.g., if the situated conceptualization did not involve eating the apple).

In contrast, consider a situation in which an individual is searching for apples in the produce section of the grocery store. The situated conceptualization mobilizing in this situation generates a very different set of top-down predictions as the situation unfolds—predictions that drive perception and attention to visual features that distinguish apples from other fruits, initiate executing actions involved in selecting apples and placing them in a cart, and so on. Different situated conceptualizations involving a given concept are constructed to tailor prediction and inference to the situation at hand. The regularities imposed by situations are critical for using concepts to shift the brain and body into states that are consistent with an individual's goals and needs, which can vary dramatically from situation to situation (Barsalou, 2009).

For situations that are highly familiar, situated conceptualization reflects an assembly of concepts that mobilize as a trajectory of top-down predictions, which may continue for as long as patterns continue to loosely match perceptual input and reafferent signals, coordinating attention, perception, action, interoception, and so forth. When there is a considerable discrepancy between experience and the pattern mobilized in the situated conceptualization (i.e., what could be considered novelty), attention operations will interrupt the top-down flow of inferences that are occurring. At this point, situated conceptualization may change dramatically, reassembling concepts to reflect the multimodal change in experience or, alternatively, conceptual processing could become more fragmented as learning and updating occurs in specific modalities. Although the complexity and coordination of conceptual processing may change dynamically in this manner, the brain is always producing predictions at some level to interpret experience. Consider a situation in which an apple that an individual intended to eat feels mushy and smells odd. In this situation, the conceptual processing will begin to produce different predictions related to foods with unusual textures and smells, which might prepare the individual to dispose of the apple. Furthermore, because the salient sensations involved reorienting attention, further encoding and retrieval will likely follow, establishing a situated conceptualization involving rotting apples.

Mobilizing Configural (Often Abstract) Concepts in Situations

Situated conceptualization occurring at any given point in time constrains the situated conceptualization that follows. Consider a situation in which an individual's goal is to prepare for a large meal the morning of a holiday (e.g., American Thanksgiving). Visual processing of an apple mobilizes a situated conceptualization that involves preparing an apple pie. At this moment in time, predictions tailored to apple occur (e.g., motor actions like slicing, taste sensations like sweet) and coordinated concepts mobilize (e.g., knife, sugar, oven), guiding shifts in attention that accompany changes in perceiving, coordinating action, regulating the body, and organizing thoughts. Situated conceptualization dynamically changes as this occurs, generating new predictions from moment to moment to infer what to do next (e.g., to locate and grasp the knife, search the cabinet for sugar).

Through such trajectories, constraints accrue as goal-directed situated conceptualization guides prediction and inference involving local concepts in a situation, and as configural relations among these concepts are integrated in working memory. With specific situational constraints in place, a shift in the assembly of concepts underlying an individual's goals often appears to provide the critical constituent for mobilizing a situated conceptualization underlying a more complex, abstract concept. In the situation described above, for example, the individual's goal might shift from preparing for the meal to sharing an enjoyable activity with family when the kids wander into the kitchen. At this point, the concepts underlying the goal of sharing an enjoyable activity—configuring with concepts underlying family, apples, pie, baking, and holiday—provide the critical constituents for mobilizing a situated conceptualization underlying tradition.

Because a concept like tradition is more complex, the underlying situated conceptualization assembles concepts configured in time and space that generate a series of predictions (inferring what is going to occur). Situated conceptualization, as we refer to it here, really refers to extended trajectories of situated conceptualization that coordinate series of predictions. Linked local concepts not yet perceived mobilize via pattern completion, producing predictions that dynamically shape moment-to-moment experience in the form of perceiving, coordinating action, regulating the body, and so on as described above. Because this particular situated conceptualization is driving perception, for example, the individual might perceive family members' smiles as broader and more intensely positive than they would otherwise, consistent with the goal of sharing an enjoyable activity. Goals often shape the local concepts that are assembling in such situated conceptualizations. If an individual's goal is to share an enjoyable experience, for example, assemblies of local concepts will organize around actions shaping interactions between family members. On the other hand, if an individual's goal is to teach his or her children to execute a family recipe, the assemblies of local concepts will organize around actions shaping precise pie baking.

Similar to other concepts, we assume many different situated conceptualizations, grounded in goals, are constructed for complex, abstract concepts to tailor prediction and inference to the situation at hand. Situated conceptualizations underlying the concept of tradition could include holiday traditions involving annual activities, religious traditions involving weekly rituals, vacation traditions involving travel when friends are available, and so on. We further assume that the situated conceptualizations underlying abstract concepts are largely assembled based on prior learning, with learning and updating occurring in novel situations as described above. Because language is often involved in these more complex experiences, and because abstract concepts involve assemblies of concepts, "ad hoc" variations of situated conceptualizations underlying an abstract concept may occur relatively frequently.

Mobilizing Emotion Concepts in Situations

Initiating shifts in the brain and body quickly is often especially important during emotional experiences. Situated conceptualizations serve this function by coordinating concepts to prepare and engage the body as the situation unfolds. Because the concepts underlying emotional experience often develop as abstract concepts (i.e., that integrate local concepts into configural relational structures), trajectories of situated conceptualization can be initiated when they mobilize. Pattern completion inferences across space and time generate predictions and initiate changes quickly and fluidly.

Consider a situation in which an individual is driving home late in the evening, after indulging in a delicious holiday meal and drinking several glasses of wine. Resting her eyes for just a moment, the car starts to drift off the road. When her hands slip from the steering wheel, she jerks awake. Through a rapid trajectory of situated conceptualizations, key constraints of the situation then emerge (i.e., actions involved in awaking, perceptions of the car drifting off the road) that shift her goal to avoiding the potential harm involved in a car crash. The assembly of these concepts mobilizes a situated conceptualization underlying fear. Linked local concepts not yet perceived mobilize via pattern completion to initiate specific changes in the brain and body (in the form of perceiving, coordinating action, regulating the body, organizing thoughts). For this situation, in which linked local concepts underlying driving are central, visceromotor changes might occur that underlie scanning the road for other cars and activating muscle tension to grip the steering wheel. Shifts in attention and perceptual changes occur such that surrounding cars appear closer and sound louder than they would otherwise. Motor actions occur that support turning the steering wheel and decelerating such that the car stays on the road. Thus, the situation is experienced as "threatening" because the brain is constructing situated conceptualizations to interpret and engage in the situation.

If the concepts assembled in the situated conceptualization were not available in memory (including the concepts underlying car, steering wheel, driving, crashing, etc.), the situation would not be so readily perceived as threatening. Furthermore, the changes that occur during a situation like this one will differ across individuals because situated conceptualization reflects prior learning (i.e., instead of changes reflecting stereotyped patterns of responding that are consistent across individuals).

The changes that occur during situated conceptualizations underlying an emotion concept vary greatly from situation to situation. Consider a very different situation, in which an individual is unprepared for an impromptu work presentation. As he stumbles through the presentation, and his goals shifts to minimizing damage to his professional reputation, the brain mobilizes a different situated conceptualization underlying fear. Predictions generated by the situated conceptualization initiate changes in the brain and body that are specific to the situation. In this situation, for example, visceromotor changes might inhibit the motor system from performing further actions unless absolutely necessary. Shifts in attention occur to organize thoughts involved in a compensatory strategy and to monitor the supervisor's reactions. Perceptual changes occur such that the supervisor's facial actions are interpreted as a frown instead of a neutral expression. As this example illustrates, different situated conceptualizations develop for an emotion concept like fear to initiate changes via prediction and inference as efficiently as possible in the situation.

Similar to other abstract concepts, we assume that goals are central to the situated conceptualizations that underlie emotion concepts. It might be tempting to also assume a one-to-one relationship between goals and emotion concepts (e.g., the goal of avoiding harm and suffering involved in all situated conceptualizations underlying fear). As discussed earlier, however, it appears that goals often vary across the various situated conceptualizations that underlie an emotion concept (e.g., when fear is experienced during thrill seeking), and that goals like avoiding potential harm/distress often operate very differently when grounded in specific situations.

Finally, we assume that the situated conceptualizations underlying emotion concepts are largely assembled based on prior learning, with new learning and updating occurring routinely as novelty is encountered and/or as language is involved in assembling concepts. We further assume that situated conceptualization underlies explicit and implicit forms of emotion regulation, with language often playing a central role in shaping trajectories of situated conceptualization (an extended discussion is beyond the scope of this chapter but see Barrett, Wilson-Mendenhall, & Barsalou, 2014).

Concepts Underlie How Emotions Function

In closing, we would like to briefly address how a situated conceptualization approach built on prediction and inference impacts how we view the functions of emotions, and by doing so, situate our theoretical approach with other theoretical approaches to emotion. Theories of emotions routinely assume that specific emotions or appraisal mechanisms evolved to serve a specific function that is adaptive. Basic emotion models typically assume that each discrete emotion system for fear, anger, disgust, sadness, and so forth evolved to deal with an important kind of problem related to survival, such as escaping predators (Tracy & Randles, 2011). Another major class of theories—appraisal theories—typically suggest that emotions reflect appraisals of the changing environment that function to detect situations relevant to an organism's well-being (Moors, Ellsworth, Scherer, & Frijda, 2013).

A situated conceptualization approach suggests that function is grounded in *learning and mobilizing* situated patterns to guide responding, and this functioning is not specific to emotional experiences. In general, situated approaches to the mind typically view the brain as a coordinated system designed to use information captured during prior situations (and available in memory) to flexibly infer what is currently happening and what to do about it—dynamically shaping moment-to-moment responding in the form of perceiving, coordinating action, regulating the body, and organizing thoughts (Aydede & Robbins, 2009; Barrett, 2013; Barsalou, 2003b, 2009; Glenberg, 1997; Mesquita, Barrett, & Smith, 2010; Wilson-Mendenhall, Barrett, et al., 2013). From a biological systems perspective, it is generally adaptive to use prior experience to predict what will happen in the present or future. This approach is largely consistent with an emerging family of psychological construction theories of emotion (Barrett, 2012; Clore & Ortony, 2013; Cunningham, Dunfield, & Stillman, 2014; Russell, 2003). Situated conceptualizations are especially central in the conceptual act theory

(Barrett, 2006, 2012, 2013), and much of what we have proposed and developed here is inspired by this theoretical approach.

Because a situated conceptualization approach offers a very different perspective on the functions of emotions than has traditionally been discussed, it motivates new research questions. From our perspective, it is critical to understand how situated conceptualizations develop and change. Instead of assuming that specific emotions or appraisals are inherently adaptive, a situated conceptualization approach suggests starting with the basic processes that scaffold attention and learning to establish the conceptual patterns that drive prediction. A possible starting point is that initial goals and motivations are grounded in ensuring immediate and prospective integrity of internal physiology (Critchley & Harrison, 2013), with the increasingly complex conceptual patterns underlying emotions emerging through attention and learning. If we assume that the patterns underlying affect and emotion are learned to a large degree, developmental and lifespan perspectives become increasingly important. Caregivers and close others play a large role in shaping emotional experiences throughout life, with crucial emotional development occurring early in life (Lindquist, MacCormack, & Shablack, 2015).

From our perspective, it is not surprising that emotional experiences vary dramatically within an individual (from situation to situation) and across individuals. Our approach suggests that it is important to understand this variability, and that understanding how situated conceptualizations create this variability could inform how we approach mental health and well-being. Some adults, for example, do not appear to distinguish among discrete emotions like fear, sadness, and anger that are typically unpleasant (Lindquist & Barrett, 2008)—similar to what has been characterized as the initial stages of learning discrete emotions during childhood (Widen & Russell, 2010). Initial evidence suggests that this lack of "granularity" impacts mental health (Demiralp et al., 2012; Suvak et al., 2011; Tugade, Fredrickson, & Barrett, 2004). Restructuring situated conceptualizations and learning new situated conceptualizations (often guided by others) arguably underlies the flexibility to cope with life's challenges. Many of the positive changes that occur in psychotherapy and in supportive relationships could be understood in terms of situated conceptualization (Barrett et al., 2014).

A situated conceptualization approach to emotion differs from many traditional approaches to emotion. From this perspective, the emphasis is on learning, variability, and change, which is how function is understood. Perhaps most importantly, assuming conceptual processing is fundamental to emotion, and thereby changing how we understand the functions of emotion, holds promise for illuminating important individual differences in emotional experiences and vulnerabilities for poor mental health.

Notes

1. Even this may not be that automatic—people learn to sleep through morning alarms, which may become too predictable to be arousing.
2. The neural patterns that underlie initial concepts are developing early in the first year of life (Bergelson & Swingley, 2012; Murphy, 2002; Tincoff & Jusczyk, 1999, 2012) and perhaps before then in the prenatal environment (e.g., patterns that underlie recognizing and responding to a mother's voice; DeCasper & Spence, 1986; Voegtline, Costigan, Pater, & DiPietro, 2013). Because concepts develop to predict what will occur in situations, concepts for experiences that are salient to infants (and that are made salient by parents) will develop first. What is salient to an infant initially may reflect the biological organization that scaffolds learning.
3. In our framework, no strict definitions distinguish affect from emotion. We primarily discuss the categories of emotional experiences that are a focus in the literature (e.g., fear, anger, sadness, happiness), but we assume that many different concepts develop for affective and emotional experiences.
4. Interoceptive activity (involving visceromotor changes) is not typically considered in models of attention, which instead focus on the sense modalities that interface with the external world.
5. For this reason, it is important to distinguish selection of interoceptive activity from "interoceptive awareness," which involves conscious, focal attention to bodily states (Kleckner & Quigley, 2014).
6. Efficiency is not synonymous with well-being. It is generally adaptive to use prior experience to guide responding in the present. Because prediction is experience dependent, however, learned conceptual structures could become entrenched and drive responding in a way that is unhealthy.
7. The term "situated" takes on a broad meaning in our view, referring to the distributed neural activity involved in constructing situations, which reflects the dynamic actions that individuals engage in, and the events, internal bodily sensations, and mentalizing that they experience, as well as the perceptions of the environmental setting and the physical entities

and individuals it contains (Wilson-Mendenhall, Barrett, & Barsalou, 2013; Wilson-Mendenhall et al., 2011).

8. The situated conceptualizations that underlie a concept often exist without any conceptual “core.” Instead, situated conceptualizations tend to vary in their similarity to one another, with regularities clustering in various ways, and with no regularities that are common to all situated conceptualizations (e.g., Lakoff, 1987; Rosch & Mervis, 1975; see also Lebois, Wilson-Mendenhall, & Barsalou, 2015). Furthermore, a representation that is separate from individual instances is not required to represent a concept—“prototypes” can be constructed dynamically (Barsalou, 1987; Murphy, 2002).
9. Kopp (1989) discusses the transition from “preadapted programs” to “elemental cognitive” processes. The elemental cognitive mechanism “implicates perceptual discrimination of an event, memory of past experiences in similar situations and learned associations of contingencies, and current self-needs and goal states” (p. 364).
10. These situated, preverbal patterns may underlie infant behaviors that adults would describe as fear (e.g., when abruptly scolded, when meeting “strange” novel people) or anger (e.g., when a caregiver departs, when unable to manipulate a toy). It is possible that these patterns are the starting points for more complex concepts that later become associated with the words “fear” and “anger.” It is also possible, however, that these patterns change substantially before children begin to organize them in memory around discrete emotion words (as situated conceptualizations develop through language-based learning).
11. Situated conceptualizations can develop as concepts mobilize to interpret a situation that is presently occurring or to interpret a situation that is occurring as a reconstruction of past experience or a projection of future possibilities. Situated conceptualizations underlying fear, for example, can develop when simulating potential pain or discomfort (e.g., during a car crash) via concepts in memory.

References

Akhtar, N., & Tomasello, M. (2000). The social nature of words and word learning. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward, N. Akhtar, et al. (Eds.), *Becoming a word learner: A debate on lexical acquisition* (pp. 115–135). Oxford, UK: Oxford University Press.

Allen, S. W., & Brooks, L. R. (1991). Specializing the operation of an explicit rule. *Journal of Experimental Psychology: General, 120*(1), 3–19.

Aslin, R. N., & Newport, E. L. (2012). Statistical learning: From acquiring specific items to forming general rules. *Current Directions in Psychological Science, 21*(3), 170–176.

Aydede, H., & Robbins, P. (Eds.). (2009). *The Cambridge handbook of situated cognition*. New York: Cambridge University Press.

Bahrick, L. E., Lickliter, R., & Flom, R. (2004). Intersensory redundancy guides the development of selective attention, perception, and cognition in infancy. *Current Directions in Psychological Science, 13*(3), 99–102.

Bannert, M. M., & Bartels, A. (2013). Decoding the yellow of a gray banana. *Current Biology, 23*(22), 2268–2272.

Bar, M. (2004). Visual objects in context. *Nature Reviews Neuroscience, 5*(8), 617–629.

Barrett, L. F. (2006). Emotions as natural kinds? *Perspectives on Psychological Science, 1*, 28–58.

Barrett, L. F. (2009). Variety is the spice of life: A psychological construction approach to understanding variability in emotion. *Cognition and Emotion, 23*(7), 1284–1306.

Barrett, L. F. (2012). Emotions are real. *Emotion, 12*(3), 413–429.

Barrett, L. F. (2013). Psychological construction: A Darwinian approach to the science of emotion. *Emotion Review, 5*, 379–389.

Barrett, L. F., & Bar, M. (2009). See it with feeling: Affective predictions during object perception. *Philosophical Transactions of the Royal Society of London: Biological Sciences, 364*(1521), 1325–1334.

Barrett, L. F., Lindquist, K. A., Bliss-Moreau, E., Duncan, S., Gendron, M., Mize, J., et al. (2007). Of mice and men: Natural kinds of emotions in the mammalian brain? A response to Panksepp and Izard. *Perspectives on Psychological Science, 2*(3), 297–311.

Barrett, L. F., & Simmons, W. K. (2015). Interoceptive predictions in the brain. *Nature Reviews Neuroscience, 16*, 419–429.

Barrett, L. F., Wilson-Mendenhall, C. D., & Barsalou, L. W. (2014). A psychological construction account of emotion regulation and dysregulation: The role of situated conceptualizations. In J. J. Gross (Ed.), *The handbook of emotion regulation* (2nd ed., pp. 447–465). New York: Guilford Press.

Barrett, L. F., Wilson-Mendenhall, C. D., & Barsalou, L. W. (2015). The conceptual act theory: A road map. In L. F. Barrett & J. A. Russell (Eds.), *The psychological construction of emotion* (pp. 83–110). New York: Guilford Press.

Barsalou, L. W. (1987). The instability of graded structure: Implications for the nature of concepts. In U. Neisser (Ed.), *Concepts and conceptual development: Ecological and intellectual factors in categorization* (pp. 101–140). Cambridge, UK: Cambridge University Press.

Barsalou, L. W. (1991). Deriving categories to achieve goals. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 27, pp. 1–64). San Diego, CA: Academic Press.

Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences, 22*(4), 577–609.

Barsalou, L. W. (2003a). Abstraction in perceptual symbol systems. *Philosophical Transactions of the Royal Society of London: Biological Sciences, 358*(1435), 1177–1187.

Barsalou, L. W. (2003b). Situated simulation in the human conceptual system. *Language and Cognitive Processes, 18*, 513–562.

Barsalou, L. W. (2005). Abstraction as dynamic interpretation in perceptual symbol systems. In L. Gershkoff-Stowe & D. Rakison (Eds.), *Carnegie Symposium Series. Building object categories* (pp. 389–431). Mahwah, NJ: Erlbaum.

Barsalou, L. W. (2008a). Grounded cognition. *Annual Review of Psychology, 59*, 617–645.

Barsalou, L. W. (2008b). Situating concepts. In P. Robbins & M. Aydede (Eds.), *Cambridge handbook of situated cognition* (pp. 236–263). New York: Cambridge University Press.

Barsalou, L. W. (2009). Simulation, situated conceptualization, and prediction. *Philosophical Transactions of the Royal Society of London: Biological Sciences, 364*(1521), 1281–1289.

Barsalou, L. W. (2011). Integrating Bayesian analysis and mechanistic theories in grounded cognition. *Behavioral and Brain Sciences, 34*, 191–192.

Barsalou, L. W. (2012). The human conceptual system. In M. J. Spivey, K. McRae, & M. Joanisse (Eds.), *The Cambridge handbook of psycholinguistics* (pp. 239–258). New York: Cambridge University Press.

Barsalou, L. W., Breazeal, C., & Smith, L. B. (2007). Cognition as coordinated non-cognition. *Cognitive Processing, 8*(2), 79–91.

Barsalou, L. W., & Hale, C. R. (1993). Components of coceptual representation: From feature lists to recursive frames. In I. Van Mechelen, J. Hampton, R. Michalski, & P. Theuns (Eds.), *Categories and concepts: Theoretical views and inductive data analysis* (pp. 97–144). San Diego, CA: Academic Press.

Barsalou, L. W., Niedenthal, P. M., Barbey, A., & Ruppert, J. (2003). Social embodiment. In B. Ross (Ed.), *The psychology of learning and motivation* (Vol. 43, pp. 43–92). San Diego, CA: Academic Press.

Barsalou, L. W., Santos, A., Simmons, W. K., & Wilson, C. D. (2008). Language and simulation in conceptual processing. In M. De Vega, A. M. Glenberg, & A. Graesser (Eds.), *Symbols, embodiment, and meaning* (pp. 245–283). Oxford, UK: Oxford University Press.

Barsalou, L. W., & Weimer-Hastings, K. (2005). Situating abstract concepts. In D. Pecher & R. Zwann (Eds.), *Grounding cognition: The role of perception and action in memory, language, and thought* (pp. 129–163). New York: Cambridge University Press.

Bastos, A. M., Usrey, W. M., Adams, R. A., Mangun, G. R., Fries, P., & Friston, K. J. (2012). Canonical microcircuits for predictive coding. *Neuron, 76*(4), 695–711.

Benedict, H. (1979). Early lexical development: Comprehension and production. *Journal of Child Language, 6*, 183–200.

Bergelson, E., & Swingley, D. (2012). At 6–9 months, human infants know the meanings of many common nouns. *Proceedings of the National Academy of Sciences of the United States of America, 109*(9), 3253–3258.

Bloom, L. (1993). *The transition from infancy to language*. New York: Cambridge University Press.

Bretherton, I., & Beeghly, M. (1982). Talking about internal states: The acquisition of an explicit theory of mind. *Developmental Psychology, 18*(6), 906–921.

Bretherton, I., Fritz, J., Zahn-Waxler, C., & Ridgeway, D. (1986). Learning to talk about emotions: A functionalist perspective. *Child Development, 57*, 529–548.

Busse, L., Roberts, K. C., Crist, R. E., Weissman, D. H., & Woldorff, M. G. (2005). The spread of attention across modalities and space in a multisensory object. *Proceedings of the National Academy of Sciences of the United States of America, 102*(51), 18751–18756.

Chaigneau, S. E., Barsalou, L. W., & Zamani, M. (2009). Situational information contributes to object categorization and inference. *Acta Psychologica, 130*(1), 81–94.

Chun, M. M., Golomb, J. D., & Turk-Browne, N. B. (2011). A taxonomy of external and internal attention. *Annual Review of Psychology, 62*, 73–101.

Clark, A. (2006). Language, embodiment, and the cognitive niche. *Trends in Cognitive Sciences, 10*(8), 370–374.

Clark, A. (2013). Whatever next?: Predictive brains, situated agents, and the future of cognitive science. *Behavioral and Brain Sciences, 36*(3), 181–204.

Clore, G. L., & Ortony, A. (2013). Psychological construction in the OCC model of emotion. *Emotion Review, 5*(4), 335–343.

Cohen, L. B., & Amsel, G. (1998). Precursors to infants' perception of the causality of a simple event. *Infant Behavior and Development, 21*(4), 713–731.

Cohen, L. B., Chaput, H. H., & Cashon, C. H. (2002). A constructivist model of infant cognition. *Cognitive Development, 17*(3-4), 1323–1343.

Condon, P., Wilson-Mendenhall, C. D., & Barrett, L. F. (2014). What is a positive emotion?: The psychological construction of pleasant fear and unpleasant happiness. In M. Tugade, M. Shiota, & L. Kirby (Eds.), *The handbook of positive emotion* (pp. 60–81). New York: Guilford Press.

Corbetta, M., Patel, G., & Shulman, G. L. (2008). The reorienting system of the human brain: From environment to theory of mind. *Neuron, 58*(3), 306–324.

Critchley, H. D., & Harrison, N. A. (2013). Visceral influences on brain and behavior. *Neuron, 77*(4), 624–638.

Cunningham, W. A., Dunfield, K. A., & Stillman, P. E. (2014). Emotional states from affect dynamics. *Emotion Review, 5*(4), 344–355.

DeCasper, A. J., & Spence, M. J. (1986). Prenatal maternal speech influences newborns' perception of speech sounds. *Infant Behavior and Development, 9*, 133–150.

Demiralp, E., Thompson, R. J., Mata, J., Jaeggi, S. M., Buschkuehl, M., Barrett, L. F., et al. (2012). Feeling blue or turquoise?: Emotional differentiation in major depressive disorder. *Psychological Science, 23*(11), 1410–1416.

Fehr, B., & Russell, J. A. (1984). Concept of emotion viewed from a prototype perspective. *Journal of Experimental Psychology: General, 113*, 464–486.

Fehr, B., & Russell, J. A. (1991). The concept of love viewed from a prototype perspective. *Journal of Personality and Social Psychology, 60*, 425–438.

Feldman, R. (2007). Parent–infant synchrony and the construction of shared timing: Physiological precursors, developmental outcomes, and risk conditions. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 48*(3-4), 329–354.

Feldman, R., & Greenbaum, C. W. (1997). Affect regulation and synchrony in mother–infant play as precursors to the development of symbolic competence. *Infant Mental Health Journal, 18*(1), 4–23.

Friston, K. (2012). Predictive coding, precision and synchrony. *Cognitive Neuroscience, 3*(3-4), 238–239.

Friston, K., & Kiebel, S. (2009). Predictive coding under the free-energy principle. *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences, 364*(1521), 1211–1221.

Gilhooly, K. J., & Gilhooly, M. L. (1980). The validity of age-of-aquisition ratings. *British Journal of Psychology, 71*, 105–110.

Glenberg, A. M. (1997). What memory is for. *Behavioral and Brain Sciences, 20*(1), 1–19.

Harrison, N. A., Gray, M. A., Gianaros, P. J., & Critchley, H. D. (2010). The embodiment of emotional feelings in the brain. *Journal of Neuroscience, 30*(38), 12878–12884.

Johnson, W. A., & Dark, V. J. (1986). Selective attention. *Annual Review of Psychology, 37*, 43–75.

Kirkham, N. Z., Slemmer, J. A., & Johnson, S. P. (2002). Visual statistical learning in infancy: Evidence for a domain general learning mechanism. *Cognition, 83*(2), B35–B42.

Kleckner, I. R., & Quigley, K. (2014). An approach to mapping the neurophysiological state of the body to affective experience. In L. F. Barrett & J. Russell (Eds.), *The psychological construction of emotion*. New York: Guilford Press.

Klein, R. M. (2000). Inhibition of return. *Trends in Cognitive Sciences, 4*(4), 138–147.

Kopp, C. B. (1989). Regulation of distress and negative emotions: A developmental view. *Developmental Psychology, 25*(3), 243–254.

Kroes, M. C., & Fernandez, G. (2012). Dynamic neural systems enable adaptive, flexible memories. *Neuroscience and Biobehavioral Reviews, 36*(7), 1646–1666.

Kuperman, V., Stadthagen-Gonzalez, H., & Brysbaert, M. (2012). Age-of-acquisition ratings for 30,000 English words. *Behavior Research Methods, 44*(4), 978–990.

Kuppens, P., Van Mechelen, I., Smits, D. J. M., De Boeck, P., & Ceulemans, E. (2007). Individual differences in patterns of appraisal and anger experience. *Cognition and Emotion, 21*(4), 689–713.

Lakoff, G. (1987). *Women, fire, and dangerous things: What categories reveal about the mind*. Chicago: University of Chicago Press.

Lebois, L. A. M., Wilson-Mendenhall, C. D., & Barsalou, L. W. (2015). Are automatic conceptual cores the gold standard of semantic processing?: The context-dependence of spatial meaning in grounded congruency effects. *Cognitive Science, 39*(8), 1764–1801.

Lebois, L. A. M., Wilson-Mendenhall, C. D., Simmons, W. K., Barrett, L. F., & Barsalou, L. W. (2016). *Learning emotions*. Manuscript submitted for publication.

Lindquist, K. A., & Barrett, L. F. (2008). Emotional complexity. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *The handbook of emotion* (pp. 513–530). New York: Guilford Press.

Lindquist, K. A., MacCormack, J. K., & Shablack, H. (2015). The role of language in emotion: Predictions from psychological constructionism. *Frontiers in Psychology, 6*, 444.

Lindquist, K. A., Satpute, A. B., & Gendron, M. (2015). Does language do more than communicate emotion? *Current Directions in Psychological Science, 24*, 99–108.

Lindquist, K. A., Siegel, E. H., Quigley, K. S., & Barrett, L. F. (2013). The hundred-year emotion war: Are emotions natural kinds or psychological constructions? Comment on Lench, Flores, and Bench (2011). *Psychological Bulletin, 139*(1), 255–263.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*(3), 121–143.

Littenberg, R., Tulkin, S. R., & Kagan, J. (1971). Cognitive components of separation anxiety. *Developmental Psychology, 4*(3), 387–388.

Logan, G. D. (1994). Spatial attention and the apprehension of spatial relations. *Journal of Experimental Psychology—Human Perception and Performance, 20*(5), 1015–1036.

McCauley, R. N., & Henrich, J. (2006). Susceptibility to the Muller–Lyer illusion, theory-neutral observation, and the diachronic penetrability of the visual input system. *Philosophical Psychology, 19*(1), 79–101.

Medin, D. L., & Schaffer, M. M. (1978). Context theory of classification learning. *Psychological Review, 85*(3), 207–238.

Mesquita, B., Barrett, L. F., & Smith, E. (Eds.). (2010). *The mind in context*. New York: Guilford Press.

Moll, J., de Oliveira-Souza, R., Moll, F. T., Ignacio, F. A., Bramati, I. E., Caparelli-Daquer, E. M., et al. (2005). The moral affiliations of disgust: A functional MRI study. *Cognitive and Behavioral Neurology, 18*(1), 68–78.

Moors, A., Ellsworth, P. C., Scherer, K. R., & Frijda, N. H. (2013). Appraisal theories of emotion: State of the art and future development. *Emotion Review, 5*(2), 119–124.

Murphy, G. L. (2002). *The big book of concepts*. Cambridge, MA: MIT Press.

Oosterwijk, S., Mackey, S., Wilson-Mendenhall, C., Winkielman, P., & Paulus, M. P. (2015). Concepts in context: Processing mental state concepts with internal or external focus involves different neural systems. *Social Neuroscience, 10*(3), 294–307.

Ortony, A., & Turner, T. J. (1990). What's basic about basic emotions? *Psychological Review, 97*(3), 315–331.

Papies, E. K., & Barsalou, L. W. (2015). Grounding desire and motivated behavior: A theoretical framework and review of empirical evidence. In W. Hofmann & L. F. Nordgren (Eds.), *The psychology of desire* (pp. 36–60). New York: Guildford Press.

Peelen, M. V., & Kastner, S. (2014). Attention in the real world: Toward understanding its neural basis. *Trends in Cognitive Sciences, 18*(5), 242–250.

Petersen, S., Schroijen, M., Molders, C., Zenker, S., & Van den Bergh, O. (2014). Categorical interoception: Perceptual organization of sensations from inside. *Psychological Science, 25*(5), 1059–1066.

Plude, D. J., Enns, J. T., & Brodeur, D. (1994). The development of selective attention: A life-span overview. *Acta Psychologica, 86*, 227–272.

Quigley, K. S., & Barrett, L. F. (2014). Is there consistency and specificity of autonomic changes during emotional episodes?: Guidance from the conceptual act theory and psychophysiology. *Biological Psychology, 98*, 82–94.

Raichle, M. E. (2010). Two views of brain function. *Trends in Cognitive Sciences, 14*(4), 180–190.

Ridgeway, D., Waters, E., & Kuczaj, S. A. (1985). Acquisition of emotion–descriptive language: Receptive and productive vocabulary norms for ages 18 months to 6 years. *Developmental Psychology, 21*(5), 901–908.

Rosch, E. H., & Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. *Journal of Experimental Psychology: General, 7*, 573–605.

Russell, J. A. (1991). In defense of a prototype approach to emotion concepts. *Journal of Personality and Social Psychology, 60*, 37–47.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*(1), 145–172.

Russell, J. A., & Fehr, B. (1994). Fuzzy concepts in a fuzzy hierarchy: Varieties of anger. *Journal of Personality and Social Psychology, 67*(2), 186–205.

Saffran, J. R., Aslin, R. N., & Newport, E. L. (1996). Statistical learning by 8-month-old infants. *Science, 274*(5294), 1926–1928.

Schmid, H.-J. (2000). *English abstract nouns as conceptual shells: From corpus to cognition*. Berlin: Mouton de Gruyter.

Schyns, P. G., Goldstone, R. L., & Thibaut, J. P. (1998). The development of features in object concepts. *Behavioral and Brain Sciences, 21*(1), 1–17, discussion 17–54.

Seth, A. K., & Critchley, H. D. (2013). Extending predictive processing to the body: Emotion as interoceptive inference. *Behavioral and Brain Sciences, 36*(3), 227–228.

Shipp, S., Adams, R. A., & Friston, K. J. (2013). Reflections on agranular architecture: Predictive coding in the motor cortex. *Trends in Neurosciences, 36*(12), 706–716.

Smith, L. B., Suanda, S. H., & Yu, C. (2014). The unrealized promise of infant statistical word–referent learning. *Trends in Cognitive Sciences, 18*(5), 251–258.

Smith, L. B., & Yu, C. (2008). Infants rapidly learn word–referent mappings via cross-situational statistics. *Cognition, 106*(3), 1558–1568.

Suvak, M. K., Litz, B. T., Sloan, D. M., Zanarini, M. C., Barrett, L. F., & Hofmann, S. G. (2011). Emotional granularity and borderline personality disorder. *Journal of Abnormal Psychology, 120*(2), 414–426.

Tincoff, R., & Jusczyk, P. W. (1999). Some beginnings of word comprehension in 6-month-olds. *Psychological Science, 10*(2), 172–175.

Tincoff, R., & Jusczyk, P. W. (2012). Six-month-olds comprehend words that refer to parts of the body. *Infancy, 17*(4), 432–444.

Tomasello, M. (1992). The social bases of language aquisition. *Social Development, 1*(1), 67–87.

Tracy, J. L., & Randles, D. (2011). Four models of basic emotions: A review of Ekman and Cordaro, Izard, Levenson, and Panksepp and Watt. *Emotion Review, 3*(4), 397–405.

Treisman, A. M. (1969). Strategies and models of selective attention. *Psychological Review, 76*(3), 282–299.

Treisman, A. M. (1998). Feature binding, attention and object perception. *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences, 353*(1373), 1295–1306.

Tugade, M. M., Fredrickson, B. L., & Barrett, L. F. (2004). Psychological resilience and positive emotional granularity: Examining the benefits of positive emotions on coping and health. *Journal of Personality, 72*(6), 1161–1190.

Turk-Browne, N. B. (2012). Statistical learning and its consequences. *Nebraska Symposium on Motivation, 59*, 117–146.

Vetter, P., & Newen, A. (2014). Varieties of cognitive penetration in visual perception. *Consciousness and Cognition, 27*, 62–75.

Vigliocco, G., Meteyard, L., Andrews, M., & Kousta, S. (2009). Toward a theory of semantic representation. *Language and Cognition, 1*(2), 219–247.

Voegtline, K. M., Costigan, K. A., Pater, H. A., & DiPietro, J. A. (2013). Near-term fetal response to maternal spoken voice. *Infant Behavior and Development, 36*(4), 526–533.

von dem Hagen, E. A., Beaver, J. D., Ewbank, M. P., Keane, J., Passamonti, L., Lawrence, A. D., et al. (2009). Leaving a bad taste in your mouth but not in my insula. *Social Cognitive and Affective Neuroscience, 4*(4), 379–386.

Wellman, H. M., Harris, P. L., Banerjee, M., & Sinclair, A. (1995). Early understanding of emotion: Evidence from natural language. *Cognition and Emotion, 9*(2/3), 117–149.

Widen, S. C., & Russell, J. A. (2008). Children acquire emotion categories gradually. *Cognitive Development, 23*, 291–312.

Widen, S. C., & Russell, J. A. (2010). Differentiation in preschooler's categories of emotion. *Emotion, 10*(5), 651–661.

Wilson-Mendenhall, C. D., Barrett, L. F., & Barsalou, L. W. (2013). Situating emotional experience. *Frontiers in Human Neuroscience, 7*, 764.

Wilson-Mendenhall, C. D., Barrett, L. F., & Barsalou, L. W. (2015). Variety in emotional life: Within-category typicality of emotional experiences is associated with neural activity in large-scale brain networks. *Social Cognitive and Affective Neuroscience, 10*(1), 62–71.

Wilson-Mendenhall, C. D., Barrett, L. F., Simmons, W. K., & Barsalou, L. W. (2011). Grounding emotion in situated conceptualization. *Neuropsychologia, 49*(5), 1105–1127.

Wilson-Mendenhall, C. D., Simmons, W. K., Martin, A., & Barsalou, L. W. (2013). Contextual processing of abstract concepts reveals neural representations of nonlinguistic semantic content. *Journal of Cognitive Neuroscience, 25*(6), 920–935.

Wu, L. L., & Barsalou, L. W. (2009). Perceptual simulation in conceptual combination: Evidence from property generation. *Acta Psychologica, 132*(2), 173–189.

Yeh, W., & Barsalou, L. W. (2006). The situated nature of concepts. *American Journal of Psychology, 119*(3), 349–384.

Yoshida, H., & Smith, L. B. (2005). Linguistic cues enhance the learning of perceptual cues. *Psychological Science, 16*(2), 90–95.

Zwaan, R. A., & Madden, C. J. (2004). Updating situation models. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*(1), 283–288.

Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin, 123*(2), 162–185.

CHAPTER 33

MEMORY AND EMOTION

Elizabeth A. Kensinger and Daniel L. Schacter

Although the concept of memory has existed for thousands of years, its systematic study was launched in the 1880s by the seminal experiments of the German philosopher Hermann Ebbinghaus (1885/1962). Through careful assessments of his own memory, Ebbinghaus forged the way for the field of memory research by demonstrating that humans' ability to retain information over time could be studied scientifically. It is telling that Ebbinghaus's studies involved the intentional memorization of nonsense syllables: He believed that to understand memory processes, one should study retention of information void of meaning or personal importance. Although memory researchers seemed to embrace Ebbinghaus's views on this issue for nearly a century, recent decades have seen increased emphasis on examining memory for personally important experiences and for events that evoke emotional reactions.

Throughout this chapter, we use terms like "emotional stimuli" as a shorthand to denote information in the environment that elicits a rapid change in the internal, affective state of the organism. The focus of this chapter is on how these internal changes influence memory. Affective responses are often described within a two-dimensional space consisting of arousal (the subjective feeling of excitation or the physiological response evoked) and valence (the pleasure or displeasure experienced; see Feldman Barrett & Russell, 1999; Russell, 1980). In this chapter, we focus on episodic memory, or consciously accessible memories of past events. We first describe how the arousal of a response can affect memory, and we then describe how the valence of an affective response can affect the way the event is remembered.

We consider how each of these aspects of an affective response can influence the likelihood of remembering an event, the vividness with which the event is remembered, and the details retained about the event. In each section, we present the behavioral data and cognitive theories of emotional memory, and we also discuss the relevant neuroimaging and neuropsychological research that has been influential in examining the extent to which memory for emotional experiences is supported by processes distinct from those that support memory for nonemotional events. The neuroimaging studies also have helped to pinpoint the effects of an affective response on the initial creation of a mnemonic representation and on the eventual retrieval of that information. We highlight the general conclusions that have emerged from the research, and note some of the ongoing debates and open questions that remain.

The Influence of Emotional Arousal on Episodic Memory

Not all memories come to mind with equal ease. Moments that elicit arousal often are remembered disproportionately well, with higher recall rates for positive arousing or negative arousing stimuli than for neutral stimuli (reviewed by Buchanan & Adolphs, 2002; Hamann, 2001). This finding was anticipated by William James (1890) when he stated, "An experience may be so exciting emotionally as almost to leave a scar upon the cerebral tissues" (p. 670), and the propensity to remember arousing experiences has been documented across a variety of experiments, using words, sentences, pictures, narrated slide shows, and autobiographical memories (reviewed by Berntsen & Rubin, 2002; Buchanan, 2007). These benefits can be particularly pronounced when examining a person's ability to remember information over long delays (Quevedo, Sant'Anna, & Madruga, 2003; Revelle & Loftus, 1992), likely because of the cumulative effects of emotion on both the encoding and also the consolidation phases of memory.

Although the enhancement of memory by arousal is not always seen in the quantity of information retrieved (see Bennion, Ford, Murray, & Kensinger, 2013, for a discussion), in many of these instances there are still other signatures of memory enhancement present, such as an increased feeling of reexperience or memory vividness. In this section, we examine the processes that give rise to memories for arousing experiences, first presenting behavioral evidence that high-arousal information is more likely to be remembered with subjective vividness and with select details, and then describing the encoding and retrieval processes that may convey those benefits.

Emotional Arousal Enhances Memory Vividness

People claim to remember where they were and what they were doing when they learned of the assassination of President Kennedy (Brown & Kulik, 1977; Christianson, 1989; Winograd & Killinger, 1983), the September 11th terrorist attacks (Budson et al., 2004; Hirst et al., 2009; Paradis, Solomon, Florer, & Thompson, 2004; Pezdek, 2003; Smith, Bibi, & Sheard, 2003), or the explosion of the space shuttle *Challenger* or *Columbia* (Bohannon, 1988; Kensinger, Krendl, & Corkin, 2006; Neisser & Harsch, 1992). These details are not always accurate (as we expand upon later in this section), but what remains noteworthy about the memories is that individuals reexperience them with tremendous vividness. Memory for these arousing events is more likely to be associated with the autonoetic consciousness that defines an episodic memory (Tulving, 1985).

Extremely vivid memories—coined "flashbulb memories" by Brown and Kulik (1977)—form only rarely, yet many studies have confirmed that individuals often remember emotionally arousing stimuli in a more vivid manner than nonarousing stimuli (e.g., Conway, 1990; Kensinger & Corkin, 2003; Rubin & Kozin, 1984; Schaefer & Philippot, 2005). Even for "micro-events" or stimuli presented relatively briefly within a laboratory setting, when individuals are asked not only whether they recognize having seen those micro-events before, but also whether they vividly "remember" their prior occurrence, rates of "remembering" tend to be much higher for arousing pictures or words than for nonemotional ones (Dewhurst & Parry, 2000; Kensinger & Corkin, 2003; Ochsner, 2000; Sharot, Delgado, & Phelps, 2004). This boost in the ability to vividly remember emotional information often occurs even when overall recognition rates are equivalent for emotional and neutral information (e.g., Ochsner, 2000; Sharot et al., 2004).

Emotional Arousal Leads to Selective Memory Benefits

It is important to emphasize that arousal leads to *selective* memory benefits. Although arousing events are typically remembered more vividly than nonarousing events, they are not remembered with complete detail (e.g., Levine & Edelstein, 2009; Mather & Sutherland, 2011; Phelps & Sharot, 2008). Some details are likely "lost" during the initial processing of the event, never becoming part of a memory representation. Even Brown and Kulik (1977) realized that arousal does not lead to a memory that is truly picture-perfect, because some aspects of the event might never be recorded. They stated, "An actual photograph, taken by flashbulb, preserves everything within its scope; it is altogether indiscriminate . . . a flashbulb memory is only somewhat indiscriminate and is very far from complete. In these respects, it is unlike a photograph" (p. 75). Other details appear to be encoded at the time of an event's occurrence and then later forgotten or distorted. While Brown and Kulik (1977) believed that recollections of surprising and consequential events would be immune to memory distortion or disruption, such that all the information that was encoded would be maintained in memory, numerous studies since have demonstrated that emotional memories are prone to significant forgetting and distortions over time. Individuals often report high confidence in so-called flashbulb memories despite low consistency in their reports over time, and there often is little or no correlation between how confident individuals are about their memories and how accurate or consistent their memories are (Neisser & Harsch, 1992; Schmidt, 2004; Schmolck, Buffalo, & Squire, 2000; Talarico & Rubin, 2003). Clearly, emotional events do not leave indelible traces.

Some have argued that arousal provides no benefit to memory for detail, enhancing the *feeling* of vividness without elevating the *amount of content* included in the memory trace (e.g., Sharot et al., 2004). As evidence has accumulated, however, a more likely proposal seems to be that arousal provides *selective* memory benefits. It does not enable the formation of a memory that includes all event details; rather, it increases the likelihood that select components of an experience are remembered. Debates still continue about how best to characterize the event features that are most likely to be incorporated into a memory for an arousing event (e.g., Kensinger, 2009; Mather & Sutherland, 2011). As reviewed by Levine and Edelstein (2009), these details have been described as those that capture attention; are perceptually, temporally, or conceptually integral to the emotional event; or are goal relevant (see Levine & Edelstein, 2009, table 1, p. 13). What is generally agreed upon, however, is that arousal leads to enhanced memory for some select details from the event and not others.

If arousal leads only to selective memory benefits, then the disconnection between an individual's reported confidence or vividness in a memory and the objective assessments of his or her retrieval of detail may stem from two primary factors. First, individuals may ascribe vividness or confidence not only by the number of details remembered but also by the richness or ease with which some details come to mind (see Phelps & Sharot, 2008, for a discussion). Thus, if some details come to mind easily or vividly, an individual may give a high vividness rating to the memory as a whole, or may even give an inflated rating for other event details, assuming that all event details have been retained well. Second, for many events, arousal may play a larger role in the maintenance of internal details, such as the affect experienced at the time of the event, and a lesser role in the maintenance of details that can be objectively measured, such as where, when, and how an event unfolded. Participants may report a vivid memory based on their retention of internal details, yet these internal details may provide little aid in answering questions about the objective details of the event.

The Neural Mechanisms through Which Emotional Arousal Enhances Memory

When Brown and Kulik (1977) first described "flashbulb memory," they linked these memories to Robert Livingston's (1967) "now print" theory, proposing that there was a special memory mechanism that was induced for these events, permanently "printing" them into an accessible memory trace. Perhaps because of this history, researchers have focused intensively on whether arousal enhances memory via the engagement of special mechanisms, or whether arousal simply intensifies the same processes that allow vivid remembering of nonarousing information. Although parsimony favors the hypothesis that the same processes are recruited to remember arousing and nonarousing information, there is evidence that arousal may trigger a cascade of processes not typically engaged for nonarousing information. Behavioral evidence for such a distinction comes from studies that have asked participants to encode arousing and nonarousing information while performing a secondary task. For example, Kensinger and Corkin (2004) asked participants to study words either with full attention devoted toward the encoding task or with attention divided between the encoding task and a secondary, sound-discrimination task. The addition of the secondary task impaired the likelihood of recognizing nonarousing words and reduced the vividness with which the nonarousing words were remembered, whereas it did not have a large effect on the recognition rates or vividness of memories for the arousing words (see also Bush & Geer, 2001). This finding is consistent with proposals that emotional information is privy to prioritized or relatively automatic processing (reviewed by Dolan & Vuilleumier, 2003) and suggests that arousal can modulate memory even in the absence of the elaborative processes that typically enhance memory.

Lesion studies suggest that many of the effects of arousal are critically tied to the engagement of the amygdala, an almond-shaped region of the medial temporal lobe. Patients with damage to the amygdala do not show a memory boost for arousing information: Although they are not amnesic, they are no more likely to remember arousing events than they are to remember neutral ones. The absence of the memory enhancement for arousing information has been reported in patients with focal amygdala damage (e.g., Adolphs, Cahill, Schul, & Babinsky, 1997; Brierley, Medford, Shaw, & David, 2004; Cahill, Babinsky, Markowitsch, &

McGaugh, 1995; Markowitsch et al., 1994) and in individuals with amygdala atrophy caused by Alzheimer's disease (e.g., Abrisqueta-Gomez, Bueno, Oliveira, & Bertolucci, 2002; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; Kensinger, Anderson, Growdon, & Corkin, 2004).

The amygdala-mediated effects of emotion on memory seem to be tied to noradrenaline release. Adrenergic agonists enhance memory (Soetens, Casaer, D'Hooge, & Hueting, 1995), adrenergic blockade reduces memory (Cahill, Prins, Weber & McGaugh, 1994; Strange & Dolan, 2004), and individuals with a genetic variant that is thought to increase the availability of noradrenaline show a greater enhancement of emotional memory (de Quervain et al., 2007). The effects of adrenergic modulation on memory are particularly pronounced for emotional information (e.g., Segal & Cahill, 2009)—and in fact, are often absent for neutral information—possibly because amygdala activity in the absence of noradrenaline is insufficient to modulate hippocampal activity (Anderson, Yamaguchi, Grabski, & Laeka, 2006; Onoda, Okamoto, & Yamawaki, 2009; Segal, Stark, Kattan, Stark, & Yassa, 2012).

While these studies have demonstrated the necessary contribution of the combination of adrenergic responses and amygdala engagement to arousal-mediated memory enhancements, neuroimaging methods have provided further clarity with regard to the stages of memory at which arousal yields its effects. Researchers can examine the neural processes engaged at the moment that a subsequently remembered stimulus is processed, or can assess the processes engaged at the moment of retrieval. Neuroimaging studies can also elucidate the extent of overlap between the processes that give rise to memories for arousing stimuli and those that support memories for nonarousing information.

Encoding Processes Contributing to Memory for Arousing Events

Neuroimaging studies using a subsequent-memory design, sorting neural engagement during encoding on a post hoc basis into subsequently remembered and subsequently forgotten stimuli (e.g., Wagner et al., 1998), have demonstrated that the amygdala plays a fundamental role during the encoding of high-arousal information. Amygdala activity is stronger for arousing items that are subsequently remembered than for items that are subsequently forgotten (reviewed by Hamann, 2001; Phelps, 2004; Kensinger, 2009). Moreover, the individuals who show the greatest amygdala activity during the viewing of arousing items are those who show the greatest emotional memory enhancement (Cahill et al., 1996) and remember arousing stimuli vividly (Kensinger & Corkin, 2004). For nonarousing stimuli, amygdala activity at encoding typically does not relate to memory (e.g., Kensinger & Corkin, 2004), suggesting that the amygdala guides memory only in the presence of an arousal response.

It is important to note that activation of the amygdala leads to *selective* memory benefits. Amygdala activation during encoding does not enable the formation of a memory that includes all event details; rather, it increases the likelihood that select components of an experience are remembered (reviewed by Kensinger, 2009). Amygdala activity tracks with the likelihood of remembering the emotional content from a scene (e.g., a snake) but not with the ability to remember the nonemotional context within that scene (e.g., the forest in which the snake was located; Waring & Kensinger, 2011) or with other contextual details such as the encoding task participants performed while viewing a scene (Dougal, Phelps, & Davachi, 2007; Kensinger & Schacter, 2006a; Kensinger, Addis, & Atapattu, 2011).

Although the amygdala only enhances memory for select event details, its activity at encoding does tend to correlate with a vivid memory upon subsequent retrieval. Amygdala activity during encoding corresponds with the likelihood that people will claim to vividly "remember" an event (Dolcos, LaBar, & Cabeza, 2004; Kensinger & Corkin, 2004; Mickley & Kensinger, 2008), and the greater the amygdala activity during encoding, the greater the vividness that people will later ascribe to an emotional memory (Kensinger et al., 2011).

Arousal does, then, lead to some "special" memory mechanisms, insofar as the relation between the amygdala and memory performance is specific to arousing stimuli. The amygdala, however, does not act in isolation and does not appear to store the memories for arousing information, as evidenced by the fact that amygdala damage does not lead to amnesia (Zola-Morgan, Squire, Alvarez-Royo, & Clower, 1991). Instead, the amygdala appears to exert its influence largely through its modulation of other regions, most of which are implicated in the processing and retention of nonarousing stimuli as well. It has long been proposed that the amygdala interacts with regions of the cortex to modulate memory (Gerard, 1961). The amygdala is one of the most extensively connected subcortical regions of the brain, with links to numerous cortical and subcortical regions (Amaral, Price, Pitkanen, & Carmichael, 1992; Amaral, 2003). It is, therefore, in an excellent position to modulate functioning throughout many networks. A meta-analysis of emotional memory encoding (Murty, Ritchey, Adcock, & LaBar, 2010) emphasized the role of not only the amygdala, but also other medial temporal lobe regions typically implicated in successful encoding, including the hippocampus and parahippocampal gyrus, as well as the visual, prefrontal, and parietal cortices.

Lesion and neuroimaging evidence have confirmed that the amygdala can modulate the functioning of the sensory cortices. In one study investigating the links between amygdala activity and visual attention, patients with varying amounts of amygdala damage were scanned while they performed a task in which they had to attend to fearful or neutral faces (Vuilleumier, Richardson, Armony, Driver, & Dolan, 2004). Individuals with intact amygdala showed enhanced activity in the fusiform gyrus (a visual processing region) when they attended to fearful faces as compared with neutral faces. Patients with extensive amygdala damage did not show this pattern: They showed equivalent fusiform activity for neutral and fearful faces. Moreover, the amount of amygdala preservation corresponded with the amount of fusiform modulation based on the emotional content of the attended faces. These results suggest that the amygdala can modulate visual processing in humans, increasing the likelihood that an emotional item in the environment is detected and attended.

In addition to these influences on sensory processes, a number of neuroimaging studies have provided evidence for amygdalar modulation of mnemonic processes, suggesting that interactions between the amygdala and the hippocampus serve a critical role in modulating the memory enhancement for emotional information in humans (reviewed by McGaugh, 2013). In healthy individuals, there are strong correlations between the amount of activity in the amygdala and in the hippocampus during the encoding of emotional information (e.g., Dolcos et al., 2004; Hamann, Ely, Grafton, & Kilts, 1999; Kensinger & Corkin, 2004; Kensinger & Schacter, 2005a). Although these correlations cannot speak to the direction of modulation, a neuroimaging study examining encoding-related neural activity in patients with varying amounts of amygdala and hippocampal damage provided evidence for the importance of reciprocal connections. While in the scanner, patients were asked to encode a series of emotionally aversive and neutral words. Outside of the scanner they performed a recognition task and the encoding trials were sorted on a post hoc basis into those words that were later remembered and those that were later forgotten. The critical finding from the study was that the extent of amygdala atrophy correlated negatively with the magnitude of activity in the hippocampus during the encoding of emotional information, and the amount of hippocampal atrophy also was inversely related to amygdala activity (Richardson, Strange, & Dolan, 2004). Thus, bidirectional connections between the amygdala and the hippocampal system may be important for modulating the encoding of emotional information (see also Kilpatrick & Cahill, 2003).

Ongoing research continues to distinguish the effects triggered by each component of an arousal response, including effects on visual attention and sensory modulation by the amygdala (Dolan & Vuilleumier, 2003; Talmi, Anderson, Riggs, Caplan, & Moscovitch, 2008), and interactions between the amygdala and the hippocampus (reviewed by McGaugh, 2004; Phelps, 2004). The relative contribution of each may also depend on the delay after which memory is being assessed. A long-lasting memory results from a cascade of processes, begun during the initial encoding of the event, and continued as the event is consolidated in memory (Mueller & Pilzecker, 1900). The ultimate effects of arousal on memory, therefore, reflect a culmination of the processes engaged both as the event is initially experienced and in the time that intervenes until retrieval. An active topic of current research is to understand how the effects of arousal on memory unfold over this time course. For instance, Talmi and colleagues (2008) reported that interactions between the amygdala and fusiform gyrus during encoding may explain why emotional information is remembered well after shorter delays, whereas interactions between the amygdala and regions of the hippocampal system may become more important for explaining the enhancement in memory for emotional information after longer delays.

Retrieval Processes Contributing to Memory for Arousing Events

Arousal continues to affect memory through its influences at the moment of retrieval. Just a decade ago, it was unclear whether the amygdala was activated during the retrieval of arousing events (see Damasio et al., 2000; Reiman et al., 1997), but since then, evidence has accumulated to implicate the amygdala in the retrieval of arousing experiences (Daselaar et al., 2008; Dolcos, LaBar, & Cabeza, 2005; Fink, Markowitsch, & Reinkemeier, 1996; Kensinger & Schacter, 2005b; Markowitsch et al., 2000; Greenberg et al., 2005). Just as during encoding, enhanced connectivity between the amygdala and the hippocampus may aide in the retrieval of arousing events (Dolcos et al., 2005; Greenberg et al., 2005; Sharot et al., 2004; see also Addis, Moscovitch, Crawley, & McAndrews, 2004).

In an attempt to better pinpoint the nature of the contribution of amygdala engagement to retrieval, some neuroimaging research has used a protracted retrieval trial to distinguish the *search* phase, as a person attempts to retrieve content related to an internal or external cue and to monitor the success of the attempts, from the *elaboration* phase, as a person expands upon the content retrieved. Enhanced amygdala activity appears to aid the recovery of information during the search phase (Daselaar et al., 2008; see also Markowitsch et al., 2000), with amygdala activity occurring early on, even before people retrieve a memory in full. The hippocampus is also more strongly engaged during the search for an emotional event compared with a neutral event (Daselaar et al., 2008; Ford, Morris, & Kensinger, in press); this difference arises even when the retrieval cue is always neutral (Ford et al., in press), suggesting that hippocampal activity is modulated by the emotional content of the information that is associated with a cue, even before that information has been fully recovered.

The role of the amygdala may extend beyond that initial search phase, to enhance the feeling of reexperience (Sharot et al., 2004). Amygdala activity is greater when people are asked to remember the emotional content of an event as compared with other event details (Smith, Stephan, Rugg, & Dolan, 2006). Amygdala activity is also greater in individuals who have stronger emotion associated with a retrieval cue (Sharot et al., 2004), and the amygdala activity correlates with the degree of reported reexperience of the event (Denkova, Dolcos, & Dolcos, 2013). Just as remembering a sound can reactivate auditory cortex (e.g., Buckner & Wheeler, 2001), so might remembering an emotion reactivate the amygdala.

A study that investigated emotional memory in patients with amygdala damage supports the conclusion that the amygdala is involved in both memory search and also in the reexperience of emotion (Buchanan, Tranel, & Adolphs, 2005). Patients with and without amygdala damage were asked to recall events that occurred prior to their brain damage. Because the medial temporal lobes had been intact at the time of the event and for some period of time thereafter, atypical features of their memory were likely to be connected to the retrieval phase rather than to the encoding or initial consolidation phases (although contributions of long-lasting consolidation processes cannot be ruled out). The patients with amygdala damage were less likely to retrieve memories of unpleasant events, and when they did retrieve those unpleasant events, they rated them as less intense. These findings are consistent with the neuroimaging evidence that the amygdala helps with the search and recovery of arousing memories (such that amygdala damage reduces the likelihood that arousing events will be remembered) and also participates in the reexperience of emotion during retrieval (such that the intensity of reexperienced affect is reduced with amygdala damage).

As during encoding, the amygdala engagement during retrieval is likely to modulate many processes, not only those within the medial temporal lobe. Arousing events are often associated with more retrieval activity within visual cortices (Piefke, Weiss, Zilles, Markowitsch, & Fink, 2003; Van Strien, Langeslag, Strekalova, Gootjes, & Franken, 2009), perhaps reflecting the recovery of sensory information, and within frontal regions, perhaps reflecting the thematic elaboration or online maintenance and reliving of the event (see Daselaar et al., 2008; Greenberg et al., 2005, for more discussion).

Summary of Effects of Arousal on Memory

Arousal often enhances the likelihood of remembering an event and, even when it does not affect this quantitative assessment of memory, it still tends to alter the subjective quality of memory. Memories of high-arousal experiences tend to be more vivid than memories of low-arousal events. These effects of arousal seem critically tied to the combined activation of the adrenergic system and engagement of the amygdala during the initial encoding of an event. This combination enables the modulation of the hippocampal memory system as well as prefrontal and sensory cortices, enhancing the likelihood that a memory is created and that the trace includes some types of details that will enable the recovery of a rich memory trace. The amygdala participates in retrieval as well, and it appears that the amygdala may again modulate these same systems to aid in the search and recovery of information from memory.

The Influence of Emotional Valence on Episodic Memory

Although some of the research examining the effects of arousal on memory has focused only on negative high-arousal stimuli and has excluded positive information, the general pattern of results discussed in the previous section has been found to hold for all high-arousal stimuli, regardless of their valence. A topic of ongoing investigation is the extent to which the valence of an event (whether it elicits positive or negative affect) influences the memory for that event. To assess the effects of valence, researchers often have contrasted memory for positive and negative stimuli, rated to be equally high in arousal. If different memory patterns are associated with the positive and the negative events, then these differences have been attributed to the valence of the events. In the sections below, we outline what this research has revealed about the effects of valence on the likelihood of remembering an event and on the quality of the memory. We also describe the neural mechanisms that may relate to these effects of valence.

Effects of Valence on the Quantity and Quality of Information Remembered

When examining the effects of valence on the likelihood of remembering information, virtually every conceivable outcome has been observed. Often, the boost in recall or recognition is comparable for positive and negative stimuli (e.g., Adelman & Estes, 2013; Bradley, Greenwald, Petry, & Lang, 1992; Kensinger et al., 2002). In some studies, particularly those assessing memory for verbal or pictorial stimuli presented within a laboratory setting, negative items are more likely to be recalled than positive ones (e.g., Keightley, Chiew, Anderson, & Grady, 2011). Yet other studies, generally those assessing memory for autobiographical experiences or information encoded in reference to the self, have revealed the opposite pattern: a greater tendency to recall positive events than negative ones (e.g., D'Argembeau, Comblain, & van der Linden, 2005; Linton, 1975; Matt, Vazquez, & Campbell, 1992; White, 2002), sometimes referred to as the *Pollyanna effect* (Matlin & Stang, 1978).

Some of these conflicting findings may be explained by the proposal that memory mechanisms have evolved to facilitate the encoding and retrieval of the affective information that is most relevant to one's goals (Lazarus, 1991; LeDoux, 1996). Remembering a negative experience often may be relevant to survival (see Nairne, Pandeirada, & Thompson, 2008, for evidence that memory is better for survival-relevant information) or well-being, because reexperiencing the event will help a person plan for (or avoid) its future reoccurrence (LeDoux, 1996). In these instances, more attention may be paid to the negative item, thereby enhancing memory for this negative information. However, there likely are instances in which positive events are just as relevant, or more relevant, to one's goals as negative events. Indeed, when positive and negative stimuli are equally related to one's current concerns, they show similar capture of attention (Riemann & McNally, 1995). Furthermore, there is some evidence that individuals (e.g., older adults) who seek positive goal states show enhanced attention toward positive as compared with negative stimuli and also enhanced memory for positive events (reviewed by Mather & Carstensen, 2005).

For autobiographical memories, a related possibility is that there is a memory benefit for the valence of information most likely to be processed in a self-referential fashion. Positive experiences may be more likely to be integrated into a person's conception of themselves (see Matlin & Stang, 1978) and, thus, to be remembered. Negative experiences may be better remembered when individuals are focused instead on other-perception rather than on self-referential processing (e.g., Dreben, Fiske, & Hastie, 1979; Skowronski & Carlston, 1987), or when individuals are depressed and, therefore, have a more negative self-concept (Dalgleish & Watts, 1990).

The findings discussed so far suggest that the differential effects of valence may be mediated by effects separate from the affective response. These findings emphasize the need to consider more than just arousal when examining the influence of positive and negative affect on memory. If positive and negative experiences differ in their self-relevance or in their relation to an individual's motivational state or goals, then these differences could underlie effects that would otherwise be attributable to valence. Indeed, recent debates center on whether valence—or other factors often connected to valence—best explain the effects on memory (see

Sakaki, Niki, & Mather, 2012; Levine & Edelstein, 2009).

There is evidence, however, to suggest that the valence of a response may directly influence the way in which an event is processed and remembered. According to the "affect-as-information" framework (e.g., Schwarz & Clore, 1983, 1988, 1996; Clore et al., 2001), the way we feel can alter the way that we process information. Positive affect may promote the reliance on heuristic schemas (see Mandler, 1984; Rumelhart, 1980, for discussion of schemas), on gist-based information, and on broadly activated associative networks (see Fredrickson, 2004, for a related "broaden-and-build" theory of positive affect; and Shenhav, Barret, & Bar, 2013, for a proposal that this relation between positivity and associativity may relate to the role of the medial orbitofrontal cortex in both of these abilities). Thus, when in a good mood, we may notice the global characteristics or "big picture" of an event (e.g., Clore et al., 2001; Fiedler, 2001). Negative affect, by contrast, may elicit a greater focus on the details around us; it may narrow our attention onto those details, at times causing us to lose sight of the "big picture" (Schwarz, 1990; Storbeck, 2013; Wegner & Vallacher, 1986).

These different ways we process information can have downstream impacts on how we remember events that elicited positive or negative affect. While they may not affect the likelihood that we remember the event's occurrence, they are likely to influence the types of details we retain about the events. Thus, effects of valence may become more apparent when we switch from assessments of the likelihood of remembering an event to assessments of the subjective vividness of an event or the details that are remembered.

A number of studies have suggested that the valence of the response elicited by the event does influence the subjective vividness of the memory. Negative events often are remembered with a greater sense of vividness than positive events (e.g., Ochsner, 2000; Dewhurst & Parry, 2000). Positive stimuli, in contrast, often are remembered with only a feeling of familiarity (e.g., Ochsner, 2000; Bless & Schwarz, 1999). Valence can also influence the likelihood that details are accurately remembered. Although the exact nature of these findings remains debated (see Kensinger, 2009), negative information may be more likely to be remembered with some types of details than positive information, perhaps because attention is focused on some details of the negative experiences.

It has been unclear to what extent these laboratory findings extend to autobiographical events infused with emotional importance. Research on autobiographical memory often has supported the opposite conclusion from laboratory research: that positive memories are more vivid than negative ones (e.g., D'Argembeau, Comblain, & van der Linden, 2003; Schaefer & Philippot, 2005). For example, Schaefer and Philippot (2005) asked participants to recall positive, negative, and neutral events and, for each, to rate the number of sensory, semantic, temporal, and contextual associations retrieved about the memory (using the Memory Characteristics Questionnaire; Johnson, Foley, Suengas, & Raye, 1988). They found that participants' ratings were higher for positive than for negative memories, indicating greater retrieval of contextual detail for positive events. However, some studies suggest little effect of valence on memory vividness, and instead have found intensity to be the primary predictor of autobiographical memory characteristics (e.g., Talarico, LaBar, & Rubin, 2004).

A difficulty in these studies is finding positive and negative events that are comparable across a range of event dimensions (e.g., duration of event, public or private nature of event, amount of media coverage or rehearsal). Four studies have attempted to circumvent many of these difficulties by examining whether a person's response to an event outcome (finding it positive or negative) influences what he or she remembers about the event. Levine and Bluck (2004) asked participants to indicate whether particular events had occurred during the verdict decision in the O. J. Simpson trial. Kensinger and Schacter (2006b) examined what Red Sox fans and Yankees fans remembered about the final game of the 2004 playoff series, in which the Red Sox overcame a surprising 0–3 setback in the series to win the championship. Bohn and Berntsen (2007) asked individuals to retrospectively rate their emotions and recall details regarding the fall of the Berlin Wall. Holland and Kensinger (2012) asked participants to remember details about the 2008 presidental election. All four studies found that valence affected some memory characteristics, with negative affect being more likely to enhance memory accuracy or memory for detail. Levine and Bluck (2004) found that individuals who were happy about the verdict were more liberal in accepting that something had occurred and made more memory errors than individuals who were unhappy with the verdict. Similarly, Kensinger and Schacter (2006b) found that Red Sox fans, who found the outcome of the game to be positive, showed more memory inconsistencies over a 6-month period and were more likely to be overconfident in their memories than were Yankees fans, who found the outcome to be negative. In line with the suggestion that negative emotion might be linked to enhanced memory for details, Bohn and Berntsen (2007) found that those individuals who reported feeling negative about the fall of the Berlin Wall had higher memory accuracy than indivdiuals who felt positive about the event. Holland and Kensinger (2012) similarly found that participants who were displeased with the outcome of the 2008 election remembered more details of the election night consistently over the next 6 months than those who were pleased with the outcome.

Studies that have induced participants into positive or negative moods within a laboratory setting generally have corroborated these findings. Participants are more liberal in endorsing items as ones that they have studied when they are in a good mood, and they are more susceptible to false memories when in that pleasant state (Bless et al., 1996; Park & Banaji, 2000; Storbeck & Clore, 2005). Negative mood, by contrast, makes individuals more conservative in endorsing items and reduces the propensity to inaccurately endorse items that are related (but not identical) to studied items (Storbeck & Clore, 2005; Storbeck, 2013).

The effects of valence on memory, however, may depend on the delay after which memory is assessed. Breslin and Safer (2011) tested the memories of Yankees and Red Sox fans for the 2003 and 2004 American League Championship Series, which the Yankees and Red Sox won, respectively. They tested the memories 4–5 years later and found that fans showed the most accuracy for the game that their team had won. Although the requisite longitudinal study has not yet been conducted, the contrast of the results of Breslin and Safer (2011) with those of Kensinger and Schacter (2006b), who assessed fans' memories after an approximately 6-month delay, suggests that the effects of valence on memory may change over time. Breslin and Safer (2011) attribute the different effects of valence to the rehearsal that may occur in the time between an event's occurrence and the moment of retrieval. This finding may also reflect the tendency for negative affect to fade more rapidly than positive affect (see Walker & Skowronski, 2009, for a review). Over long enough time frames, preferential retention of positive information may also relate to age-related changes in affective focus, with an increased prioritization of positive affect (Mather & Carstensen, 2005).

The tendency for negative affect to fade more rapidly over time than positive affect is also relevant to the results of a recent study by Szpunar, Addis, and Shacter. (2012) that examined memory for simulations of future events. Participants were initially instructed to imagine positive, neutral, or negative future scenarios, each comprising a familiar person, object, and location. After delays of either 20 minutes or 24 hours, participants completed a cued recall test that provided two elements of the simulated event (e.g., person, object), and participants tried to recall the third element (e.g., location). At the short delay, participants recalled more positive and negative than neutral simulations, and there were no memory differences between the positive and negative simulations. By contrast, at the long delay, participants recalled more positive and neutral than negative simulations. In other words, there was a significant delay × valence interaction, such that negative simulations were forgotten more quickly over time than either positive or neutral simulations. In line with research on the fading affect bias (Walker & Skowronski, 2009), Szpunar et al. (2012) suggested that the affect that serves to bind together the elements of a simulated event may dissipate more quickly for negative than positive events. Consistent with this idea, Gallo, Korthauer, McDonough, Teshale, and Johnson (2011) reported evidence for a positivity bias in memory for simulated future scenarios following a 24-hour retention interval. In light of other evidence that future simulations exhibit a general positivity bias (see Schacter, 2012; Schacter et al., 2012; Sharot, 2011, for a review and discussion) it remains to be determined whether reduced retention of negative simulations after long delays is specifically characteristic of imagined *future* events or whether it occurs more broadly for imagined events in general.

Neural Mechanisms Underlying the Effects of Valence on Memory

Neuroimaging evidence has corroborated the "affect-as-information" perspective, finding evidence that the effects of valence on memory may be connected to differences in how the information is processed initially. It was noted in the section "The Influence of Emotional Arousal on Episodic

Memory" that emotion seems to increase activity in a large number of regions: not only the amygdala and other medial temporal lobe regions, but also regions in the prefrontal, parietal, and sensory cortices as well. The particular modulation of these regions may vary depending on the valence of an event. Across a few studies, the frontal and parietal regions have been more active during the encoding of positive events, while the sensory regions have been more active during the encoding of negative events (Mickley & Kensinger, 2008; Mickley Steinmetz & Kensinger, 2009). These findings are consistent with the proposal that positive affect is associated with distributed attention and a focus on the conceptual aspects of an event, while negative affect heightens the processing of sensory details.

There is some evidence that this distinction may continue during the retrieval phase, with more prefrontal engagement during the retrieval of positive autobiographical memories and more posterior, sensory activation during retrieval of negative events (Piefke et al., 2003; Markowitsch, Vandekerckhove, Lanfermann, & Russ, 2003). Recent research also suggests that regions within the hippocampal system may be differently recruited during the retrieval of positive and negative events (Denkova et al., 2013; Ford et al., 2014). A difficulty with the interpretation of many of the retrieval studies is that differences between positive and negative memories could stem from a multitude of factors, including differences in the types of content retrieved or in the effort elicited to retrieve them, in the details that become elaborated, or in the reencoding of the event. Parsing apart these effects will be a worthwhile focus of future research.

Summary of Effects of Valence on Memory

There is no clear answer to whether valence affects the likelihood of retrieving an event. The answer likely depends on a number of other factors, including the relevance of the information to the person or the person's goals. There is a clearer effect of valence on the ability to remember information vividly and with at least some detail, with negative information generally being remembered with more vividness and with at least some additional detail. These differences may relate to the different types of processing engaged while experiencing negative and positive affect, with negative affect leading to a greater processing of sensory details and positive affect encouraging a broader scope of attention. The effects of valence on memory may also change over time, emphasizing that processes that unfold over time are likely to interact with those implemented during the initial occurrence of an event.

Conclusions

In this chapter, we have reviewed the effects of arousal and valence on memory. We have described how these features of an affective response can influence the likelihood that an event is remembered, the subjective vividness with which it is remembered, and the likelihood that particular types of details are retrieved. We have emphasized the importance of considering the selective enhancements conveyed by these responses. Arousal leads to good memory for some details but not others, and valence shifts the focus from a detail-oriented processing of negative information to a more general processing of positive information. Thus, the effect of the affective response on memory will depend on the way memory is assessed and the types of information people are asked to retrieve.

We have reviewed neuroimaging and neuropsychological studies, demonstrating that the effects of arousal are connected to engagement of the amygdala and to its modulatory influence on other medial temporal lobe regions and on distributed cortical networks, including the prefrontal, parietal, and sensory regions. The effects of valence may be related to the divergent recruitment of these networks, with positive affect disproportionately recruiting the prefrontal and parietal regions, and negative affect recruiting the sensory cortices. Thus, at least in part, emotional information is remembered better than nonemotional information not because of the engagement of processes unique to memory for emotional information, but rather because of limbic modulation of the same processes that are typically recruited to remember nonemotional information.

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References

Abrisqueta-Gomez, J., Bueno, O. F., Oliveira, M. G., & Bertolucci, P. H. (2002). Recognition memory for emotional pictures in Alzheimer's disease. *Acta Neurologica Scandinavica, 105*, 51–54.

Addis, D. R., Moscovitch, M., Crawley, A. P., & McAndrews, M. P. (2004). Recollective qualities modulate hippocampal activation during autobiographical memory retrieval. *Hippocampus, 14*, 752–762.

Adelman, J. S., & Estes, Z. (2013). Emotion and memory: A recognition advantage for positive and negative words independent of arousal. *Cognition, 129,* 530–535.

Adolphs, R., Cahill, L., Schul, R., & Babinsky, R. (1997). Impaired declarative memory for emotional material following bilateral amygdala damage in humans. *Learning and Memory, 4*, 291–300.

Amaral, D., Price, J., Pitkanen, A., & Carmichael, S. (1992). Anatomical organization of the primate amygdaloid complex. In J. Aggleton (Ed.), *The amygdala: Neurobiological aspects of emotion, memory, and mental dysfunction* (pp. 1–67). New York: Wiley-Liss.

Amaral, D. G. (2003). The amygdala, social behavior, and danger detection. *Annals of the New York Academy of Sciences, 1000*, 337–347.

Anderson, A. K., Yamaguchi, Y., Grabski, W., & Lacka, D. (2006). Emotional memories are not all created equal: Evidence for selective memory enhancement. *Learning and Memory, 13*, 711–718.

Bennion, K. A., Ford, J. H., Murray, B. D., & Kensinger, E. A. (2013). Oversimplification in the study of emotional memory. *Journal of the International Neuropsychological Society, 19*, 953–961.

Berntsen, D., & Rubin, D. C. (2002). Emotionally charged autobiographical memories across the life span: The recall of happy, sad, traumatic, and involuntary memories. *Psychology and Aging, 17*, 636–652.

Bless, H., Clore, G. L., Schwarz, N., Golisano, V., Rabe, C., & Wolk, M. (1996). Mood and the use of scripts: Does a happy mood really lead to mindlessness? *Journal of Personality and Social Psychology, 71*, 665–679.

Bless, H., & Schwarz, N. (1999). Sufficient and necessary conditions in dual-process models: The case of mood and information processing. In S. Chaiken & Y. Trope (Eds.), *Dual-process theories in social psychology* (pp. 423–440). New York: Guilford Press.

Bohannon, J. N. (1988). Flashbulb memories for the space shuttle disaster: A tale of two theories. *Cognition, 29*, 179–196.

Bohn, A., & Berntsen, D. (2007). Pleasantness bias in flashbulb memories: Positive and negative flashbulb memories of the fall of the Berlin Wall among East and West Germans. *Memory and Cognition, 35*, 565–577.

Bradley, M. M., Greenwald, M. K., Petry, M. C., & Lang, P. J. (1992). Remembering pictures: Pleasure and arousal in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 379–390.

Breslin, C. W., & Safer, M. A. (2011). Effects of event valence on long-term memory for two baseball championship games. *Psychological Science, 22*, 1408–1412.

Brierley, B., Medford, N., Shaw, P., & David, A. S. (2004). Emotional memory and perception in temporal lobectomy patients with amygdala damage. *Journal of Neurology, Neurosurgery and Psychiatry, 75*, 593–599.

Brown, R., & Kulik, J. (1977). Flashbulb memories. *Cognition, 5*, 73–99.

Buchanan, T. W. (2007). Retrieval of emotional memories. *Psychonomic Bulletin, 133,* 761–779.

Buchanan, T. W., & Adolphs, R. (2002). The role of the human amygdala in emotional modulation of long-term declarative memory. In S. Moore & M. Oaksford (Eds.), *Emotional cognition: From brain to behavior* (pp. 9–34). Amsterdam: Benjamins.

Buchanan, T. W., Tranel, D., & Adolphs, R. (2005). Emotional autobiographical memories in amnesic patients with medial temporal lobe damage. *Journal of Neuroscience, 25*(12), 3151–3160.

Buckner, R. I., & Wheeler, M. F. (2001). The cognitive neuroscience of remembering. *Nature Reviews Neuroscience, 2*, 624–634.

Budson, A. E., Simons, J. S., Sullivan, A. L., Beier, J. S., Solomon, P. R., Scinto, L. F., et al. (2004). Memory and emotions for the 9/11/01 terrorist attacks in patients with Alzheimer's disease, mild cognitive impairment, and healthy older adults. *Neuropsychology, 18*, 315–327.

Bush, S. I., & Geer, J. H. (2001). Implicit and explicit memory of neutral, negative emotional, and sexual information. *Archives of Sexual Behavior, 30*, 615–631.

Cahill, L., Babinsky, R., Markowitsch, H. J., & McGaugh, J. L. (1995). The amygdala and emotional memory. *Nature, 377*, 295–296.

Cahill, L., Haier, R. J., Fallon, J., Alkire, M. T., Tang, C., Keator, D., et al. (1996). Amygdala activity at encoding correlated with long-term, free recall of emotional information. *Proceedings of the National Academy of Sciences USA, 93*, 8016–8021.

Cahill, L., Prins, B., Weber, M., & McGaugh, J. L. (1994). Beta-adrenergic activation and memory for emotional events. *Nature, 371*(6499), 702–704.

Christianson, S.-A. (1989). Flashbulb memories: Special, but not so special. *Memory and Cognition, 17*, 435–443.

Clore, G. L., Wyer, R. S., Dienes, B., Gasper, K., Gohm, C., & Isbell, L. (2001). Affective feelings as feedback: Some cognitive consequences. In L. L. Martin & G. L. Clore (Eds.), *Theories of mood and cognition: A user's handbook* (pp. 27–62). Mahwah, NJ: Erlbaum.

Conway, M. A. (1990). Conceptual representation of emotions: The role of autobiographical memories. In K. J. Gilhooly, M. T. G. Keane, R. H. Logie, & G. Erdos (Eds.), *Lines of thinking: Reflections on the psychology of thought: Vol. 2. Skills, emotion, creative processes, individual differences and teaching thinking* (pp. 133–143). Chichester, UK: Wiley.

D'Argembeau, A., Comblain, C., & van der Linden, M. (2003). Phenomenal characteristics of autobiographical memories for positive, negative, and neutral events. *Applied Cognitive Psychology, 17*, 281–294.

D'Argembeau, A., Comblain, C., & van der Linden, M. (2005). Affective valence and the self-reference effect: Influence of retrieval conditions. *British Journal of Psychology, 96*, 457–466.

Dalgleish, T., & Watts, F. N. (1990). Biases of attention and memory in disorders of anxiety and depression. *Clinical Psychology Review, 10*(5), 589–604.

Damasio, A. R., Grabowski, T. J., Bechara, A., Damasio, H., Ponto, L. L., Parvizi, J., et al. (2000). Subcortical and cortical brain activity during the feeling of self-generated emotions. *Nature Neuroscience, 3*, 1049–1056.

Daselaar, S. M., Rice, H. J., Greenberg, D. L., Cabeza, R., LaBar, K. S., & Rubin, D. C. (2008). The spatiotemporal dynamics of autobiographical memory: Neural correlates of recall, emotional intensity, and reliving. *Cerebral Cortex, 18*(1), 217–229.

De Quervain, D. J., Kolassa, I. T., Erti, V., Onyut, P. L., Neuner, F., Elbert, T., et al. (2007). A deletion variant of the alpha2b-adrenoceptor is related to emotional memory in Europeans and Africans. *Nature Neuroscience, 10*, 1137–1139.

Denkova, E., Dolcos, S., & Dolcos, F. (2013). The effect of retrieval focus and emotional valence on the medial temporal lobe activity during autobiographical recollection. *Frontiers in Behavioral Neuroscience, 7*, 109.

Dewhurst, S. A., & Parry, L. A. (2000). Emotionality, distinctiveness, and recollective experience. *European Journal of Cognitive Psychology, 12*, 541–551.

Dolan, R. J., & Vuilleumier, P. (2003). Amygdala automaticity in emotional processing. *Annals of the New York Academy of Sciences, 985*, 348–355.

Dolcos, F., LaBar, K. S., & Cabeza, R. (2004). Interaction between the amygdala and the medial temporal lobe memory system predicts better memory for emotional events. *Neuron, 42*, 855–863.

Dolcos, F., LaBar, K. S., & Cabeza, R. (2005). Remembering one year later: Role of the amygdala and the medial temporal lobe memory system in retrieving emotional memories. *Proceedings of the National Academy of Sciences USA, 102*, 2626–2631.

Dougal, S., Phelps, E. A., & Davachi, L. (2007). The role of medial temporal lobe in item recognition and source recollection of emotional stimuli. *Cognitive, Affective, and Behavioral Neuroscience, 7*(3), 233–242.

Dreben, E. K., Fiske, S. T., & Hastie, R. (1979). The independence of evaluative and item information: Impression and recall order effects in behavior-based impression formation. *Journal of Personality and Social Psychology, 37*(10), 1758–1768.

Ebbinghaus, H. (1885/1962). *Memory: A contribution to experimental psychology*. New York: Dover.

Feldman Barrett, L., & Russell, J. A. (1999). The structure of current affect: Controversies and emerging consensus. *Current Directions in Psychological Science, 8*, 10–14.

Fiedler, K. (2001). Affective states trigger processes of assimilation and accommodation. In L. L. Martin & G. L. Clore. (Eds.), *Theories of mood and cognition: A user's guidebook* (pp. 85–98). Mahwah, NJ: Erlbaum.

Fink, G. R., Markowitsch, H. J., & Reinkemeier, M. (1996). Cerebral representation of one's own past: Neural networks involved in autobiographical memory. *Journal of Neuroscience, 16*(13), 4275–4282.

Ford, J. H., Morris, J., & Kensinger, E. A. (2014). Effects of emotion and emotional valence on the neural correlates of episodic memory search and elaboration. *Journal of Cognitive Neuroscience, 26*(4), 825–839.

Fredrickson, B. L. (2004). The broaden-and-build theory of positive emotions. *Philosophical Transactions of the Royal Society of London, B Series: Biological Sciences, 359*, 1367–1378.

Gallo, D. A., Korthauer, L. E., McDonough, I. M., Teshale, S., & Johnson, E. L. (2011). Age-related positivity effects and autobiographical memory detail: Evidence from a past/future source memory task. *Memory, 19*, 641–652.

Gerard, R. W. (1961). The fixation of experience. In A. Fessard, R. W. Gerard, & J. Konorski. (Eds.), *Brain mechanisms and learning* (pp. 21–35). Springfield, IL: Thomas.

Greenberg, D. L., Rice, H. J., Cooper, J. J., Cabeza, R., Rubin, D. C., & LaBar, K. S. (2005). Coactivation of the amygdala, hippocampus, and inferior frontal gyrus during autobiographical memory retrieval. *Neuropsychologia, 43*, 659–674.

Hamann, S. (2001). Cognitive and neural mechanisms of emotional memory. *Trends in Cognitive Sciences, 5*, 394–400.

Hamann, S. B., Ely, T. D., Grafton, S. T., & Kilts, C. D. (1999). Amygdala activity related to enhanced memory for pleasant and aversive stimuli. *Nature Neuroscience, 2*, 289–293.

Hirst, W., Phelps, E. A., Buckner, R. L., Budson, A. E., Cuc, A., Gabrieli, J. D. E., et al. (2009). Long-term memory for the terrorist attack of September 11: Flashbulb memories, event memories, and the factors that influence their retention. *Journal of Experimental Psychology: General, 138*, 161–176.

Holland, A. C., & Kensinger, E. A. (2012). Younger, middle-aged, and older adults' memories for the 2008 U.S. presidential election. *Journal of Applied Research in Memory and Cognition, 1*, 163–170.

James, W. (1890). *Principles of psychology*. New York: Holt.

Johnson, M. K., Foley, M. A., Suengas, A. G., & Raye, C. L. (1988). Phenomenal characteristics of memories for perceived and imagined autobiographical events. *Journal of Experimental Psychology: General, 117*, 371–376.

Keightley, M. L., Chiew, K. S., Anderson, J. A., & Grady, C. L. (2011). Neural correlates of recognition memory for emotional faces and scenes. *Social, Cognitive, and Affective Neuroscience, 6*, 24–37.

Kensinger, E. A. (2009). Remembering the details: Effects of emotion. *Emotion Review, 1*, 99–113.

Kensinger, E. A., Addis, D. R., & Atapattu, R. K. (2011). Amygdala activity at encoding corresponds with memory vividness and with memory for select episodic details. *Neuropsychologia, 49*, 663–673.

Kensinger, E. A., Anderson, A., Growdon, J. H., & Corkin, S. (2004). Effects of Alzheimer's disease on memory for verbal emotional information. *Neuropsychologia, 42*, 791–800.

Kensinger, E. A., Brierley, B., Medford, N., Growdon, J., & Corkin, S. (2002). The effect of normal aging and Alzheimer's disease on emotional memory. *Emotion, 2*, 118–134.

Kensinger, E. A., & Corkin, S. (2003). Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Memory and Cognition, 31*, 1169–1180.

Kensinger, E. A., & Corkin, S. (2004). Two routes to emotional memory: Distinct neural processes for valence and arousal. *Proceedings of the National Academy of Sciences of the USA, 101*, 3310–3315.

Kensinger, E. A., Krendl, A. C., & Corkin, S. (2006). Memories of an emotional and a nonemotional event: Effects of aging and delay interval. *Experimental Aging Research, 32*, 23–45.

Kensinger, E. A., & Schacter, D. L. (2005a). Emotional content and reality-monitoring ability: fMRI evidence for the influence of encoding processes. *Neuropsychologia, 43*, 1429–1443.

Kensinger, E. A., & Schacter, D. L. (2005b). Retrieving accurate and distorted memories: Neuroimaging evidence for effects of emotion. *NeuroImage, 27*, 167–177.

Kensinger, E. A., & Schacter, D. L. (2006a). Amygdala activity is associated with the successful encoding of item, but not source, information for positive and negative stimuli. *Journal of Neuroscience, 26*, 2564–2570.

Kensinger, E. A., & Schacter, D. L. (2006b). When the Red Sox shocked the Yankees: Comparing negative and positive memories. *Psychonomic Bulletin and Review, 13*, 757–763.

Kilpatrick, L., & Cahill, L. (2003). Amygdala modulation of parahippocampal and frontal regions during emotionally influenced memory storage. *NeuroImage, 20*, 2091–2099.

Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

LeDoux, J. E. (1996). *The emotional brain: The mysterious underpinnings of emotional life*. New York: Simon & Schuster.

Levine, L. J., & Bluck, S. (2004). Painting with broad strokes: Happiness and the malleability of event memory. *Cognition and Emotion, 18*, 559–574.

Levine, L. J., & Edelstein, R. S. (2009). Emotion and memory narrowing: A review and goal-relevance approach. *Cognition and Emotion, 23*(5), 833–875.

Linton, M. (1975). Memory for real-world events. In D. A. Norman & D. E. Rumelhart (Eds.), *Explorations in cognition* (pp. 376–404). San Francisco: Freeman.

Livingston, R. B. (1967). Reinforcement. In G. Quarton, T. Melnechuk, & F. Schmitt (Eds.), *The neurosciences: A study program* (pp. 514–576). New York: Rockefeller Press.

Mandler, J. M. (1984). *Stories, scripts, and scenes: Aspects of schema theory*. Hillsdale, NJ: Erlbaum.

Markowitsch, H. J., Calabrese, P., Wurker, M., Durwen, H. F., Kessler, J., & Babinsky, R. (1994). The amygdala's contribution to memory: A study on two patients with Urbach–Wiethe disease. *NeuroReport, 5*, 1349–1352.

Markowitsch, H. J., Thiel, A., Reinkemeier, M., Kessler, J., Koyuncu, A., & Heiss, W. D. (2000). Right amygdalar and temporofrontal activation during autobiographic, but not during fictitious memory retrieval. *Behavioral Neuroscience, 12*, 181–190.

Markowitsch, H. J., Vandekerckhove, M. M., Lanfermann, H., & Russ, M. O. (2003). Engagement of lateral and medial prefrontal areas in the ecphory of sad and happy autobiographical memories. *Cortex, 39*, 643–665.

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences, 9*, 496–502.

Mather, M., & Sutherland, M. R. (2011). Arousal-biased competition in perception and memory. *Perspectives in Psychological Science, 6*, 114–133.

Matlin, M., & Stang, D. J. (1978). *The Pollyanna principle*. Cambridge, MA: Shenkman.

Matt, G. E., Vazquez, C., & Campbell, W. C. (1992). Mood-congruent recall of affectively toned stimuli: A meta-analytic study. *Clinical Psychology Review, 12*, 227–255.

McGaugh, J. L. (2004). The amygdala modulates the consolidation of memories of emotionally arousing experiences. *Annual Review of Neuroscience, 27*, 1–28.

McGaugh, J. L. (2013). Making lasting memories: Remembering the significant. *Proceedings of the National Academy of Sciences, USA, 110*, 10402–10407.

Mickley, K. R., & Kensinger, E. A. (2008). Emotional valence influences the neural correlates associated with remembering and knowing. *Cognitive, Affective, and Behavioral Neuroscience, 8*, 143–152.

Mickley Steinmetz, K. R., & Kensinger, E. A. (2009). The effects of valence and arousal on the neural activity leading to subsequent memory. *Psychophysiology, 46*(6), 1190–1199.

Mueller, G. E., & Pilzecker, A. (1900). Experimentelle Beitrage zur Lehre vom Gedachtniss. *Zeitschrift fuer Psychologie, 1*, 1–300.

Murty, V. P., Ritchey, M., Adcock, R. A., & LaBar, K. S. (2010). fMRI studies of successful emotional memory encoding: A quantitative meta-analysis. *Neuropsychologia, 48*, 3459–3469.

Nairne, J. S., Pandeirada, J. N., & Thompson, S. R. (2008). Adaptive memory: The comparative value of survival processing. *Psychological Science, 19*, 176–180.

Neisser, U., & Harsch, N. (1992). Phantom flashbulbs: False recollections of hearing the news about Challenger. In E. Winograd & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of "flashbulb" memories* (pp. 9–31). Cambridge, UK: Cambridge University Press.

Ochsner, K. N. (2000). Are affective events richly "remembered" or simply familiar?: The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General, 129*, 242–261.

Onoda, K., Okamoto, Y., & Yamawaki, S. (2009). Neural correlates of associative memory: The effects of negative emotion. *Neuroscience Research, 64*(1), 50–55.

Paradis, C. M., Solomon, L. Z., Florer, F., & Thompson, T. (2004). Flashbulb memories of personal events of 9/11 and the day after for a sample of New York City residents. *Psychological Reports, 95*, 304–310.

Park, J., & Banaji, M. R. (2000). Mood and heuristics: The influence of happy and sad states on sensitivity and bias in stereotyping. *Journal of Personality and Social Psychology, 78*(6), 1005–1023.

Pezdek, K. (2003). Event memory and autobiographical memory for the events of September 11, 2001. *Applied Cognitive Psychology, 17*, 1033–1045.

Phelps, E. A. (2004). Human emotion and memory: Interactions of the amygdala and hippocampal complex. *Current Opinion in Neurobiology, 14*, 198–202.

Phelps, E. A., & Sharot, T. (2008). How (and why) emotion enhances the subjective sense of recollection. *Current Directions in Psychological Science, 17*, 147–152.

Piefke, M., Weiss, P. H., Zilles, K., Markowitsch, H. J., & Fink, G. R. (2003). Differential remoteness and emotional tone modulate the neural correlates of autobiographical memory. *Brain, 126*, 650–668.

Quevedo, J., Sant'Anna, M. K., & Madruga, M. (2003). Differential effects of emotional arousal in short- and long-term memory in healthy adults. *Neurobiology of Learning and Memory, 79*, 132–135.

Reiman, E. M., Lane, R. D., Ahern, G. L., Schwartz, G. E., Davidson, R. J., Friston, K. J., et al. (1997). Neuroanatomical correlates of externally and internally generated human emotion. *American Journal of Psychiatry, 154*, 918–925.

Revelle, W., & Loftus, D. (1992). The implications of arousal effects for the study of affect and memory. In S. A. Christianson (Ed.), *Handbook of emotion and memory* (pp. 113–150). Hillsdale, NJ: Erlbaum.

Richardson, M. P., Strange, B., & Dolan, R. J. (2004). Encoding of emotional memories depends on the amygdala and hippocampus and their interactions. *Nature Neuroscience, 7*, 278–285.

Riemann, B., & McNally, R. J. (1995). Cognitive processing of personally relevant information. *Cognition and Emotion, 9*, 325–340.

Rubin, D. C., & Kozin, M. (1984). Vivid memories. *Cognition, 16*, 63–80.

Rumelhart, D. E. (1980). Schemata: The building blocks of cognition. In R. J. Spiro, B. C. Bruce, & W. F. Brewer (Eds.), *Theoretical issues in reading comprehension* (pp. 33–58), New York: Erlbaum.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39*, 1161–1178.

Sakaki, M., Niki, K., & Mather, M. (2012). Beyond arousal and valence: The importance of the biological versus social relevance of emotional stimuli. *Cognitive, Affective, and Behavioral Neuroscience, 12*, 115–139.

Schacter, D. L. (2012). Adaptive constructive processes and the future of memory. *American Psychologist, 67*, 603–613.

Schacter, D. L., Addis, D. R., Hassabis, D., Martin, V. C., Spreng, R. N., & Szpunar, K. K. (2012). The future of memory: Remembering, imagining, and the brain. *Neuron, 76*, 677–694.

Schaefer, A., & Philippot, P. (2005). Selective effects of emotion on the phenomenal characteristics of autobiographical memories. *Memory, 13*, 148–160.

Schmidt, S. R. (2004). Autobiographical memories for the September 11th attacks: Reconstructive errors and emotional impairment of memory. *Memory and Cognition, 32*, 443–454.

Schmolck, H., Buffalo, E. A., & Squire, L. R. (2000). Memory distortions develop over time: Recollections of the O. J. Simpson trial verdict after 15 and 32 months. *Psychological Science, 11*, 39–45.

Schwarz, N. (1990). Feelings as information: Informational and motivational functions of affective states. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 527–561), New York: Guilford Press.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgements of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology, 45*(3), 513–523.

Schwarz, N., & Clore, G. L. (1988). How do I feel about it?: Informative functions of affective states. In K. Fiedler & J. Forgas (Eds.), *Affect, cognition, and social behavior* (pp. 44–62). Toronto, Canada: Hogrefe International.

Schwarz, N., & Clore, G. L. (1996). Feelings and phenomenal experiences. In E. T. Higgins & A. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 433–465), New York: Guilford Press.

Segal, S. K., & Cahill, L. (2009). Endogenous noradrenergic activation and memory for emotional material in men and women. *Psychoneuroendocrinology, 34*, 1263–1271.

Segal, S. K., Stark, S. M., Kattan, D., Stark, C. E., & Yassa, M. A. (2012). Norepinephrine-mediated emotional arousal facilitates subsequent pattern separation. *Neurobiology of Learning and Memory, 97*, 465–469.

Shakow, D. (1930). Hermann Ebbinghaus. *American Journal of Psychology, 42*, 505–518.

Sharot, T. (2011). *The optimism bias*. New York: Pantheon Books.

Sharot, T., Delgado, M. R., & Phelps, E. A. (2004). How emotion enhances the feeling of remembering. *Nature Neuroscience, 12*, 1376–1380.

Shenhav, A., Barrett, L. F., & Bar, M. (2013). Affective value and associative processing share a cortical substrate. *Cognitive, Affective, and Behavioral Neuroscience, 13*, 46–59.

Skowronski, J. J., & Carlston, D. E. (1987). Social judgement and social memory: The role of cue diagnosticity in negativity, positivity, and extremity biases. *Journal of Personality and Social Psychology, 52*(4), 689–699.

Smith, A. P., Stephan, K. E., Rugg, M. D., & Dolan, R. J. (2006). Task and content modulate amygdala–hippocampal connectivity in emotional retrieval. *Neuron, 49*, 631–638.

Smith, M. C., Bibi, U., & Sheard, D. E. (2003). Evidence for the differential impact of time and emotion on personal and event memories for September 11, 2001. *Applied Cognitive Psychology, 17*, 1047–1055.

Soetens, E., Casaer, S., D'Hooge, R., & Hueting, J. E. (1995). Effect of amphetamine on long-term retention of verbal material. *Psychopharmacology, 119*(2), 155–162.

Storbeck, J. (2013). Negative affect promotes encoding of and memory for details at the expense of the gist: Affect, encoding, and false memories. *Cognition and Emotion, 27*, 800–819.

Storbeck, J., & Clore, G. L. (2005). With sadness comes accuracy; with happiness, false memory: Mood and the false memory effect. *Psychological Science, 16*, 785–791.

Strange, B. A., & Dolan, R. J. (2004). Beta-adrenergic modulation of emotional memory-evoked human amygdala and hippocampal responses. *Proceedings of the National Academy of Sciences, 101*(31), 11454–11458.

Szpunar, K. K., Addis, D. R., & Schacter, D. L. (2012). Memory for emotional simulations: Remembering a rosy future. *Psychological Science, 23*, 24–29.

Talarico, J. M., LaBar, K. S., & Rubin, D. C. (2004). Emotional intensity predicts autobiographical memory experience. *Memory and Cognition, 32*, 1118–1132.

Talarico, J. M., & Rubin, D. C. (2003). Confidence, not consistency, characterizes flashbulb memories. *Psychological Science, 14*, 455–461.

Talmi, D., Anderson, A. K., Riggs, L., Caplan, J. B., & Moscovitch, M. (2008). Immediate memory consequences of the effect of emotion on attention to pictures. *Learning and Memory, 15*, 172–183.

Tulving, E. (1985). Memory and consciousness. *Canadian Psychologist, 25*, 1–12.

Van Strien, J. W., Langeslag, S. J., Strekalova, N. J., Gootjes, L., & Franken, I. H. (2009). Valence interacts with the early ERP old/new effect and arousal with the sustained ERP old/new effect for affective pictures. *Brain Research, 1251*, 223–235.

Vuilleumier, P., Richardson, M. P., Armony, J. L., Driver, J., & Dolan, R. J. (2004). Distinct influences of amygdala lesion on visual cortical activation during emotional face processing. *Nature Neuroscience, 7*, 1271–1278.

Wagner, A. D., Schacter, D. L., Rotte, M., Koutstaal, W., Maril, A., Dale, A. M., et al. (1998). Building memories: Remembering and forgetting of verbal experiences as predicted by brain activity. *Science, 281*, 1188–1190.

Walker, W. R., & Skowronski, J. J. (2009). The fading affect bias: But what the hell is it for? *Applied Cognitive Psychology, 23*, 1122–1136.

Waring, J. D., & Kensinger, E. A. (2011). How emotion leads to selective memory: Neuroimaging evidence. *Neuropsychologia, 49*, 1831–1842.

Wegner, D. M., & Vallacher, R. R. (1986). Action identification. In R. M. Sorrentino & E. T. Higgins (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (pp. 550–582). New York: Guilford Press.

White, R. T. (2002). Memory for events after twenty years. *Applied Cognitive Psychology, 16*, 603–612.

Winograd, E., & Killinger, W. A., Jr. (1983). Relating age at encoding in early childhood to adult recall: Development of flashbulb memories. *Journal of Experimental Psychology: General, 112*, 413–422.

Zola-Morgan, S., Squire, L. R., Alvarez-Royo, P., & Clower, R. P. (1991). Independence of memory functions and emotional behavior: Separate contributions of the hippocampal formation and the amygdala. *Hippocampus, 1*, 207–220.

CHAPTER 34

Language and Emotion

Putting Words into Feelings and Feelings into Words

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In his 1981 essay "Feeling into Words," the poet Seamus Heaney suggests that putting feelings into words is "a search for images and symbols adequate to our predicament." Of course, a poet would know better than anyone why it is important to understand the link between emotion and language. Humans have the unique capacity to experience complex, nuanced emotions. Humans also have the unique challenge of communicating those experiences to one another with language. To date, much research has investigated how our emotional experiences get translated into language; this research is important for domains ranging from the arts to therapy to cross-cultural communication. Yet what Heaney did not acknowledge is that the symbols we know might also shape how we experience our "predicament" in the first place. That is, language might not just translate feelings into words, but might help shape the nature of those feelings to begin with.

Throughout this chapter, we review the various traditions that have investigated relationships between language and emotion. These traditions stem from different areas of research (e.g., psychology, neuroscience, linguistics, anthropology) and often make different assumptions about the nature of the relationship between language and emotion. We begin our chapter by first offering a few definitions of what we mean by "language" and "emotion," in the first place. We next discuss accounts of the relationship between language and emotion. We first introduce an account that explicitly hypothesizes that language helps to constitute emotions—the *psychological constructionist* model of emotion. Next, we review evidence from the emotion regulation literature that assumes that language can modulate emotions after the fact (e.g., by virtue of "reappraisal" or "affect labeling," as described below). Finally, we discuss a literature on the *emotion lexicon*, which typically (with some exceptions from linguistics) focuses on how emotional experiences get translated into words for the sole means of communication. We close the chapter by suggesting that a psychological constructionist approach can unite findings from across these seemingly diverse domains: it describes how words help shape the emotions that people experience and perceive, proposes the ultimate mechanism by which words help regulate emotions, and explains cultural variation in how emotions get put into words.

Definitions

Before we begin, it bears mention what we mean by the terms "language" and "emotion" throughout this chapter. Herein we use "language" to refer exclusively to the words that people use to describe emotional states (such as anger, disgust, fear, joy, contentment, pride, *schadenfreude*, *amae*, etc.). More specifically, we are referring to what linguists call the "semantic" aspects of language. It is beyond the scope of this chapter to discuss the role of syntax or metaphor in emotion, or how the affective meaning of words impacts their understanding or use (although these are interesting areas of study in their own right). Nor do we discuss words that name other categories (e.g., "mother," "murder") that might themselves have emotional connotations (see Lindquist, MacCormack, & Shablack, 2015, for a brief comment on the implications of these types of words in emotion).

We also have a very particular meaning in mind when we use the term "emotion" throughout this chapter. As it turns out, there is no single agreed-upon scientific definition of the term "emotion." In keeping with the psychological constructionist approach we take in our own research, we thus use the term "emotion" to refer to what are sometimes called "discrete emotions" in the psychology literature—psychological states that are *experienced as* coordinated patterns of physiology, behavior, and thoughts that occur within certain types of situations, and which are described with certain emotion category words (e.g., in English, "anger," "disgust," "fear," "happiness," "sadness"). We differentiate emotions from affect, which consists of basic feelings from the core of the body (for this reason, it is sometimes called "core affect"; Barrett, 2006b; Barrett & Bliss-Moreau, 2009; Russell, 2003). Affect is the representation of the body's ever-changing internal state (from the smooth muscles, skeletal muscles, peripheral nervous system, and neurochemical/hormonal system) and is often described as a homeostatic barometer that allows an organism to understand whether objects in the world are good for it, bad for it, approachable, or avoidable (Barrett & Bliss-Moreau, 2009).

Throughout, we also differentiate between *experiences* of emotion (or affect), which we identify as feelings in one's own body (e.g., a feeling of anger, a feeling of unpleasantness) and *perceptions* of emotion (or affect), which we define as inferring emotional feelings in another based on his or her face, voice, body, behavior, and so on (e.g., seeing someone else as angry, seeing someone else as feeling unpleasant). We turn now tvo the psychological constructionist approach to emotion, which explicitly hypothesizes that the words someone knows for emotion shapes how he or she makes meaning of affect, turning those affective states into emotion experiences and perceptions.

Putting Words into Feelings: Language and the Psychological Construction of Emotion

Psychological constructionist views are a family of psychological and neuroscience models that predict a constitutive role of language in emotions. According to *psychological constructionist* views, emotions are experienced when affective states are made meaningful as specific instances of the emotion categories that exist in a given culture. Emotions are thus considered the resulting products, or constructions, of more basic psychological "elements" (Barrett, 2006a, 2006b; Clore & Ortony, 2013; Cunningham, Dunfield, & Stillman, 2013; Lindquist, 2013; Russell, 2003). According to our particular psychological constructionist approach, called the conceptual act theory (CAT; cf. Barrett, 2006b, 2009, 2012, 2014), these more basic elements are representations of sensations from inside the body (affect), representations of sensations from outside the body (e.g., vision, audition), conceptual knowledge about the emotion categories experienced in one's culture, and executive attention (see Barrett & Bar, 2009; Barrett & Bliss-Moreau, 2009; Barrett & Satpute, 2013; Lindquist & Barrett, 2012; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012, for reviews). A person experiences an emotion when conceptual knowledge is used to make meaning of his or her core affect (in experiences of emotion), or another person's affective facial movements (in perceptions of emotion), tailoring them to the context at hand. Importantly, rather than viewing emotions as physical types of categories that all individuals are born with, psychological constructionist views conceive of the emotions that are constructed out of more basic elements as nominal kind categories that exist only by nature of fact that a group of people agrees about their features (e.g., a culture agrees that "anger" is an emotion that occurs in contexts when norms are violated, when people scowl, and when vasodilation and an increased heart rate occurs, whereas "fear" is an emotion that occurs in contexts when uncertain events occur, when people gasp, and when vasoconstriction and an increased heart rate occurs; see Barrett, 2012; Lindquist, Gendron, Oosterwijk, & Barrett, 2013, for discussions).

Although all psychological constructionist views agree that emotions are nominal kind categories constructed out of more basic elements, not all views see a role for language in this process.

The CAT is unique in that it explicitly describes a role for language in the construction of emotion, insofar as language supports the acquisition and use of concept knowledge about emotion categories (cf. Lindquist, MacCormack, et al., 2015; Lindquist, Satpute, & Gendron, 2015). The CAT predicts that language plays an especial role in emotion because emotion categories (e.g., anger, fear, disgust) are abstract concepts with highly variable instances (e.g., Barrett, 2006a; Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000; Mauss & Robinson, 2009; Wilson-Mendenhall, Barrett, & Barsalou, 2013; Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011; see Lindquist, MacCormack, et al., 2015, for a discussion). Language helps humans represent all category knowledge (see Lupyan, 2012), but may be especially important to representing abstract categories that do not have strong perceptual regularities in the world (see Barsalou & Wiemer-Hastings, 2005; Lindquist, MacCormack, et al., 2015; Lupyan, 2012). In the case of abstract categories, words are a form of "glue" that holds the concept together (see Barrett & Lindquist, 2008; Lindquist, MacCormack, et al., 2015, for a discussion). The word "anger" is thus thought to be in part constitutive of an angry feeling because it supports the category knowledge that is brought online to make meaning of a rapidly beating heart, high blood pressure, and unpleasantness when a person's trust is violated, or to make meaning of a calmly beating heart, decreased blood pressure, and pleasantness when a person enacts revenge. This does not mean that a person needs to speak the word "anger," or even think it when making meaning of an affective state. Instead, the idea is that anger groups a population of instances in a person's conceptual knowledge (involving representations of sensations from the body, behaviors, and the context) that are all conceived of as members of the same category despite what otherwise might be large differences among them. For instance, within the behavioral domain, punching, running away, kicking, smiling, crying, and scowling can all occur in an instance of anger. Without the word to bind them, and based on their perceptual similarities alone (what it looks like or feels like to punch, run, kick, smile, etc.), these instances might otherwise belong to different categories and be experienced as such (see Lindquist, MacCormack, et al., 2015, for a discussion). During experiences or perceptions of affect, labels connected to concepts shape the conceptual information that is brought to bear when making meaning of sensations in the environment (a "label feedback hypothesis"; cf. Lupyan, 2012; see Lindquist, MacCormack, et al., 2015, for a discussion of how the label feedback hypothesis applies to emotion).

Mounting evidence from social cognitive, neuropsychological, cross-cultural, and neuroimaging studies is consistent with the psychological constructionist view that language helps constitute emotion. It is beyond the scope of this chapter to discuss all of this evidence since we have done so extensively elsewhere (Barrett, 2009; Barrett, Lindquist, & Gendron, 2007; Barrett, Mesquita, Ochsner, & Gross, 2007; Lindquist, 2013; Lindquist & Gendron, 2013; Lindquist, MacCormack, et al., 2015; Lindquist, Satpute, et al., 2015). However, we discuss several illustrative examples of how emotion words help to create the types of discrete emotional experiences and perceptions that people feel in their own bodies or see in the bodies of others.

Perhaps most notably, evidence shows that impairing participants' access to the meaning of words impairs their ability to perceive emotion on faces, even in tasks that do not require language. This finding suggests that language reaches relatively "deep" into visual perception to help construct a perception that someone else is "angry" or "sad." For instance, temporarily impairing access to an emotion concept by having participants repeat a word (e.g., "anger") out loud 30 times (a procedure called semantic satiation) makes participants slower and less accurate to perceptually match two facial expressions (e.g., judge that two faces are both angry; Lindquist, Barrett, Bliss-Moreau, & Russell, 2006).

Similarly, when language is permanently impaired due to a neurodegenerative disease called semantic dementia, so too is emotion perception. Semantic dementia occurs following neurodegeneration in the left anterior temporal lobe (ATL) of the brain, an important hub in a network supporting the representation of concept knowledge (Patterson, Nestor, & Rogers, 2007). Patients were asked to freely sort pictures of facial expressions (associated with the categories "anger," "disgust," "fear," "sadness," "happiness," and "neutral") into meaningful piles—a task that did not require linguistic responses. Whereas healthy control participants sorted the facial expressions into six or more distinct piles for the six emotion categories represented in the set, patients instead sorted faces into three to four piles representing positive, negative, and neutral feelings (Lindquist, Gendron, Barrett, & Dickerson, 2014). These findings converge with earlier evidence from a patient, LEW, who could no longer access and use words following a stroke (Roberson, Davidoff, & Braisby, 1999). LEW had difficulty sorting facial expressions of emotion into consistent piles and created several different configurations of piles across multiple testing instances.

Just as impairing access to emotion words impairs emotion perception, there is evidence that making emotion words more accessible alters how emotional facial portrayals of emotion, and even one's own body feelings, are made meaningful as discrete emotional perceptions and experiences. For instance, we (Nook, Lindquist, & Zaki, 2015), assessed whether the presence of words in a repetition-priming paradigm task made participants faster and more sensitive to perceive emotions on faces than did the mere presence of other faces. On each trial, participants viewed a rapidly presented facial emotion expression (the *cue* stimulus) followed by a second emotional stimulus (the *target* stimulus) and indicated whether or not the emotion categories reflected in the cue and target stimuli matched or not. On some trials, the target was a second facial expression (*face–face trials*), and on other trials, it was an emotion category word (*face–word trials*). Consistent with the hypothesis that increased accessibility to emotion words facilitates discrete emotion perceptions, we found that pairing emotional faces (e.g., a pouting face) with emotion labels (e.g., "sad") increased individuals' speed and sensitivity in perceiving emotions on faces. By contrast, participants' less sensitive judgments on face–face trials were driven by the similarity of facial features between cue and target (e.g., the presence of a furrowed brow), which did not necessarily differ between different emotion categories. In fact, the findings on face–face trials suggest that participants were not likely to spontaneously perceive faces in terms of discrete emotion because they were focusing on more basic perceptual similarities between faces. Participants did not tend to perceive a face in terms of a discrete emotion category unless a discrete emotion category word was present to facilitate this judgment.

There is also growing, yet still preliminary, evidence that increasing accessibility to emotion words while someone experiences a state of unpleasant affect alters the particular discrete emotion that he or she experiences. To test this hypothesis in a behavioral experiment (Lindquist & Barrett, 2008a), we first increased participants' access to the concepts of "fear" versus "anger" (i.e., "primed" those concepts) by asking participants to write a story about a fearful or angry character. In a control condition that did not prime any emotion concepts, participants wrote a neutral story about characters discussing a neutral event. We next separately manipulated whether participants felt unpleasant and highly activated versus neutral by asking them to listen to unpleasant versus neutral music and relive past experiences in which they felt unpleasant versus neutral. We hypothesized that making the concept of "fear" more accessible prior to making participants feel unpleasant would cause them to make meaning of their unpleasant state as an instance of fear. To test this hypothesis, we assessed participants' degree of risk aversion (i.e., the perception that the world is full of danger), which is consistent with how people view the world when they are in a fearful state. As predicted, those participants primed with the word "fear," who listened to unpleasant music subsequently, behaved in a fearful manner (i.e., saw the world as full of danger).

Another recent study demonstrated that the accessibility of emotion concepts influences how feelings manifest as physiological responses during emotion. Participants who were asked to report on their emotions (thereby activating emotion concepts), and who were then berated by an experimenter while completing a challenging mental arithmetic task, showed relative increases in total peripheral resistance (Kassam & Mendes, 2013), consistent with physiological responses to perceived threats. On the other hand, participants who did not have emotion concepts activated experienced less total peripheral resistance. Labeling states actually reduced heart rate and cardiac output (Kassam & Mendes, 2013), which are more generally related to feelings of arousal. These findings are consistent with other growing evidence that categorizing a stress response with an emotion word associated with adaptive responding (e.g., "excitement") versus an emotion word associated with nonadaptive responding (e.g., "fear") alters the resulting emotional experience, physiology, and behavior (see Jamieson, Mendes, & Nock, 2013, for a review).

Another area of research consistent with the psychological constructionist view that language helps constitute emotion comes from research investigating the role of language in the acquisition of new emotion categories. This research is both correlational, tracking the development of language and its relation to emotion perception across early development, and experimental, demonstrating that pairing affective exemplars with words helps adults acquire novel emotion categories over and above mere experience with category exemplars. The correlational evidence suggests that prior to the development of language, infants are unable to perceive discrete emotions on faces, although they can differentiate pleasant, unpleasant, and neutral expressions relatively well (e.g., after habituating to happy faces, 5-month-olds look longer at any unpleasant face, whether fearful, angry, or sad; Bornstein & Arterberry, 2003). Like infants, 2-year-olds, who only know the very simple emotion words "sad" and "happy," can only reliably differentiate between unpleasant and pleasant facial expressions (e.g., they mistakenly perceive all unpleasant faces as "sad," even in a task that does not require language). Yet as we mentioned in the later section "Putting Feelings into Words: The Emotion Lexicon" as 3- and 4-year-olds begin to learn the words "anger" and "fear," they can correspondingly differentiate between sad, angry, and fearful facial expressions (see Widen, 2013, for a review).

Presumably, words help adults learn the meaning of novel facial expressions in much the same way as they help infants and children over the course of development, and experimental research is consistent with this hypothesis. For instance, in the absence of words to label distinct faces, adults were unable to perceive novel chimpanzee facial expressions (e.g., "play," "scream," "bared teeth," and "hoot" faces) as distinct from one another. In the first phase of the experiment, adults viewed pictures of unfamiliar chimpanzee facial muscle movements (e.g., a bared teeth or screaming face) or viewed the faces while also learning to associate them with nonsense words. Participants were later shown images taken from a continuous morphed array of two facial expressions (e.g., ranging from bared teeth to a scream) and were asked to indicate when two faces from the array were similar to each other, and when they were different. Participants who had learned to associate faces with a label displayed "categorical perception"—they were able to perceive a categorical boundary at the midpoint in the morphed array of bared teeth and scream faces—but participants who did not learn to associate faces with a label did not perceive such a categorical distinction (Fugate, Gouzoules, & Barrett, 2010).

Critically, if language helps constitute emotion, then people who speak languages with different emotion concepts should not just communicate emotion differently, but should also perceive and experience it differently. Consistent with this idea, a recent study found that participants who speak different languages see facial expressions differently. The authors used a computer graphics program to measure and then reconstruct East Asian and Western Caucasian participants' visual representations of facial expressions associated with the categories "happy," "surprised," "fearful," "disgusted," "angry," and "sad." Whereas Western Caucasian participants represented each of the six categories with a distinct set of facial movements, East Asian participants did not (Jack, Garrod, Yu, Caldara, & Schyns, 2012).

Our own recent work finds that emotion words guide emotion perception, but only when the words match the concepts that a culture regularly uses to make meaning of emotional faces. Individuals from a remote culture, the Himba of Namibia, and the United States were asked to complete an emotional face-sorting task like that completed in the study of semantic dementia patients. Participants completed the task either with or without emotion words as cues (e.g., a cue that a pile should contain "anger"/"okupindika" faces). Without emotion word cues, even U.S. participants did not sort in line with an assumed "universal" model of emotion based on the English emotion concepts of "anger," "disgust," "fear," "sadness," "happiness," and "neutral" (e.g., Sauter et al., 2010; see Ekman & Cordaro, 2011, for a discussion). Yet with emotion word cues, U.S. participants sorted more in line with this "universal" model. Importantly, Himba individuals did not sort in line with the "universal" model, even when translated versions of English categories were provided to them (Gendron, Roberson, van der Vyver, & Barrett, 2014). These findings suggest that English-language categories may not reflect the categories that are most relevant for Himba participants during facial emotion perception.

Finally, if language helps constitute emotion, then activity in brain regions correlated with language representation, retrieval, and use should also have increased activity when individuals experience or perceive emotions. Consistent with this hypothesis, meta-analyses of brain activity show considerable overlap in the brain regions with increased activity during language use (e.g., semantics; Binder, Desai, Graves, & Conant, 2009) and those with increased activity during emotional experiences and perceptions (Kober et al., 2008; Lindquist et al., 2012) (see Lindquist, Satpute, et al., 2015, figure 2). Shared areas include the dorsomedial prefrontal, ventrolateral prefrontal, and temporal cortical areas. Dovetailing with meta-analytic observations, we (Satpute, Shu, Weber, Roy, & Ochsner, 2013) recently manipulated components of emotional experience and observed that areas related to semantics played functionally dissociable roles during emotional experiences. Medial prefrontal regions and temporoparietal areas had increased activity when individuals retrieved mental state categories relevant for making meaning of their body states (i.e., making "I feel" judgments). By contrast, lateral prefrontal regions had increased activity when individuals retrieved specific semantic categories to make meaning of their feelings (e.g., affective labels such as "neutral," "bad," and "good"). Finally, consistent with the psychological constructionist account that language helps make affect meaningful, we found that limbic/paralimbic regions correlated with the intensity of experienced negative affect.

Together, these findings suggest that words may in fact be constitutive of emotion, suggesting that feelings don't just get "put into words," but that words get "put into feelings" too. However, not all models of emotion conceive of language as constitutive of emotion. We turn now to a perspective that views language and emotion as separate systems, but which hypothesizes that language can modulate emotions after they are formed.

Putting Feelings into Words: Language and the Regulation of Emotion

According to research on *emotion regulation* in psychology and neuroscience, language can serve as a means of altering an emotion after it is formed. Broadly, emotion regulation refers to a family of strategies in which people voluntarily increase or decrease the intensity, meaning, and/or expression of their emotional experiences (e.g., Beauregard, Levesque, & Bourgouin, 2001; Gross, 1998; Ochsner, Bunge, Gross, & Gabrieli, 2002). Models of emotion regulation often take a dual-systems approach, assuming that the processes involved in emotion regulation are distinct from the processes involved in emotion generation (cf. Gross & Barrett, 2011). The bodily, "bottom-up" processes involved in producing the emotion are thus considered distinct from the cognitive, "top-down" processes involved in regulating the emotion (e.g., Gross, 1998; Ochsner et al., 2002). If language is involved in regulating emotion, then it might be one of the so-called "top-down" mechanisms mediated by cognitive systems of the brain.

One of the most commonly studied cognitive mechanisms of emotion regulation is reappraisal, a method by which people up- or down-regulate their affective response to a stimulus by thinking about or reappraising the stimulus or their reaction to it in another way. The extent to which reappraisal involves language is unclear, but it stands to reason that people may be relying on emotion language when they engage in reappraisal. Imagine, for instance, reappraising the feeling experienced when standing atop a skyscraper as "exciting" as opposed to "frightening." In theory, a person is drawing on knowledge about excitement to do so, and may even be implicitly or explicitly labeling the state anew in his or her own mind.

Many studies reveal that participants can successfully decrease or increase self-reported affective experiences using reappraisal (see Gross, 1998; Ochsner et al., 2004), and are suggestive that language could be involved in this process. For instance, neuroimaging studies find that the act of reappraising a stimulus correlates with activity in the ventrolateral prefrontal cortex and dorsomedial prefrontal cortex, areas that are implicated in the representation of semantic knowledge (Binder et al., 2009) and semantic retrieval (Badre & Wagner, 2007; Satpute, Badre, & Ochsner, 2014; Wagner, Pare-Blagoev, Clark, & Poldrack, 2001).[1] Reappraisal also correlates with decreases in amygdala activity while viewing unpleasant images (see Buhle et al., 2013, for a meta-analysis). Since the amygdala is a brain region that responds to the presence of salient or uncertain stimuli and produces autonomic responding (see Cunningham & Brosch, 2012; Whalen, 2007), a reduction in amygdala activity is taken as convergent evidence of successful emotion regulation. These findings imply that language might be involved in reappraisal, but a clear test of the hypothesis that reappraisal depends on language has yet to be conducted.

By contrast, another area of the emotion regulation literature explicitly hypothesizes that language plays a role in emotion regulation. It has been long known that putting feelings into words after the fact can serve as a form of emotion regulation (Pennebaker & Beall, 1986). Pennebaker and colleagues found that writing or talking about one's emotions can reduce long-term distress associated with traumatic events (Pennebaker, 1997). More recent studies have explored the role of labeling emotions in the moment, or "affect labeling" (cf. Lieberman et al., 2007). Unlike reappraisal, which asks participants to actively reconstruct the meaning of a stimulus, affect labeling involves simply relating a single word with a stimulus (e.g., relating the word "anger" with a picture of a scowling face or feelings in the body). This task does not instruct participants to change the intensity of their emotional state, but nevertheless, labeling one's state has the unintended or incidental impact of reducing the intensity of emotional experiences (e.g., Lieberman, Inagaki, Tabibnia, & Crockett, 2011).

In one experimental paradigm, participants are asked to match a photograph of a person making an affective facial expression (e.g., a face with wide eyes) with one of two verbal labels presented below it (e.g., "fear" or "happiness"). Lieberman and colleagues (see Liberman et al., 2011; Lieberman, 2011) propose that accessing words to describe perceptions causes participants to engage in "reflective consciousness," the kind of consciousness that involves thought and symbolic language use. Engaging in reflective consciousness is thought to simultaneously cause detachment or disruption from "reflexive consciousness," the type of consciousness that involves focusing on "qualia" from perceptions in the world or feelings in one's body (cf. Lieberman, 2011). Their hypothesis is that the very act of using language to describe perceptions detaches individuals from the impact of those perceptions. Consistent with this hypothesis, activity in the amygdala was reduced when participants were asked to match an emotional facial expression (e.g., a scowling face) with one of two words (e.g., "anger" vs. "disgust"; Lieberman et al., 2007). The impact of affect labeling has also been observed behaviorally. Spider phobics took more steps toward a caged spider after using emotion words to describe their situation than when using neutral words (Kircanski, Lieberman, & Craske, 2012).

A current question of interest, particularly for this chapter, is the degree to which affect labeling also has an impact on emotional experience. Most studies of affect labeling present participants with facial expressions (Lieberman, 2011). In these contexts, participants may be labeling the meaning of someone else's facial expression rather than their own affective experience. Only a handful of studies have examined affect labeling in contexts that are more oriented toward eliciting and measuring emotional experience in the participant. Some of these studies show reduced affective experience when labeling emotional experience (Lieberman et al., 2011), but others do not (Kircanski et al., 2012; McRae, Taitano, & Lane, 2010). Nevertheless, findings from affect labeling are all the more impressive when considering that these studies—relative to reappraisal studies—do not involve the voluntary intention to change emotional states. Rather, the instructions to participants are minimal; they are merely asked to match a single word with a stimulus. Lieberman thus suggests that affect labeling is a form of incidental affect regulation; that when children are told "Use your words!," the mere act of doing so reduces unpleasant affective states.

Affect labeling resembles mindfulness-based meditation approaches, which have also been shown to reduce unpleasant feelings. In most forms of mindfulness, practitioners are instructed to label their psychological state using a word (e.g., "anger") with nonjudgmental awareness (Brown, Ryan, & Creswell, 2007): The mind is trained to observe sensations dispassionately, without exerting motivation to maintain or remove them. Mindfulness has been associated with a variety of health benefits and stress reduction (Grossman, Niemann, Schmidt, & Walach, 2004), but of more relevance here is the resemblance of mindfulness-based techniques to affect labeling. For instance, dispositional mindfulness appears to have an interactive effect with affect labeling: activity in the prefrontal cortical regions is greater and activity in the amygdala is less when individuals high in trait mindfulness perform an affect labeling task (Creswell, Way, Eisenberger, & Lieberman, 2007). These findings suggest that individuals high in trait mindfulness may in essence be habitual affect labelers.

In stark contrast to the idea that habitual affect labeling reduces the intensity of one's emotion is a body of literature from anthropology, linguistics, and psychology, which sees language and emotion as fundamentally distinct systems that interact only for the sake of communication. We now turn to this literature, which focuses how emotional experiences and perception get translated (often imperfectly) into the "emotion lexicon."

Putting Feelings into Words: The Emotion Lexicon

Research on the "emotion lexicon" systematically describes the terms that speakers of different languages use for emotions (see Clore & Ortony, 1988, for an excellent example of English emotion categories).[2] This approach (with a few notable exceptions, e.g., in linguistics; Pavlenko, 2006;

Wierzbicka, 1999) tends to see language as epiphenomenal to emotion. Indeed, the dominant view within this literature is that the capacity to experience and perceive certain emotions is innate and universal; these universal experiences then "sediment" out in language for the sole purpose of communication (cf. Fontaine, Scherer, & Soriano, 2013). This view thus assumes that emotions are "natural kind" categories that consist of a class of universal experiences that are united by a deep causal mechanism and shared surface features (e.g., all instances of anger are similar because they have the same biological mechanism and produce similar observable feelings, physiological changes, and behaviors across instances; see Barrett, 2006a; Lindquist et al., 2013 for a discussion).

The language sedimentation idea is most likely the dominant perspective in research on the emotion lexicon because it is most consistent with common sense—people essentialize emotion categories (e.g., Lindquist et al., 2013), assuming that emotion words map on to natural kind categories with universal metaphysical essences that make them what they are. People also believe that language is exclusively for communication, despite growing evidence that language feeds back to intrinsically shape mental states ranging from emotions (see Lindquist & Gendron, 2013; Lindquist, Satpute, et al., 2015, for reviews) to basic visual perception (e.g., Lupyan & Ward, 2013). This said, there are alternate viewpoints, largely in linguistics (Pavlenko, 2006; Wierzbicka, 1999) and in approaches that trace the history of the emotion lexicon (Frevert et al., 2014), that assume, like a psychological constructionist view, that emotion categories are social constructions that vary across culture and over time.

Since it is frequently assumed that emotion categories each share a universal "essence," research on the emotion lexicon likewise assumes that language is a mere "representation" of the emotion categories that already exist, albeit a sometimes imperfect representation of those categories. The translation of emotional experiences and perceptions into words is thus thought to occur in a largely consistent manner across languages. From this perspective, some languages might have an emotion lexicon that is relatively "accurate" and others a relatively "inaccurate" representation of the emotional states that humans are biologically prepared to experience and perceive. Much ethnography on the emotion lexicon has implicitly anchored on this assumption. For instance, Russell (1991) concluded that across 114 ethnographies of emotion surveyed "the ethnographer assumed that the way in which emotion is described in English suited that society and . . . that native words could be accurately translated into English" (p. 433).

In cases where a translational equivalent for an English emotion word does not exist, it is typically assumed that the emotion still exists in nature, but that the society did not develop a need to communicate about that particular state. For instance, Levy (1984) referred to states that exist but are not marked with language as "hypocognized," with the assumption that there are universal patterns of expression/behavior/physiology that mark these states even if they are not represented in language. In this view, individuals may experience and perceive states (e.g., "sadness" in Tahitians) that they have no language to communicate. For example, this assumption was tested in speakers of Yucatec Maya, a language that does not have a word for "disgust" (Sauter et al., 2010). The researchers examined whether Yucatec Maya speakers would still be able to differentiate among scowling (angry), wrinkle-nosed (disgusted), and frowning (sad) caricatures of facial expressions (i.e., show categorical perception, or perceptual distortions of a linear continuum of facial actions) despite not having a word for "disgust" in their language. Yucatec Maya participants could reliably differentiate caricatured facial expressions with wrinkled noses from caricatures with frowns or scowls. However, these findings are open to alternate interpretations because participants saw prototypes of each caricature prior to completing the categorization task, during which they received feedback on the accuracy of their judgments. This experience could have allowed them to form perceptual representations for the three different categories even if they did not previously possess separate representations of each of the three categories. At the very least, these findings are inconsistent with other studies in which individuals fail to show categorical perception for emotional faces when they do not know a corresponding emotional word (e.g., Fugate et al., 2010) or cannot access the relevant emotional word due to verbal load (e.g., Roberson & Davidoff, 2000).

Still other research focuses on documenting diversity in emotion language across cultures, focusing on unique categories that do not have a clear translational equivalent across cultures. For example, emotions such as "liget" and "amae" are concepts for which there is no translational equivalent in English. It is clearly difficult to grasp the meaning of a word that does not have an English translational equivalent, but researchers have attempted to unpack the meaning of such terms by describing the contexts in which they are typically used or combining English-language concepts together. For example, "liget" is an emotion that compels members of the Ilongot tribe to kill others by beheading (Rosaldo, 1980). Based on this context alone, an obvious English translation of liget might be "anger." Yet, Rosaldo (1980) also indicates that the "Ilongots see liget in the perspiration of a person hard at work" and invoke "imagery of focused liget in magical spells before they harvest rice" (p. 24). As a result it can be argued that no single word, or even simple combination of emotion terms from the English-language lexicon will capture the meaning of "liget." Similarly, "amae" is a term from the Japanese language and is the emotion experienced when you "depend and presume upon another's love" (Doi, 1973, p. 180)—it occurs in the context of being lovingly cared for. This emotion word has no exact translation in English, although research (Niiya, Ellsworth, & Yamaguchi, 2006) shows that English-language speakers can understand aspects of the concept of "amae" when associated with Western situations (e.g., a friend asks you for help with the computer in the middle of the night). This finding underscores a caveat about the literature on non-English-language emotion categories, more generally: It is possible that there is a bias toward unearthing and publishing about the concepts that are most easily imported into English, simply because they are understandable (even when that understanding comes from combining several English concepts or anchoring on scenarios typical of Western individuals). For instance, English speakers may understand "amae" because the concept maps on to some of the situations that they can identify in their own lives (Niiya et al., 2006). That said, English speakers likely have a more narrow understanding of the concept than Japanese speakers, who use the concept to refer to more than just a state that is felt. "Amae" can refer to "an emotion that a person holds toward another person, an interpersonal relationship, a behavior, or even a belief" (Niiya et al., 2006, p. 281).

Similarly, despite not having a term for "schadenfreude" (pleasure at another's pain) in English, many English speakers easily understand the word. Indeed, "schadenfreude" has been imported into common English parlance and is now the topic of study by English-speaking researchers (e.g., Cikara & Fiske, 2012). By contrast, there are clearly other concepts that do not possess translational equivalents in English and which English speakers are not readily adopting into daily language, such as "liget" in Ilongot (an exuberence during aggressive acts, decribed as a force of life; Rosaldo, 1980), "fago" in Ifaluk (sharing features with the English-language terms of compassion, love, and sadness; Lutz, 1988), and "lajja" in India (sharing features with the English-language term "shame," often occuring in the context of publicly aired achievement; Menon & Shweder, 1994).

A lesser-known set of findings focuses on cultures in which there is a lack of translation for English-language emotion words (see Russell, 1991, for a review). For example, Russell (1991) reviewed (primarily ethnology) reports that some cultures lack terms for specific English-language emotion categories. Tahitians appeared to lack a term for "sadness" and "guilt" (Levy, 1973). A term for "guilt" also appeared to be lacking in the Sinhala language of Sri Lanka (Obeyesekere, 1981), the llongot language of the Philippines (Rosaldo, 1980), the Pintupi language of aboriginal Australians (Morice, 1978), the Samoan language (Gerber, 1975), and in the Ifalukians (Lutz, 1980). A term for "depression" appeared to be lacking in the Yoruba of Nigeria (Leighton et al., 1963), the Fulani in Africa (Riesman, 1986), the Xhosa of South Africa (Cheetham & Cheetham, 1976), the Kaluli of Papua New Guinea (Schieffelin, 1985), in indigenous North American languages (Leff, 1973; Termansen & Ryan, 1970), in the Malay (Resner, 1970), and Chinese (Chan, 1990). Similarly, the term "anxiety" is lacking in the Eskimos of North America and the Yoruba of Nigeria (Leff, 1973), the Chinese (Cheng, 1977), and the Machiguenga of Peru (Johnson, Johnson, & Baksh, 1986). More recently, it was also documented that the Yucatec Maya lack a term for "disgust" (Sauter, LeGuen, & Haun, 2011). This list is, of course, by no means comprehensive. The strong emphasis on cultural universality in the emotion lexicon literature may mean that there are many more instances in which cultural differences in emotion concepts have not been documented. Strikingly, some researchers who uncovered lack of translational equivalents still interpreted their findings within a universalism framework. For example, Levy (1973) suggested that crying (a behavior) in the Tahitians was evidence that they still experienced sadness, even if the emotion did not sediment into language.

The lack of *simple*, single-word translational equivalents for emotion categories between English and other languages suggest that English categories may be a limited "anchor" for explorations of the emotion lexicon across cultures. Not only is there variety in the terms for emotion across cultures but even the overall number of terms in any given lexicon varies widely. According to Levy (1984), cultures not only hypocognize emotions (e.g., the Chewong of Malasia appear to have an emotion lexicon with only seven terms; Howell, 1989), but some cultures hypercognize emotions, with thousands of words to mark different states (e.g., over 2,000 terms in the English language). Perhaps even more intriguing is the fact that cultures disagree on what constitutes an "emotion" in the first place—some cultures do not mark emotions with a single linguistic category and identify them as a special kind of mental state (e.g., the Samoans [Gerber, 1975]; the Gidjingali aborigines of Australia [Hiatt, 1978]; the Chewong of Malaysia [Howell, 1989]; the Tahitians [Levy, 1973]; the Ifalukians of Micronesia [Lutz, 1980]; and the Bimin-Kuskusmin of Papua New Guinea [Poole, 1985]).

At the intersection of extreme universalism and extreme relativism lies a literature that seeks fundamental commonalities among emotion lexicons. This research began with Osgood and colleagues, who assessed core commonalities that define emotion lexicons across cultures during the 1950s and 1960s. Osgood (1975) employed a semantic differential approach in which participants rated the meaning of emotion terms on a number of different bipolar adjective scales. For example, scales might range from "good" to "bad," or "strong" to "weak," with "neutral" as the midpoint. Using data reduction techniques, Osgood (1975) revealed that three dimensions—evaluation, potency, and activity—contributed to the connotation of emotion words across 20 different cultural contexts. Since this seminal work, the same or similar dimensions (e.g., valence and arousal; Russell, 1983) have been documented across many different studies, using a variety of methods (see Russell, 1991, for a review).

More recently, Fontaine and colleagues again assessed the dimensional space that best accounts for the meaning of emotion terms across multiple cultural contexts (Fontaine, Scherer, Roesch, & Ellsworth, 2007). Their approach was theoretically anchored in a "componential" framework for emotions. The authors thus asked participants to rate emotion words on a set of a priori scales assessing action tendencies, subjective experience, and regulatory aspects of emotion (i.e., the GRID instrument; Scherer, 2005). Dimension reduction of data collected across Belgium, the United Kingdom, and Switzerland revealed four dimensions that characterized the similarities among emotion terms: evaluation, potency, arousal, and unpredictability (Fontaine et al., 2007). Although these dimensions are quite similar to those derived in prior research (particularly the first three dimensions, which are largely consistent with Osgood's [1975] results), the fourth dimension of unpredictability was unique to Fontaine et al.'s (2007, 2013) findings. One explanation of the discrepancy between Fontaine et al.'s (2007, 2013) findings and the large literature that observes only two or three dimensions is methodological. Fontaine et al. (2007, 2013) used unipolar rating scales, whereas previous dimension reduction research used bipolar rating scales (see Russell, 1991, for a review). The nature of the scale can impact the correlations between items in factor analysis, with unipolar scales decreasing correlations between items and inflating the number of independent factors observed (see Russell & Carroll, 1999, for a discussion). There is justification for using bipolar scales because participants often implicitly impose a bipolar opposite on a unipolar scale, even if the endpoint is specified as "neutral" (e.g., they assume a scale ranges from "unpleasant" to "pleasant," even when the scale specifies "neutral" to "pleasant") and this causes measurement error (see Russell & Carroll, 1999, for a discussion). Second, prior research did not invoke an a priori set of "components" for emotions. As a result, the structure underlying emotion terms may differ when perceivers anchor on their internal representations of emotion in a relatively unstructured manner versus when cued about specific content as in Fontaine et al. (2007). For example, items related to the "regulation" of emotion appear to load highly on to the "unpredictability" dimension in Fontaine et al.'s (2007) analysis, but it is not clear that individuals standardly think of the regulatory implications of an emotion when they are not prompted to emphasize that meaning of an emotion term.

Wierzbicka's natural semantic meta-language (NSML) offers another approach to understanding the commonalities between emotion terms. Wierzbicka's (1999, 2009) linguistic research indicates that there is minimal universality in concepts across cultures and she argues that more fundamental concepts (e.g., "good," "bad,", "do," "happen," "know," etc.), should form the foundation for cross-cultural comparisons of emotion. The NSML approach is a useful tool for revealing whether words that are assumed to be translational equivalents in different languages (e.g., Russian "smertnaja muca" and English "sorrow"; Wierzbicka, 2009) really have the same underlying meaning. This approach has not been adopted into mainstream psychology (Wierzbicka, 2009), however.

Of course, cultural diversity is not the only factor that produces differences in emotion lexicons. A growing literature also explores the development of emotion words across the lifespan (see Widen, 2013). For instance, children follow a slow and fairly predictable trajectory of linguistic emotion category acquisition (e.g., Widen, 2013). This development is striking because it suggests that some emotion terms, and the corresponding perceptual representations of that emotion category, emerge much later than others. For instance, 2-year-old children reliably use the words “happy” and “angry” (or “happy” and “sad,” depending on the child) to describe faces and can correspondingly distinguish positive from negative faces. However, children do not become able to meaningfully use the word “fear” until later in childhood (around 4 years of age) and do not reliably differentiate fearful faces from other negative faces until this point (see Widen & Russell, 2008). As we note in the Summary, such findings are ultimately consistent with the psychological constructionist view, in which language helps to constitute emotion by driving category acquisition and online categorization of one’s experiences or others’ facial expressions.

Summary

Throughout this chapter, we reviewed three traditions that each explores the relationship between language and emotion. The psychological constructionist approach assumes that concept knowledge supported by words constructs emotions in the first place, when affect is made meaningful as an instance of an emotion category (that is relevant to the speaker of a given language). By contrast, the emotion regulation research assumes that words can modulate emotions, helping to regulate emotions after the fact. Finally, the work on the emotion lexicon typically assumes that feelings merely get put into words after the fact. The fact that so many approaches are concerned with the relationship between language and emotion underscores the importance of this topic area in contemporary psychology, neuroscience, linguistics, and anthrophology. However, the three approaches we discussed herein appear to be mechanistically inconsistent with one another, at least on the surface. We argue that despite their apparent inconsistencies, a psychological constructionist approach can in fact unite findings from across these seemingly diverse domains.

For instance, if language helps to constitute emotional feelings in the first place by shaping how people make meaning of affective states, then it follows that prompting people to make meaning of their states with linguistic categories (as in affect labeling), or to reconstrue the meaning of a feeling with a different linguistic category (as in reappraisal), will contribute to the regulation of emotions. Of course, there is debate about whether the processes involved in emotion regulation are the same or different from those involved in emotion generation (Gross & Barrett, 2011), but early evidence is suggestive that the neural mechanisms involved in emotion experience and regulation are similar (cf. Ochsner, Silvers, & Buhle, 2012). Furthermore, there are alternative interpretations of the affect labeling literature that are consistent with the psychological constructionist view. For instance, it is possible that putting feelings into words actually forces individuals to make meaning of their otherwise ambiguous feelings of affect (pleasantness/unpleasantness or activation/deactivation) toward stimuli (cf. Lindquist, Satpute, et al., 2015). For instance, the finding that explicitly labeling facial expressions with emotion words decreases activity in the amygdala (Lieberman et al., 2007) could be evidence that words help reduce the uncertainty of affective stimuli. The amygdala, although broadly involved in emotion, is thought to be specifically involved in signaling the brain to process uncertain stimuli further (Whalen, 2007). As such, an alternate, but not incompatible, interpretation of the affect labeling findings is that language helps to regulate emotion by reducing uncertainty about the meaning of sensations in the body (as in emotion experience) or the world (as in emotion perception). Once a person constructs an emotional experience or perception and knows what his or her sensations mean, he or she can successfully regulate them. Indeed, greater specificity about the meaning of one’s emotions in daily life (called “emotional granularity”) is associated with greater emotion regulation success across instances (e.g., Barrett, Gross, Conner, & Benvenuto, 2001), perhaps because knowing the meaning of one’s affective state makes it easier to regulate that state (Kashdan, Barrett, & McKnight, 2015; Lindquist & Barrett, 2008b). Indeed, emotional intelligence interventions in children first teach children about different emotion concepts (e.g., “anger,” “fear,” “disgust”) and how to differentiate between instances of those concepts. Once knowledge about the concepts has been learned, children are taught how to regulate their feelings (Rivers, Brackett, Reyes, Elbertson, & Salovey, 2013). The idea that the ultimate mechanism of affect labeling is the categorization of an affective state as an instance of emotion is more consistent with psychological constructionist accounts of emotion, than the assumption that language only feeds back to shape emotions after the fact. Of course, more research is needed to better understand whether the role of language differs in emotion regulation versus emotion construction.

Just as the emotion regulation literature is ultimately consistent with a psychological constructionist view, the emotion lexicon literature can be interpreted as consistent with the idea that language helps construct emotions in the first place. For instance, if words in part constitute emotions, then this might describe why different cultures possess different emotion categories, why there are imperfect translations among different languages about the meaning of emotion words, and why children do not have fully formed emotion concepts until they know the relevant emotion category words. We argue that instead of revealing imperfect linguistic concepts for natural kind categories that already exist in the world, research on the emotion lexicon instead reveals the conceptual content that has the power to shape emotions in the speakers of that language. Consistent with the psychological constructionist view, the emotion categories represented in language might thus be better considered "cognitive types" (Clore & Ortony, 2008, 2013), "nominal kinds" (Barrett, 2012; Lindquist et al., 2013), or situation-specific concepts (Wilson-Mendenhall et al., 2011, 2013) that have the power to shape how speakers of a language make meaning of affective experiences or perceptions in a given moment. This interpretation would explain why speakers of different languages literally "see" different emotions on faces (Gendron et al., 2014; Jack et al., 2012) or describe instances of the same emotion category differently (Wierzbicka, 2009). Until only very recently, researchers assumed that translations of English emotion categories (if they exist) are the same categories that are used by all cultures to describe day-to-day emotional experiences and perceptions. Yet the findings of Gendron et al. (2014) suggests that when studying emotional experiences and perceptions across cultures, researchers should use more open-ended methods to discover (rather than stipulate) what categories members of a culture spontaneously use to make meaning of affective experiences and perceptions in their own daily lives.

In total, the research reviewed in this chapter suggests that conceiving of words as constitutive of emotion charts a new path forward for the science of emotion, helping to unite seemingly disparate traditions of study and suggesting new implications. Taking into consideration that words get put into feelings, alongside the more common-sense notion that feelings get put into words, might just change what researchers discover about the role of language and emotion.

Notes

1. As we pointed out in the first section of this chapter, these same areas are also involved during the experience and perception of emotions (Lindquist, Satpute, et al., 2015), and suggest that language may play a constitutive role in the *generation* of emotional states in the first place.
2. Separate but related lines of research (see Majid, 2012, for a review) focus on how affect/emotion is conveyed in classes of words such as interjections (Gendron et al., 2014; Sauter, Eisner, Ekman, & Scott, 2010; Simon-Thomas, Keltner, Sauter, Sinicropi-Yao, & Abramson, 2009), ideophones (Oda, 2000), and metaphor (Kövecses, 2003; Lakoff, 1987). There is also research assessing the impact of grammar (e.g., syntax), the sound of language (e.g., prosody), and the distinct ways that words are combined in discourse on emotion. This latter topic is an increasing field of inquiry in computing. The growing field of "sentiment analysis" analyzes natural language use (typically in "big data"; Pennebaker, Páez, & Rimé, 2013), with the goal of deriving a measure of the subjective state of the individual (be it an attitude, affective state, or emotion; e.g., Kramer, Guillory, & Hancock, 2014).

References

Badre, D., & Wagner, A. D. (2007). Left ventrolateral prefrontal cortex and the cognitive control of memory. *Neuropsychologia, 45*(13), 2883–2901.

Barrett, L. F. (2006a). Are emotions natural kinds? *Perspectives on Psychological Science, 1*(1), 28–58.

Barrett, L. F. (2006b). Solving the emotion paradox: Categorization and the experience of emotion. *Personality and Social Psychology Review, 10*(1), 20–46.

Barrett, L. F. (2009). The future of psychology: Connecting mind to brain. *Perspectives on Psychological Science, 4*, 326–339.

Barrett, L. F. (2012). Emotions are real. *Emotion, 12*, 413–429.

Barrett, L. F. (2014). The conceptual act theory: A précis. *Emotion Review, 6*, 292–297.

Barrett, L. F., & Bar, M. (2009). See it with feeling: Affective predictions in the human brain. *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences, 364*, 1325–1334.

Barrett, L. F., & Bliss-Moreau, E. (2009). Affect as a psychological primitive. *Advances in Experimental Social Psychology, 41*, 167–218.

Barrett, L. F., Gross, J. J., Conner, T., & Benvenuto, M. (2001). Emotion differentiation and regulation. *Cognition and Emotion, 15*, 713–724.

Barrett, L. F., & Lindquist, K. A. (2008). The embodiment of emotion. In G. R. Semin & E. R. Smith (Eds.), *Embodied grounding: Social, cognitive, affective, and neuroscientific approaches* (pp. 237–262). New York: Cambridge University Press.

Barrett, L. F., Lindquist, K. A., & Gendron, M. (2007). Language as context for the perception of emotion. *Trends in Cognitive Sciences, 11*(8), 327–332.

Barrett, L. F., Mesquita, B., Ochsner, K. N., & Gross, J. J. (2007). The experience of emotion. *Annual Review of Psychology, 58*, 373–373.

Barrett, L. F., & Satpute, A. B. (2013). Large-scale brain networks in affective and social neuroscience: Towards an integrative functional architecture of the brain. *Current Opinion in Neurobiology, 23*, 361–372.

Barsalou, L. W., & Wiemer-Hastings, K. (2005). Situating abstract concepts. In D. Pecher & R. Zwaan (Eds.), *Grounding cognition: The role of perception and action in memory, language, and thought* (pp. 129–163). New York: Cambridge University Press.

Beauregard, M., Levesque, J., & Bourgouin, P. (2001). Neural correlates of conscious self-regulation of emotion. *Journal of Neuroscience, 21*, 6993–7000.

Binder, J. R., Desai, R. H., Graves, W. W., & Conant, L. L. (2009). Where is the semantic system?: A critical review and meta-analysis of 120 functional neuroimaging studies. *Cerebral Cortex, 19*(12), 2767–2796.

Bornstein, M. H., & Arterberry, M. E. (2003). Recognition, discrimination and categorization of smiling by 5-month-old infants. *Developmental Science, 6*(5), 585–599.

Brown, K. W., Ryan, R. M., & Creswell, J. D. (2007). Mindfulness: Theoretical foundations and evidence for its salutary effects. *Psychological Inquiry, 18*, 211–237.

Buhle, J. T., Silvers, J. A., Wager, T. D., Lopez, R., Onyemekwu, C., Kober, H., et al. (2013). Cognitive reappraisal of emotion: A meta-analysis of human neuroimaging studies. *Cerebral Cortex, 24*, 2981–2990.

Cacioppo, J. T., Berntson, C. G., Larsen, J. T., Poehlmann, K. M., & Ito, T. A. (2000). The psychophysiology of emotion. In M. Lewis & J. M. H. Jones (Eds.), *Handbook of emotions* (2nd ed., pp. 173–191). New York: Guilford Press.

Chan, D. W. (1990). The meaning of depression: Chinese word associations. *Psychologia, 33*, 191–196.

Cheetham, W. S., & Cheetham, R. J. (1976). Concepts of mental illness amongst the Xhosa people in South Africa. *Australian and New Zealand Journal of Psychiatry, 10*, 39–45.

Cheng, T. (1977). *A phenomenological study of emotional experience: A search for cultural differences and similarities in the construction of emotion by a Hong Kong Chinese sample*. Unpublished master's thesis, University of Hong Kong.

Cikara, M., & Fiske, S. T. (2012). Stereotypes and schadenfreude: Affective and physiological markers of pleasure at outgroup misfortunes. *Social Psychological and Personality Science, 3*, 63–71.

Clore, G. L., & Ortony, A. (1988). The semantics of the affective lexicon. In V. Hamilton, G. Bower, & N. Frijda (Eds.), *Cognitive perspectives on emotion and motivation* (pp. 367–397). Amsterdam: Springer

Clore, G. L., & Ortony, A. (2008). Appraisal theories: How cognition shapes affect into emotion. In J. M. Haviland-Jones, M. Lewis, & L. F. Barrett (Eds.), *Handbook of emotions* (Vol. 3, pp. 628–642). New York: Guilford Press.

Clore, G. L., & Ortony, A. (2013). Psychological construction in the OCC model of emotion. *Emotion Review, 5*, 335–343.

Creswell, J. D., Way, B. M., Eisenberger, N. I., & Lieberman, M. D. (2007). Neural correlates of dispositional mindfulness during affect labeling. *Psychosomatic Medicine, 69*, 560–565.

Cunningham, W. A., & Brosch, T. (2012). Motivational salience: Amygdala tuning from traits, needs, values, and goals. *Current Directions in Psychological Science, 21*, 54–59.

Cunningham, W. A., Dunfield, K. A., & Stillman, P. (2013). Emotional states from affective dynamics. *Emotion Review, 5*, 344–355.

Doi, T. (1973). *The anatomy of dependence*. Tokyo: Kodansha.

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic. *Emotion Review, 3*, 364–370.

Fontaine, J. R., Scherer, K. R., Roesch, E. B., & Ellsworth, P. C. (2007). The world of emotions is not two-dimensional. *Psychological Science, 18*, 1050–1057.

Fontaine, J. R., Scherer, K. R., & Soriano, C. (2013). *Components of emotional meaning: A sourcebook*. New York: Oxford University Press.

Frevert, U., Eitler, P., Scheer, M., Hitzer, B., Schmidt, A., & Verheyen, N. (2014). *Emotional lexicons: Continuity and change in the vocabulary of feeling 1700–2000*. Oxford, UK: Oxford University Press.

Fugate, J., Gouzoules, H., & Barrett, L. F. (2010). Reading chimpanzee faces: Evidence for the role of verbal labels in categorical perception of emotion. *Emotion, 10*(4), 544–554.

Gendron, M., Roberson, D., van der Vyver, J. M., & Barrett, L. F. (2014). Perceptions of emotion from facial expressions are not culturally universal: Evidence from a remote culture. *Emotion, 14*, 251–262.

Gerber, E. (1975). *The cultural patterning of emotions in Samoa*. Unpublished doctoral dissertation, University of California, San Diego.

Gross, J. J. (1998). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology, 74*(1), 224–237.

Gross, J. J., & Barrett, L. F. (2011). Emotion generation and emotion regulation: One or two depends on your point of view. *Emotion Review, 3*(1), 8–16.

Grossman, P., Niemann, L., Schmidt, S., & Walach, H. (2004). Mindfulness-based stress reduction and health benefits: A meta-analysis. *Journal of Psychosomatic Research, 57*, 35–43.

Heaney, S. (1981). Feeling into words. In S. Heaney (Ed.), *Preoccupations: Selected prose 1968–1978* (pp. 41–60). New York: Faber and Faber.

Hiatt, L. R. (1978). Classification of the emotions. In L. R. Hiatt(Ed.), *Australian aboriginal concepts* (pp. 182–187). Princeton, NJ: Humanities Press

Howell, S. (1989). *Society and cosmos: Chewong of Peninsular Malaysia*. Chicago: University of Chicago Press.

Jack, R. E., Garrod, O. G., Yu, H., Caldara, R., & Schyns, P. G. (2012). Facial expressions of emotion are not culturally universal. *Proceedings of the National Academy of Sciences, 109*, 7241–7244.

Jamieson, J. P., Mendes, W. B., & Nock, M. K. (2013). Improving acute stress responses: The power of reappraisal. *Current Directions in Psychological Science, 22*, 51–56.

Johnson, A., Johnson, O., & Baksh, M. (1986). The colours of emotions in Machiguenga. *American Anthropologist*, 88, 674–681.

Kashdan, T. B., Barrett, L. F., & McKnight, P. E. (2015). Unpacking emotion differentiation: Transforming unpleasant experience by perceiving distinctions in negativity. *Current Directions in Psychological Science, 24*, 10–16.

Kassam, K. S., & Mendes, W. B. (2013). The effects of measuring emotion: Physiological reactions to emotional situations depend on whether someone is asking. *PLOS One, 8*(7), e64959.

Kircanski, K., Lieberman, M. D., & Craske, M. G. (2012). Feelings into words: Contributions of language to exposure therapy. *Psychological Science, 23*, 1086–1091.

Kober, H., Barrett, L. F., Joseph, J., Bliss-Moreau, E., Lindquist, K. A., & Wager, T. D. (2008). Functional grouping and cortical–subcortical interactions in emotion: A meta-analysis of neuroimaging studies. *NeuroImage, 42*(2), 998–1031.

Kövecses, Z. (2003). *Metaphor and emotion: Language, culture, and body in human feeling*. Cambridge, UK: Cambridge University Press.

Kramer, A. D. I., Guillory, J. E., & Hancock, J. T. (2014). Experimental evidence of massive-scale emotional contagion through social networks. *Proceedings of the National Academy of Sciences, 111*, 8788–8790.

Lakoff, G. (1987). *Women, fire and dangerous things: What categories reveal about the mind*. Chicago: University of Chicago Press.

Leff, J. (1973). Culture and the differentiation of emotional states. *British Journal of Psychiatry, 123*, 299–306.

Leighton, A. H., Lambo, T. A., Hughes, C. C., Leighton, D. C., Murphy, J. M., & Macklin, D. B. (1963). *Psychiatric disorder among the Yoruba*. Ithaca, NY: Cornell University Press.

Levy, R. I. (1973). *Tahitians*. Chicago: University of Chicago Press.

Levy, R. I. (1984). The emotions in comparative perspective. In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 397–412). Hillsdale, NJ: Erlbaum.

Lieberman, M. D. (2011). Why symbolic processing of affect can disrupt negative affect: Social cognitive and affective neuroscience investigations. In J. T. Cacioppo, G. G. Berntson, A. Bechara, D. Tranel, & L. C. Hawkley (Eds.), *Social neuroscience: Toward understanding the underpinnings of the social mind* (pp. 188–209). New York: Oxford University Press.

Lieberman, M. D., Eisenberger, N. I., Crockett, M. J., Tom, S. M., Pfeifer, J. H., & Way, B. M. (2007). Putting feelings into words. *Psychological Science, 18*(5), 421–428.

Lieberman, M. D., Inagaki, T. K., Tabibnia, G., & Crockett, M. J. (2011). Subjective responses to emotional stimuli during labeling, reappraisal, and distraction. *Emotion, 11*, 468–480.

Lindquist, K. A. (2013). Emotions emerge from more basic psychological ingredients: A modern psychological constructionist model. *Emotion Review, 5*, 356–368.

Lindquist, K. A., & Barrett, L. F. (2008a). Constructing emotion: The experience of fear as a conceptual act. *Psychological Science, 19*(9), 898–903.

Lindquist, K. A., & Barrett, L. F. (2008b). Emotional complexity. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 513–530). New York: Guilford Press.

Lindquist, K. A., & Barrett, L. F. (2012). A functional architecture of the human brain: Insights from emotion. *Trends in Cognitive Sciences, 16*, 533–554.

Lindquist, K. A., Barrett, L. F., Bliss-Moreau, E., & Russell, J. A. (2006). Language and the perception of emotion. *Emotion, 6*(1), 125–138.

Lindquist, K. A., & Gendron, M. (2013). What's in a word: Language constructs emotion perception. *Emotion Review, 5*, 66–71.

Lindquist, K. A., Gendron, M., Barrett, L. F., & Dickerson, B. C. (2014). Emotion, but not affect perception, is impaired with semantic memory loss. *Emotion, 14*, 375–387.

Lindquist, K. A., Gendron, M., Oosterwijk, S., & Barrett, L. F. (2013). Do people essentialize emotion?: Individual differences in emotional essentialism and consequences for emotional complexity. *Emotion, 13*, 629–644.

Lindquist, K. A., MacCormack, J. K., & Shablack, H. (2015). The role of language in emotion: Predictions from psychological constructionism. *Frontiers in Psychology, 6*, 444.

Lindquist, K. A., Satpute, A. B., & Gendron, M. (2015). Does language do more than communicate emotion? *Current Directions in Psychological Science, 24*, 99–108.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*, 121–143.

Lupyan, G. (2012). Linguistically modulated perception and cognition: The label-feedback hypothesis. *Frontiers in Psychology, 3*, 54.

Lupyan, G., & Ward, E. J. (2013). Language can boost otherwise unseen objects into visual awareness. *Proceedings of the National Academy of Sciences of the United States of America, 110*(35), 14196–14201.

Lutz, C. (1980). *Emotion words and emotional development on Ifaluk Atoll*. Unpublished doctoral dissertation, Harvard University, Cambridge, MA.

Lutz, C. (1988). Ethnographic perspectives on the emotion lexicon. In V. Hamilton, G. Bower, & N. H. Frida (Eds.), *Cognitive perspectives on emotion and motivation* (Vol. 44, pp. 399–419). Netherlands: Springer.

Majid, A. (2012). Current emotion research in the language sciences. *Emotion Review, 4*, 432–443.

Mauss, I. B., & Robinson, M. D. (2009). Measures of emotion: A review. *Cognition and Emotion, 23*, 209–237.

McRae, K., Taitano, E. K., & Lane, R. D. (2010). The effects of verbal labelling on psychophysiology: Objective but not subjective emotion labelling reduces skin-conductance responses to briefly presented pictures. *Cognition and Emotion, 24*, 829–839.

Menon, U., & Shweder, R. A. (1994). Kali's tongue: Cultural psychology and the power of shame in Orissa, India. In S. Kitayama & H. R. Markus (Eds.), *Emotion and culture: Empirical studies of mutual influence* (pp. 241–282). Washington, DC: American Psychological Association.

Morice, R. (1978). Psychiatric diagnosis in a transcultural setting: The importance of lexical categories. *British Journal of Psychiatry, 132*, 87–95.

Niiya, Y., Ellsworth, P. C., & Yamaguchi, S. (2006). Amae in Japan and the United States: An exploration of a "culturally unique" emotion. *Emotion, 6*, 279–295.

Nook, E. C., Lindquist, K. A., & Zaki, J. (2015). A new look at emotion perception: Concepts speed and shape facial emotion recognition. *Emotion, 15*, 569–578.

Obeyesekere, G. (1981). *Medusa's hair: An essay on personal symbols and religious experience*. Chicago: University of Chicago Press.

Ochsner, K. N., Bunge, S. A., Gross, J. J., & Gabrieli, J. D. (2002). Rethinking feelings: An fMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience, 14*, 1215–1229.

Ochsner, K. N., Ray, R. D., Cooper, J. C., Robertson, E. R., Chopra, S., Gabrieli, J. D. E., et al. (2004). For better or for worse: Neural systems supporting the cognitive down- and up-regulation of negative emotion. *NeuroImage, 23*(2), 483–499.

Ochsner, K. N., Silvers, J. A., & Buhle, J. T. (2012). Functional imaging studies of emotion regulation: A synthetic review and evolving model of the cognitive control of emotion. *Annals of the New York Academy of Sciences, 1251*, E1–E24.

Oda, H. (2000). *An embodied semantic mechanism for mimetic words in Japanese*. Bloomington, IN:Indiana University Press.

Osgood, C. E. (1975). *Cross-cultural universals of affective meaning.* Urbana-Champagne: University of Illinois Press.

Patterson, K., Nestor, P. J., & Rogers, T. T. (2007). Where do you know what you know?: The representation of semantic knowledge in the human brain. *Nature Reviews Neuroscience, 8*, 976–987.

Pavlenko, A. (Ed.). (2006). *Bilingual minds: Emotional experience, expression and representation*. Clevedon, UK: Multilingual Matters.

Pennebaker, J. W. (1997). Writing about emotional experiences as a therapeutic process. *Psychological Science, 8*, 162–166.

Pennebaker, J. W., & Beall, S. K. (1986). Confronting a traumatic event: Toward an understanding of inhibition and disease. *Journal of Abnormal Psychology, 95*(3), 274–281.

Pennebaker, J. W., Páez, D., & Rimé, B. (2013). *Collective memory of political events: Social psychological perspectives*. Mahwah, NJ: Erlbaum.

Poole, F. J. P. (1985). Coming into social being: Cultural images of infants in Bimin-Kuskusmin folk psychology. In G. M. White & J. Kirkpatrick (Eds.), *Person, self, and experience: Exploring Pacific ethnopsychologies* (pp. 183–242). Berkeley: University of California Press

Resner, G. H., J. (1970). Concepts and terminology of mental disorder among Malays. *Journal of Cross-Cultural Psychology, 1*, 369–381.

Riesman, P. (1986). The person and the life cycle in African social life and thought. *African Studies Review, 29*, 71–138.

Rivers, S. E., Brackett, M. A., Reyes, M. R., Elbertson, N. A., & Salovey, P. (2013). Improving the social and emotional climate of classrooms: A clustered randomized controlled trial testing the RULER approach. *Prevention Science, 14*, 77–87.

Roberson, D., & Davidoff, J. (2000). The categorical perception of colors and facial expressions: The effect of verbal interference. *Memory and Cognition, 28*(6), 977–986.

Roberson, D., Davidoff, J., & Braisby, N. (1999). Similarity and categorisation: Neuropsychological evidence for a dissociation in explicit categorisation tasks. *Cognition, 71*(1), 1–42.

Rosaldo, M. Z. (1980). *Knowledge and passion: Ilongot notions of self and social life*. Cambridge, UK: Cambridge University Press.

Russell, J. A. (1983). Pancultural aspects of the human conceptual organization of emotions. *Journal of Personality and Social Psychology, 45*, 1281–1288.

Russell, J. A. (1991). Culture and the categorization of emotions. *Psychological Bulletin, 110*(3), 426–450.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*(1), 145–172.

Russell, J. A., & Carroll, J. M. (1999). On the bipolarity of positive and negative affect. *Psychological Bulletin, 125*, 3–30.

Satpute, A. B., Badre, D., & Ochsner, K. N. (2014). Distinct regions of prefrontal cortex are associated with the controlled retrieval and selection of social information. *Cerebral Cortex, 24*, 1269–1277.

Satpute, A. B., Shu, J., Weber, J., Roy, M., & Ochsner, K. N. (2013). The functional neural architecture of self-reports of affective experience. *Biological Psychiatry, 73*(7), 631–638.

Sauter, D. A., Eisner, F., Ekman, P., & Scott, S. K. (2010). Cross-cultural recognition of basic emotions through nonverbal emotional vocalizations. *Proceedings of the National Academy of Sciences, 107*, 2408–2412.

Sauter, D. A., LeGuen, O., & Haun, D. (2011). Categorical perception of emotional facial expressions does not require lexical categories. *Emotion, 11*, 1479–1483.

Scherer, K. R. (2005). What are emotions?: And how can they be measured? *Social Science Information, 44*, 695–729.

Schieffelin, B. B. (1985). *The acquisition of Kaluli*. Hillsdale, NJ: Erlabaum.

Simon-Thomas, E. R., Keltner, D., Sauter, D., Sinicropi-Yao, L., & Abramson, A. (2009). The voice conveys specific emotions: Evidence from vocal burst displays. *Emotion, 9*(6), 838–846.

Termansen, P. E., & Ryan, J. (1970). Health and disease in a British Columbian Indian community. *Canadian Psychiatric Association Journal, 15*, 121–127.

Wagner, A. D., Pare-Blagoev, E. J., Clark, J., & Poldrack, R. A. (2001). Recovering meaning: Left prefrontal cortex guides controlled semantic retrieval. *Neuron, 31*(2), 329–338.

Whalen, P. J. (2007). The uncertainty of it all. *Trends in Cognitive Sciences, 11*(12), 499–500.

Widen, S. C. (2013). Children's interpretation of facial expressions: The long path from valence-based to specific discrete categories. *Emotion Review, 5*, 72–77.

Widen, S. C., & Russell, J. A. (2008). Children acquire emotion categories gradually. *Cognitive Development, 23*(2), 291–312.

Wierzbicka, A. (1999). *Emotions across languages and cultures: Diversity and universals*. Cambridge, UK: Cambridge University Press.

Wierzbicka, A. (2009). Language and metalanguage: Key issues in emotion research. *Emotion review, 1*(1), 3–14.

Wilson-Mendenhall, C. D., Barrett, L. F., & Barsalou, L. W. (2013). Situating emotional experience. *Frontiers in Human Neuroscience, 7*, 764.

Wilson-Mendenhall, C. D., Barrett, L. F., Simmons, W. K., & Barsalou, L. W. (2011). Grounding emotion in situated conceptualization. *Neuropsychologia, 49*, 1105–1127.

CHAPTER 35

Emotion and Attention

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The notion of a struggle between the rational mind and the capricious heart plays out across countless literary plots, monologues, and works of art throughout history. We have come to expect that emotions (e.g., fear, anger, elation) and cognitive processes (e.g., attention, logic, reasoning) are in conflict, vying to control our behavior. Despite this classic view, emotions and cognitive processes seem to work more symbiotically than previously acknowledged. The focus of this chapter is to explore the interaction of emotion and attention: to discuss the ways in which emotional stimuli rapidly and preferentially capture attention, but also how attention can be leveraged to impact the processing of emotional stimuli. To this end, we examine behavioral and electrophysiological measures, in addition to eye-tracking and functional neuroimaging data. We argue that attention–emotion interactions are highly dynamic, unfold over time, and are quite sensitive to context.

From Attention and Emotion to Motivated Attention

The amount of information in the environment far exceeds the processing capacity of the visual system (Anderson, Van Essen, & Olshausen, 2005; Driver, 2001; Parkhurst, Law, & Niebur, 2002; Rensink, O'Regan, & Clark, 1997; Treue, 2003); indeed, only a small portion of information in the environment is actually perceived (Driver, 2001; Raichle, 2010; Rensink et al., 1997). The brain is tasked with quickly sifting through an abundance of information to determine what is most important. The set of cognitive processes that enhance the perception and processing of specific information is referred to as attention (Hillyard, Vogel, & Luck, 1998). Somewhat akin to a spotlight, attention helps focus on specific input. Broadly speaking, attention can be thought of in terms of bottom-up, or exogenous processes, and top-down, or endogenous processes.

As an instance of top-down processes, an individual's goals and motivation can shape how attention filters information (Rock & Gutman, 1981; Tipper, Weaver, Jerreat, & Burak, 1994). Suppose someone was helping a friend look for a lost dog. In this scenario, endogenous attentional processes would facilitate the perception of dogs in the environment. In the laboratory, endogenous attention has been studied by asking participants to detect or locate specific stimuli while ignoring others. In this way, attention can facilitate the processing of specific target stimuli based on their task relevance. On the other hand, bottom-up attentional processes can be driven by perceptual properties of visual stimuli, such as motion or color (Bacon & Egeth, 1994; Parkhurst et al., 2002; Theeuwes, 1994). As an example, the sudden movement of an object captures attention—it is as if changes in certain perceptual properties of stimuli cause them to "pop out."

Stimuli with content that is biologically relevant, or crucial for survival, also seem to capture attention in a similar fashion: with little effort, and relatively automatically, regardless of their perceptual properties and often regardless of their relevance to ongoing tasks or goals (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Mohanty & Sussman, 2013; Vuilleumier, Armony, Driver, & Dolan, 2001; Vuilleumier & Driver, 2008). In this way, stimuli that convey potential danger, reproductive opportunities, or the availability of other rewards are especially effective at capturing attention; the relatively reflexive engagement of attention by motivational imperatives has been referred to as motivated attention (Lang, Bradley, & Cuthbert, 1997).

It is unclear whether motivated attention reflects bottom-up or top-down mechanisms of attention. One possibility is that stimulus features related to emotional content may capture attention in a bottom-up fashion. For instance, emerging data suggest that certain geometric shapes (e.g., downward-pointing triangles) may automatically convey potential threat and reflexively capture attention (Larson, Aronoff, Sarinopoulos, & Zhu, 2009). However, it is also possible that motivational imperatives direct attention to emotional content in a more top-down fashion: if emotional content is relevant to our survival, then we may constantly be on the lookout for potential threat and opportunity. Indeed, cognitive neuroscience is gradually acknowledging that the distinction between top-down and bottom-up attention is oversimplified, and emotional processing is more likely a combination of multiple top-down and bottom-up processes occurring synchronously and interactively (Mesulam, 1998; Mohanty, Egner, Monti, & Mesulam, 2009; Mohanty & Sussman, 2013; Oliveira et al., 2013; Pessoa, 2008, 2010; Pessoa & Adolphs, 2010; Raichle, 2010).

In what follows, we argue that attentional engagement with emotional content begins relatively automatically, but rapidly comes to reflect both universal motivational imperatives and an individual's idiosyncratic ongoing goals and motivation—that is, the nature of the attention–emotion interaction is dynamic and unfolds over time. We discuss evidence for this view derived from multiple behavioral and physiological methods, but focus primarily on event-related potentials (ERPs), a technique with excellent temporal resolution capable of tracking rapidly shifting patterns of attention over time.

ERPs are derived from the ongoing electroencephalogram (EEG), a continuous measure of the electrical activity generated by postsynaptic potentials and measured by electrodes at the scalp. ERPs represent elements of the EEG that are time-locked neural responses to specific events—elicited by the presentation of specific stimuli, or the commission of a motor response (Luck, 2005; Luck & Kappenman, 2012). The rate of electrical conduction from synapse to scalp approaches the speed of light, meaning the signal recorded at the electrode is virtually instantaneous with the underlying neural activity. The temporal resolution of ERPs thus makes them ideal for investigating when conditions differ from one another; this is particularly useful to researchers concerned with shifting and dynamic patterns of attention. Although multiple ERP components are sensitive to the presentation of emotional compared to neutral stimuli (Hajcak, Weinberg, MacNamara, & Foti, 2012; reviewed in Olofsson, Nordin, Sequeira, & Polich, 2008; Weinberg, Ferri, & Hajcak, 2013), we focus specifically on ERP components that have been studied in relation to visual–spatial and sustained attention.

The Allocation of Visual–Spatial Attention to Emotion

A number of behavioral paradigms have been utilized to measure the preferential allocation of visual–spatial attention to emotional content (reviewed in MacNamara, Kappenman, Black, Bress, & Hajcak, 2013). For instance, in a visual search task, a participant is asked to locate a target stimulus among a background of many distracters—imagine looking for your keys in a cluttered drawer. Now instead imagine that you are searching for a picture of a snake among an array of relatively benign objects. Research confirms that if the search target is emotional, participants are faster in visual search tasks; moreover, if distracters are emotional, search speed is slower (Öhman, Flykt, & Esteves, 2001; Öhman, Lundqvist, & Esteves, 2001). Emotional content appears to draw the spotlight of attention, which can facilitate or impede performance in visual search tasks.

Studies have also utilized eye tracking to examine how people attend to emotional compared to neutral stimuli. For instance, Calvo and Lang (2004) simultaneously presented participants with an emotional and neutral picture, and examined eye fixations. Consistent with reaction time measures from visual search tasks described above, participants were more likely to fixate first on emotional compared to neutral pictures. Note here, however, that there were no specific instructions—participants essentially "searched" for and automatically attended to the emotional stimulus using eye movements, even in the absence of a goal to do so.

Fixation location is a reasonable proxy for where attention is allocated (Findlay & Gilchrist, 2003; Parkhurst et al., 2002). However, it is possible to measure the covert allocation of attention using ERPs. Specifically, the N2 posterior contralateral (N2pc) is an early ERP component occurring between 150 and 300 milliseconds, which is thought to reflect the focus of visual–spatial attention on a target while filtering out distracters (Luck, 2012; Luck & Hillyard, 1994). The N2pc has been used to index covert visual attention in cognitive psychology for over 25 years (see Luck, 2012, for a recent review) and more recently has been used to examine the allocation of attention to emotion. These results demonstrate that attention is rapidly directed toward emotional content (Brosch, Pourtois, Sander, & Vuilleumier, 2011; Buodo, Sarlo, & Munafò, 2010; Eimer & Kiss, 2007; Fox, Derakshan, & Shoker, 2008; Ikeda, 2013; Shaw, Lien, Ruthruff, & Allen, 2011).

In a study from our lab, we measured behavior and ERPs during a dot-probe task. On each trial of the dot-probe task, an emotional and neutral picture was presented for approximately 500 milliseconds to the left and right of fixation. Then, a target was presented in either the location previously occupied by the emotional or neutral picture; the participants' goal was to categorize the target as quickly and as accurately as possible. Importantly, we explicitly instructed participants to maintain their gaze on the fixation cross, and we eliminated all trials with eye movements to either picture. Although participants were not faster to categorize the target when presented in the location of the emotional picture, the N2pc revealed an initial shift in attention to the location of emotional stimuli—a difference that was evident by 190 milliseconds after stimuli onset (Kappenman, MacNamara, & Proudfit, 2014).

There is also evidence that the increased allocation of visual attention to emotional stimuli accelerates perception. As in the studies described above, West, Anderson, and Pratt (2009) presented participants with two visual stimuli to the left and right of fixation. However, these stimuli were either presented simultaneously (as in all of the studies described above), or with a slight lag between them; participants were asked to indicate which picture was presented first. Interestingly, West and colleagues (2009) found that neutral faces had to be presented several milliseconds before an angry face in order for participants to perceive them as having simultaneous onset. In other words, if presented simultaneously, participants actually perceived the angry face as being presented prior to the neutral face. Across a range of behavioral, eye-tracking, and electrophysiological measures, these studies collectively suggest that when an emotional stimulus is pitted against a neutral stimulus, visual–spatial attention is directed toward the former.

It is important to note that the facilitated processing of emotional stimuli may depend on the availability of attentional resources (Bishop, Duncan, & Lawrence, 2004; Bishop, Jenkins, & Lawrence, 2007; Liberzon et al., 2000; Pessoa, McKenna, Gutierrez, & Ungerleider, 2002; Pessoa, Padmala, & Morland, 2005). Lavie (2005) proposed that when a task commands sufficient attentional resources, there may not be enough additional bandwidth for the processing of task-irrelevant stimuli, even if they are emotional (see Lavie, Beck, & Nikos, 2014, for a review). However, the impact of load on emotional processing may depend on the specific measure used to index visual–spatial attention to emotion. For instance, much of the evidence that load reduces attention to emotional distracters is based on behavioral (Erthal et al., 2005), functional magnetic resonance imaging (fMRI; Pessoa et al., 2002, 2005), and positron emission tomography (PET) neuroimaging measures (Liberzon et al., 2000). Many of these measures do not directly index visual–spatial attention. On the other hand, the N2pc does not appear to be impacted by concurrent task load (Ikeda, 2013). Moreover, the intensity of the emotional content may further determine whether load attenuates visual–spatial attention to emotion. In our view, future research is required to more definitively examine whether visual–spatial attention to emotion, in particular, is attenuated by cognitive load.

The Allocation of Sustained Attention to Emotion

In all of the studies described above, visual–spatial attention is examined in the context of competition between simultaneously presented emotional and neutral stimuli. However, a good deal of what we know about emotion and attention involves the impact of a single emotional stimulus on subsequent performance. Reaction time measures to targets are slower if they are presented after emotional compared to neutral stimuli (Mitchell, Richell, Leonard, & Blair, 2006; Verbruggen & De Houwer, 2007)—that is, emotional content not only directs visual attention, but engrosses us and sustains attentional engagement, which causes subsequent interference. In one example, Mitchell and colleagues (2006) utilized the emotional interrupt task, which requires participants to categorize a shape that is immediately preceded and followed by a task-irrelevant emotional or neutral picture. In this task, participants are slower to perform the categorization if the target stimulus is sandwiched between emotional compared to neutral pictures (see Weinberg & Hajcak, 2011b, for similar results).

Using an experimental design in which pictures are presented in rapid serial presentation, Wang and colleagues found that emotional stimuli can cause perceptual interference (Wang, Kennedy, & Most, 2012). In a traditional attentional blink paradigm, participants view a rapidly presented series of images, and are asked to look for two target pictures. If the second target is presented shortly after the first, the former is not "seen" by the participant—it is as if the capture of attention by the first target causes a temporary perceptual "blink." Wang and colleagues (2012) found that target detection is similarly impaired if presented in close proximity to an emotional stimulus; thus, emotional stimuli seem to automatically capture attention and elicit an attentional blink.

Other evidence similarly suggests that emotional stimuli engage attentional resources throughout the picture presentation duration. Specifically, Schupp, Cuthbert, Bradley, and Birbaumer (1997) had participants view emotional and neutral pictures for 6 seconds, and presented irrelevant loud tones either during or after the picture viewing period. These tones elicited a P300—a component of the ERP that is larger for attended than unattended stimuli (Polich, 1987). The P300 to auditory probes was reduced when participants were viewing emotional compared to neutral pictures (Schupp et al., 1997). These data suggest that sustained attention to emotional content reduced the available attentional resources that were allocated to the auditory tone.

Sustained Attention and the Late Positive Potential

When participants view emotional compared to neutral stimuli, the ERP at parietal electrode sites is characterized by a sustained slow wave that begins as early as 200 milliseconds (Hajcak, Dunning, & Foti, 2009) and persists for the duration of picture presentation—even up to several seconds beyond picture offset (Hajcak & Olvet, 2008; Pastor et al., 2008). This late positive potential (LPP) is enhanced to emotional images (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Foti, Hajcak, & Dien, 2009; Pastor et al., 2008; Schupp et al., 2000), emotional words (Fischler & Bradley, 2006; Kissler, Herbert, Winkler, & Junghofer, 2009; Tacikowski & Nowicka, 2010) and even emotional hand gestures (Flaisch, Häcker, Renner, & Schupp, 2011). Figure 35.1 depicts a typical LPP, enhanced during the first 3,000 milliseconds while participants view unpleasant compared to neutral pictures. We have argued that the protracted increase in the LPP to emotional compared to neutral pictures reflects sustained engagement with salient content—that the LPP reflects the dynamic interplay between attention and emotion (Hajcak et al., 2012; Weinberg et al., 2013).

The LPP bears a striking resemblance to the P300, which has been studied extensively in nonaffective research. Specifically, the P300 is larger in response to stimuli that have been designated as targets. In a typical P300 oddball paradigm, a participant might be instructed to count the appearances of an infrequently presented neutral target (e.g., a circle) that appears in a sequential stream of frequently presented (i.e., standard) stimuli (e.g., squares). The P300 is enhanced for these infrequent target stimuli relative to the frequently presented standards (Duncan Johnson & Donchin, 1977; Squires, Wickens, Squires, & Donchin, 1976). Moreover, the P300 is larger for targets even when targets and standards are equated for probability, suggesting that task relevance itself is sufficient to potentiate the P300 (Duncan Johnson & Donchin, 1977).

Early research found that emotional stimuli elicited an enhanced positivity between 300 and 600 milliseconds following picture presentation, similar in timing and topography to the P300 observed in oddball tasks (Johnston, Miller, & Burleson, 1986; Lifshitz, 1966; Radilova, 1982). Consistent results were reported for emotional adjectives (Naumann, Bartussek, Diedrich, & Laufer, 1992), faces (Allison, Puce, Spencer, & McCarthy, 1999; Cacioppo, Crites, Berntson, & Coles, 1993; Schupp, Öhman et al., 2004), and even lines conditioned to have emotional meaning (Begleiter, Porjesz, & Garozzo, 1979), suggesting that the processes indexed by the P300 may be linked broadly to motivation. In the language of the classic oddball task, we suggested that emotional stimuli may be considered natural targets (Hajcak et al., 2012).

Many of us have wondered whether the P300 and LPP are the same thing—manifestations of

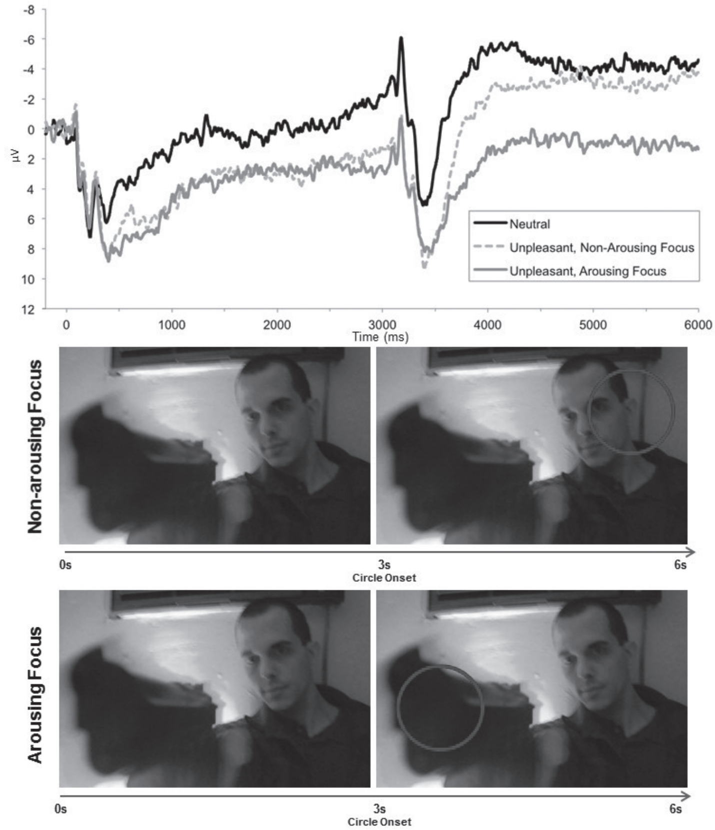

FIGURE 35.1. Data presented are from Dunning and Hajcak (2009), in which participants were instructed to passively view IAPS images for 3 seconds. During passive viewing, the LPP was enhanced to unpleasant relative to neutral images. After 3 seconds, a circle was presented that directed attention toward either an arousing or nonarousing portion of the image. When attention was directed toward an arousing portion of the image, the enhanced LPP was maintained. However, when attention was directed toward a nonarousing portion of the image, the magnitude of the LPP was reduced.

the same process. A key difference between the P300 and LPP is time course: the P300 appears relatively transient, whereas the LPP is more protracted. But why is the LPP a more sustained positivity than the P300? In a variant of a classic oddball paradigm, Gable and Adams (2013) instructed participants to either count the number of times a neutral image was presented, or to determine the duration the neutral target was on the screen. As such, targets in the "count" condition were attentionally salient for a short period of time, whereas "duration" targets were salient for more sustained periods of time. Importantly, Gable and colleagues found a relatively typical P300 to neutral targets in the "count" condition; however, neutral target images in the "duration" condition elicited a sustained LPP. These results demonstrate that the distinction between the P300 and LPP may reflect task-related differences in the time required to categorize target stimuli—that is, typical oddball paradigms only require fleeting engagement with target stimuli and produce a relatively transient LPP (i.e., the P300); however, the target-elicited LPP can be protracted if the oddball task requires more sustained engagement with target stimuli. Conversely, the time course of the LPP depends on the presentation duration of emotional stimuli. When emotional images are presented briefly (e.g., for 500 milliseconds), the LPP is relatively transient; on the other hand, a more sustained LPP is elicited when emotional images are presented for longer (i.e., 2,000 milliseconds; Gable, Adams, & Proudfit, 2014). If emotional stimuli are natural targets, then they are more akin to duration targets (see Gable & Adams, 2013, above) that sustain engagement for their entire presentation duration.

The sustained LPP is sensitive to motivational salience, defined in multiple ways. As mentioned above, target status also impacts the magnitude of the LPP (Azizian, Freitas, Parvaz, & Squires, 2006; Chong et al., 2008; Ferrari, Bradley, Codispoti, & Lang, 2010; Ferrari, Codispoti, Cardinale, & Bradley, 2008; Luck & Hillyard, 2000; Weinberg, Hilgard, Bartholow, & Hajcak, 2012), and nonemotional but personally salient stimuli (e.g., photographs of relatives, or one's own name and face) appear to elicit a larger LPP even than familiar celebrity faces (Grasso & Simons, 2010; Tacikowski & Nowicka, 2010). The amplitude of the LPP is not only sensitive to gross distinctions between emotional and neutral stimuli; it also appears to reflect more fine-grained distinctions between stimuli in terms of their biological relevance (e.g., threat, mutilation, and erotic images; Briggs & Martin, 2009; Schupp, Öhman, et al., 2004; Schupp, Junghöfer, Weike, & Hamm, 2003; Weinberg & Hajcak, 2010; Wheaton et al., 2013). Erotic pictures within the pleasant category elicit a larger LPP than "exciting" images (e.g., content related to sports, cars, or feats of daring), though both erotic and exciting images are rated as highly arousing and pleasant (Weinberg & Hajcak, 2010). This is presumably because exciting images have little direct bearing on survival or reproduction (Briggs & Martin, 2009).

If the LPP reflects sustained engagement with stimulus content, then it should predict subsequent interference from emotional distracters. In a study from our lab, we utilized a version of the emotional interrupt task (described above) in which participants were asked to identify a target—either a circle or a square—which was both preceded and followed by task-irrelevant pleasant, neutral, or unpleasant International Affective Picture System (IAPS) images. As in Mitchell and colleagues' (2006) work, responses to imperative targets were slowed by the presence of task-irrelevant emotional images (Weinberg & Hajcak, 2011b). Furthermore, the larger the LPP to the initial presentation of the emotional image, the slower the response to targets. This was true between participants, such that individuals with an enhanced LPP to task-irrelevant images were slower to respond to targets. And it was also true within participants: For each individual, slower trials tended to be preceded by pictures that elicited a larger LPP. Additionally, a larger LPP to task-irrelevant images was related to a reduction in the magnitude of the P300 elicited by targets. These results suggest that the sustained attentional engagement indexed by the LPP uniquely relates to interference with subsequent targets, as reflected in the subsequently slower response times and reduced P300 to targets in this task.

In terms of neurobiological substrates, the LPP appears to arise from the ongoing activation of, and communication among, multiple regions of the brain—including the visual, parietal, and frontal cortices (Keil et al., 2002; Sabatinelli, Keil, Frank, & Lang, 2013; Sabatinelli, Lang, Keil, & Bradley, 2007), as well as subcortical structures like the ventral striatum and the amygdala (Liu, Huang, McGinnis-Deweese, Keil, & Ding, 2012; Sabatinelli et al., 2013). These findings are consistent with the idea that the magnitude of these later components might reflect both bottom-up influences emerging from activation of the amygdala and visual cortex, as well as additive or competing influences of the frontoparietal attention networks (Bradley et al., 2003; Lang & Bradley, 2010; Lang, Bradley, & Cuthbert, 1998; Vuilleumier, 2005).

Modulating the LPP and Sustained Attention to Emotion

We have argued that the LPP indexes the time course of sustained attention (i.e., engagement) to visual stimuli based on motivational salience—determined both by emotional content and task relevance. Accordingly, the amplitude of the LPP should be sensitive to manipulations that alter the emotional significance of stimuli. Indeed, the LPP can be modulated by a range of strategies that impact how emotional content is appraised (reviewed in Proudfit, Dunning, Foti, & Weinberg, 2013). For instance, in one study, participants viewed emotional or neutral pictures, and had to make either an affective decision (i.e., Is it emotional or neutral?) or a nonaffective decision (i.e., How many people in the picture?) about each picture; the LPP was reduced when participants made nonaffective decisions about emotional pictures, consistent with the notion that these decisions impacted appraisal processes and reduced the salience of emotional content (Hajcak, Moser, & Simons, 2006).

Likewise, manipulations that ask participants to explicitly adjust their thinking about emotional stimuli have been shown to impact the magnitude of the LPP (e.g., Proudfit et al., 2013). One popular experimental technique to study this is cognitive reappraisal, which involves attending directly to emotional content and altering emotional response by reinterpreting the meaning of the stimulus (Sheppes & Gross, 2011). For instance, a participant might view a distressing picture of a sinking ship and think, "The ship is sinking, but everyone aboard survives." Thus, in reappraisal paradigms, the emotional content of stimuli is not made less relevant. Instead, reappraisal is achieved while engaging directly with emotionally arousing aspects of stimuli. Cognitive reappraisal appears to engage frontal brain regions in order to downregulate regions of the brain including the amygdala (Beauregard, Levesque, & Bourgouin, 2001; Ochsner, Bunge, Gross, & Gabrieli, 2002; Phan et al., 2005), and has been shown to reduce both subjective and peripheral physiological indicators of emotional arousal (Urry, 2010). It also effectively reduces the magnitude of the LPP.

In one of the first investigations of cognitive reappraisal using the LPP, Hajcak and Nieuwenhuis (2006) had participants view a series of unpleasant IAPS images; an instruction to "reinterpret" (i.e., reappraise the picture in order to reduce one's negative response) or "attend" (i.e., focus on one's natural feelings about the picture) was then presented, after which the same picture was again presented. Compared with unpleasant pictures presented after the attend instructions, those presented after reappraisal instructions were associated with a reduced LPP—an effect that lasted for the duration of picture presentation. Furthermore, greater reduction in the LPP was related to greater reduction in self-reported arousal ratings of the images. These results have been replicated several times (e.g., Krompinger, Moser, & Simons, 2008; Paul, Simon, Kniesche, Kathmann, & Endrass, 2013; Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2011), and there is even evidence that reappraisal can have a longer-term impact on the LPP to emotional stimuli. For instance, Thiruchselvam and colleagues (2011) found that participants who reappraised unpleasant images demonstrated a reduced LPP in response to these same pictures when they were viewed again 30 minutes later (see MacNamara, Ochsner, & Hajcak, 2011, for similar results). Combined, these data suggest that the magnitude of the LPP can be modulated by changing the way participants think about emotional stimuli.

It is possible that the observed reduction in the LPP associated with reappraisal reflects the fact that the reappraisal condition is associated with increased cognitive load, which also reduces the magnitude of the LPP (MacNamara, Ferri, & Hajcak, 2011). Thus, in a series of studies we refer to in terms of preappraisal, we attempted to separate the effect of load from the effect of meaning change (Foti & Hajcak, 2008; MacNamara, Foti, & Hajcak, 2009). In these studies, participants were again shown neutral and unpleasant images, but here they were given a brief description prior to viewing each image. These descriptions could also be either neutral or unpleasant—participants might see an image of a soldier pointing a gun in the direction of a child preceded by either "This soldier notices the child and does not shoot" (neutral description) or "This child is about to be shot and killed by this soldier" (unpleasant description). Even when the cognitive load of having to generate reappraisals was lifted, these preappraisals modulated the LPP, such that unpleasant images preceded by neutral descriptors elicited a smaller LPP than unpleasant images preceded by unpleasant descriptors. These findings demonstrate that the reduction of the LPP in these reappraisal designs was not a result of the additional cognitive load involved in reappraising each image; rather, elaborative processes associated with stimulus meaning impact the magnitude of the LPP (Foti & Hajcak, 2008; MacNamara et al., 2009; Mocaiber et al., 2010).

Meaning-based manipulations can impact the LPP, even when emotional stimuli are completely irrelevant to the primary task. In one study, participants were asked to identify the spatial orientation of geometric shapes while irrelevant mutilation and neutral scenes were presented as distractors (Mocaiber et al., 2010). These images were described beforehand as being either real or fictitious, thereby shaping the initial appraisal. Consistent with previous research, unpleasant images in the "real" condition elicited a larger LPP than neutral images, and were associated with significantly slower reaction times to the targets, indicating attentional capture that interfered with performance on the primary task. On the other hand, no affective modulation of the LPP was observed in the "fictitious" condition, and there were no differences in reaction time, suggesting that the distractor images in the fictitious condition—while equally gruesome—were less salient and produced less behavioral interference.

Up to this point, we have discussed sustained attention to emotion, reflected in the LPP, as if it was independent of visual–spatial attention. However, there is increasing evidence that even in the absence of competition from other stimuli, visual attention is directed to the most arousing aspects of emotional images. For instance, even when viewing a single unpleasant picture, participants tend to fixate first—and dwell longer—on the most emotionally intense portion of the picture (e.g., the victim's face and the knife in an image depicting an assault; Ferri, Schmidt, Hajcak, & Canli, 2013). Moreover, individuals who are instructed to decrease negative emotion using reappraisal simultaneously shift their gaze away from unpleasant information (van Reekum et al., 2007) and shifting the gaze away from unpleasant information is associated with reduced negative affect as well as reductions in neural indices of emotional processing (Ferri et al., 2013; van Reekum et al., 2007). Thus, how attention is deployed within emotional pictures appears to be a powerful determinant of subjective and physiological measures of emotion.

A line of work from our lab has examined the impact of directed attention on the magnitude of the LPP. For instance, we have asked participants to both passively view emotional and neutral pictures during a portion of each trial; however, we have also directed their attention to more or less emotionally evocative aspects of unpleasant pictures. When participants focus on neutral and nonarousing parts of emotional pictures, the LPP is reduced; when the attention is focused on highly emotional regions of the image, the LPP is increased and appears similar to what we observe during passive viewing (Dunning & Hajcak, 2009; Hajcak, MacNamara, Foti, Ferri, & Keil, 2013). The impact of directed attention on the LPP is rapid—reliably reducing the LPP within about 600 milliseconds (Hajcak et al., 2009). Figure 35.1 presents data from a paradigm in which participants first passively viewed neutral and unpleasant images for 3,000 milliseconds; then, their attention was directed to a specific portion of the image for an additional 3,000 milliseconds (Dunning & Hajcak, 2009). In an exciting extension of this work, Thiruchselvam and colleagues found similar effects on the LPP when attention was directed to more or less emotional aspects of images that participants were holding in working memory (Thiruchselvam, Hajcak, & Gross, 2012).

In other words, the emotional modulation of the LPP appears to track—even within pictures—the dynamic allocation of sustained attention to emotional content. These data are also consistent with previous studies that fail to find emotional modulation of the LPP when pictures are presented in unattended spatial locations (MacNamara & Hajcak, 2009, 2010). Indeed, modulation of the LPP by emotional content likely requires awareness of stimulus content. One study used masking to obscure awareness of emotional images (Codispoti, Mazzetti, & Bradley, 2009). Emotional stimuli masked after 25 to 40 milliseconds failed to modulate the LPP, yet when the same stimuli were presented for 80 milliseconds before the mask, the LPP was enhanced. In addition, Codispoti and colleagues found that some participants were able to accurately report the valence and arousal of images shown for approximately 50 milliseconds, and those participants ("discriminators") showed affective modulation of the LPP at this latency, while "nondiscriminators" did not.

Even when emotional content is consciously perceived, the magnitude of the LPP appears to depend on the availability of resources based on concurrent task demands. For instance, greater cognitive load has been shown to decrease the LPP (MacNamara, Ferri, et al., 2011; Wangelin, Löw, McTeague, Bradley, & Lang, 2011). In MacNamara, Ferri, et al.'s (2011) study, participants were given 5 seconds to memorize a string of consonants; an aversive or neutral task-irrelevant IAPS image was then presented in the retention interval for 2 seconds.

At the end of each trial, participants were asked to type in the letters they had memorized. Working memory load was manipulated via the number of letters, such that on some trials participants were asked to memorize two letters, and on others they were asked to memorize six letters. The magnitude of the LPP decreased as a function of increasing working memory load: When participants were asked to memorize six letters, the LPP to both neutral and aversive images was attenuated. However, working memory load did not eliminate the effect of emotion. Along the same lines as the working memory study described above, several studies have examined the impact of distraction on emotional picture viewing (Paul et al., 2013; Thiruchselvam et al., 2011)—in other words, what happens when individuals maintain their visual attention on emotional stimuli but are instructed to think of something unrelated to the image on the screen (e.g., "mental imagery of complex geometric designs or elaborate scenes around their neighborhood"; Thiruchselvam et al., 2011, p. 86)? In each of these studies, the magnitude of the LPP elicited by unpleasant images in the distract condition was reduced relative to unpleasant images in an unconstrained viewing condition, suggesting cognitive distraction may be sufficient to modulate the LPP, even when visual attention is maintained on the target emotional stimuli. However, as in the working memory studies described above (e.g., MacNamara, Ferri, et al., 2011), emotional modulation of the LPP by unpleasant pictures was observed even in the distract condition, suggesting that distraction and cognitive load may not abolish the emotional modulation of the LPP.

Individual Differences in Attention to Emotion

The majority of the studies we have discussed above were conducted in unselected samples and did not examine individual differences. Yet, the motivational salience of emotional stimuli varies widely across individuals. Although a full review of individual differences in attention to emotion is not possible here, we highlight some interesting instances of the ways in which idiosyncratic goals and biases can impact attention to emotion.

For instance, there is evidence that transitory differences in motivational states can impact the ways in which individuals attend to visual stimuli. Several studies have demonstrated that hunger compared with satiety can impact the processing of food cues: Hunger can increase attention to food-related stimuli (Mogg, Bradley, Hyare, & Lee, 1998), direct spatial attention to irrelevant food cues (Mohanty, Gitelman, Small, & Mesulam, 2008), improve memory for food-related stimuli (Morris & Dolan, 2001), and restrict attentional shifting away from those stimuli (Piech, Hampshire, Owen, & Parkinson, 2009). Hunger can even make food-related stimuli behave like more potent emotional distractors in emotional attentional blink paradigms, decreasing accuracy for targets, even when target detection is associated with monetary reward (Piech, Pastorino, & Zald, 2010). Likewise, food deprivation appears to specifically enhance the magnitude of the LPP elicited by food compared with flower images (Stockburger, Schmälzle, Flaisch, Bublatzky, & Schupp, 2009).

There is also evidence for developmental shifts in motivated attention. For example, older, but not younger, adults appear to attend more to pleasant and less to unpleasant information when they are in a negative mood (Isaacowitz, Toner, Goren, & Wilson, 2008), and these shifts in gaze are positively related to improvements in mood (Isaacowitz, Toner, & Neupert, 2009). Consistent with this, there is evidence that older participants display a smaller LPP than younger participants to unpleasant stimuli, as well as a larger LPP to pleasant stimuli (Kisley, Wood, & Burrows, 2007; Langeslag & Van Strien, 2010).

Stable individual differences can also impact visual spatial attention. There is a wealth of evidence, for example, that phobic individuals, relative to nonphobic individuals, are able to more rapidly detect phobic objects, even in very crowded visual fields (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Öhman, Flykt, et al., 2001). Additionally, individuals with blood phobia exhibit a larger early N2pc to disorder-themed photos paired with either neutral or non-disorder-themed unpleasant images, compared with non-phobic individuals (Buodo et al., 2010). Moreover, there is increasing evidence that individual differences in motivated attention can impact sustained attention to emotional stimuli. For instance, individuals with psychopathy do not show behavioral interference from the emotional distractors in the emotional interrupt task (Mitchell et al., 2006), consistent with evidence that psychopathy may be in part characterized by extreme insensitivity to emotional content. The LPP may be a particularly useful tool for studies of individual differences in sustained emotion processing, in that it is an increasingly well-validated measure and appears to be trait-like in nature. The LPP appears to be a reliable signal with as few as 12 trials (Moran, Jendrusina, & Moser, 2013), and its magnitude is stable over a period of up to 2 years, even in late childhood (Kujawa, Klein, & Proudfit, 2013). Moreover, there is evidence that the magnitude of the overall LPP is substantially heritable (i.e., the LPP to pleasant, neutral, and unpleasant images; Weinberg, Venables, Proudfit, & Patrick, 2014), but also that emotional modulation—the degree to which the LPP differentiates emotional from neutral images—is subject to significant genetic contributions.

The LPP also relates in sensible ways to self-reported differences in motivated attention. For example, Wheaton and colleagues found that the LPP was enhanced by disgust-related images across all participants; however, it was most enhanced among individuals who reported high levels of disgust sensitivity (Wheaton et al., 2013). Likewise, larger LPPs are elicited by idiographic substance cues in alcohol- (Namkoong, Lee, Lee, Lee, & An, 2004), heroin- (Franken, Stam, Hendriks, & van den Brink, 2003), and cocaine-addicted individuals (Dunning et al., 2011; Franken, Hulstijn, Stam, Hendriks, & van den Brink, 2004; van de Laar, Licht, Franken, & Hendriks, 2004). On the other hand, currently depressed individuals (Foti, Olvet, Klein, & Hajcak, 2010) and children at risk for depression (Kujawa, Hajcak, Torpey, Kim, & Klein, 2012) appear to display an attenuated LPP to emotional stimuli, consistent with the notion that depression reflects motivational disengagement from the environment (Rottenberg, 2007; Rottenberg, Gross, & Gotlib, 2005).

The relationship of the LPP to anxiety, on the other hand, appears to be somewhat context dependent. For instance, anxiety has been associated with an increased LPP when pictures are task irrelevant (MacNamara, Ferri, et al., 2011), suggesting deficits among anxious individuals when disengaging attention from irrelevant emotional stimuli. Yet there is also evidence from passive-viewing tasks—in which the pictures are task relevant—that anxiety is instead characterized by initial vigilance for threat images, as indicated by enhancement of early ERP components, followed by a failure to engage in sustained processing of these images, as indicated by an attenuation of the LPP (e.g., Leutgeb, Schäfer, & Schienle, 2009; Weinberg & Hajcak, 2011a). In the study from Leutgeb and colleagues (2009), the anxious individuals completed exposure therapy and were again brought into the lab. Following successful treatment, they no longer showed enhanced early activity to images of their phobic objects, and likewise, the sustained LPP to these images had normalized, providing further evidence that sustained attention to emotional stimuli is flexible and multiply determined.

Conclusions and Future Directions

In this chapter, we have reviewed literature that pertains to emotion and both visual and sustained attention, as reflected in the N2pc and LPP, respectively, as well as behavioral, fMRI, and eye-tracking research. Several measures are uniquely suited for tracking the time-course attention to emotion. Visual–spatial attention is reflexively allocated to emotional content—in this way, emotional stimuli are quite akin to target stimuli in cognitive research. However, emotional stimuli uniquely sustain engagement. Much of the chapter focused on the LPP, as an index of sustained attention to salient visual stimuli, based on the integration of emotional content and broader goals. Indeed, shifting attention can be leveraged as a powerful way to impact the processing of emotional content—that is, emotion and attention are highly related, integrated, and interactive.

References

Allison, T., Puce, A., Spencer, D. D., & McCarthy, G. (1999). Electrophysiological studies of human face perception: I. Potentials generated in occipitotemporal cortex by face and non-face stimuli. *Cerebral Cortex, 9*(5), 415–430.

Anderson, A. K., Christoff, K., Panitz, D., De Rosa, E., & Gabrieli, J. D. E. (2003). Neural correlates of the automatic processing of threat facial signals. *Journal of Neuroscience, 23*(13), 5627–5633.

Anderson, C., Van Essen, D., & Olshausen, B. (2005). *Directed visual attention and the dynamic control of information flow: Neurobiology of attention*. San Diego, CA: Elsevier.

Azizian, A., Freitas, A., Parvaz, M., & Squires, N. (2006). Beware misleading cues: Perceptual similarity modulates the N2/P3 complex. *Psychophysiology, 43*(3), 253–260.

Bacon, W., & Egeth, H. (1994). Overriding stimulus-driven attentional capture. *Perception and Psychophysics, 55*(5), 485–496.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*(1), 1–24.

Beauregard, M., Levesque, J., & Bourgouin, P. (2001). Neural correlates of conscious self-regulation of emotion. *Journal of Neuroscience, 21*(18), 165.

Begleiter, H., Porjesz, B., & Garozzo, R. (1979). Visual evoked potentials and affective ratings of semantic stimuli. In H. Begleiter (Ed.), *Evoked brain potentials and behavior* (Vol. 2, pp. 127–141). New York: Springer.

Bishop, S., Duncan, J., & Lawrence, A. (2004). State anxiety modulation of the amygdala response to unattended threat-related stimuli. *Journal of Neuroscience, 24*(46), 10364–10368.

Bishop, S., Jenkins, R., & Lawrence, A. (2007). Neural processing of fearful faces: Effects of anxiety are gated by perceptual capacity limitations. *Cerebral Cortex, 17*(7), 1595.

Bradley, M. M., Sabatinelli, D., Lang, P. J., Fitzsimmons, J. R., King, W., & Desai, P. (2003). Activation of the visual cortex in motivated attention. *Behavioral Neuroscience, 117*(2), 369–380.

Briggs, K., & Martin, F. (2009). Affective picture processing and motivational relevance: Arousal and valence effects on ERPs in an oddball task. *International Journal of Psychophysiology, 72*(3), 299–306.

Brosch, T., Pourtois, G., Sander, D., & Vuilleumier, P. (2011). Additive effects of emotional, endogenous, and exogenous attention: Behavioral and electrophysiological evidence. *Neuropsychologia, 49*(7), 1779–1787.

Buodo, G., Sarlo, M., & Munafò, M. (2010). The neural correlates of attentional bias in blood phobia as revealed by the N2pc. *Social Cognitive and Affective Neuroscience, 5*(1), 29–38.

Cacioppo, J., Crites, S., Jr., Berntson, G., & Coles, M. (1993). If attitudes affect how stimuli are processed, should they not affect the event-related brain potential? *Psychological Science, 4*(2), 108–112.

Calvo, M., & Lang, P. (2004). Gaze patterns when looking at emotional pictures: Motivationally biased attention. *Motivation and Emotion, 28*(3), 221–243.

Chong, H., Riis, J. L., McGinnis, S. M., Williams, D. M., Holcomb, P. J., & Daffner, K. R. (2008). To ignore or explore: Top-down modulation of novelty processing. *Journal of Cognitive Neuroscience, 20*(1), 120–134.

Codispoti, M., Mazzetti, M., & Bradley, M. (2009). Unmasking emotion: Exposure duration and emotional engagement. *Psychophysiology, 46*(4), 731–738.

Cuthbert, B. N., Schupp, H. T., Bradley, M. M., Birbaumer, N., & Lang, P. J. (2000). Brain potentials in affective picture processing: Covariation with autonomic arousal and affective report. *Biological Psychology, 52*(2), 95–111.

Driver, J. (2001). A selective review of selective attention research from the past century. *British Journal of Psychology, 92*(1), 53–78.

Duncan Johnson, C. C., & Donchin, E. (1977). On quantifying surprise: The variation of event related potentials with subjective probability. *Psychophysiology, 14*(5), 456–467.

Dunning, J., & Hajcak, G. (2009). See no evil: Directing visual attention within unpleasant images modulates the electrocortical response. *Psychophysiology, 46*(1), 28–33.

Dunning, J., Parvaz, M. A., Hajcak, G., Maloney, T., Alia-Klein, N., Woicik, P. A., et al. (2011). Motivated attention to cocaine and emotional cues in abstinent and current cocaine users: An ERP study. *European Journal of Neuroscience, 33*(9), 1716–1723.

Eimer, M., & Kiss, M. (2007). Attentional capture by task-irrelevant fearful faces is revealed by the N2pc component. *Biological Psychology, 74*(1), 108–112.

Erthal, F. S., Oliveira, L., Mocaiber, I., Pereira, M. G., Machado-Pinheiro, W., Volchan, E., et al. (2005). Load-dependent modulation of affective picture processing. *Cognitive, Affective, and Behavioral Neuroscience, 5*(4), 388–395.

Ferrari, V., Bradley, M., Codispoti, M., & Lang, P. (2010). Detecting novelty and significance. *Journal of Cognitive Neuroscience, 22*(2), 404–411.

Ferrari, V., Codispoti, M., Cardinale, R., & Bradley, M. (2008). Directed and motivated attention during processing of natural scenes. *Journal of Cognitive Neuroscience, 20*, 1753–1761.

Ferri, J., Schmidt, J., Hajcak, G., & Canli, T. (2013). Neural correlates of attentional deployment within unpleasant pictures. *NeuroImage, 70*, 268–277.

Findlay, J. M., & Gilchrist, I. D. (2003). *Active vision: The psychology of looking and seeing.* New York: Oxford University Press.

Fischler, I., & Bradley, M. (2006). Event-related potential studies of language and emotion: Words, phrases, and task effects. *Progress in Brain Research, 156*, 185–203.

Flaisch, T., Häcker, F., Renner, B., & Schupp, H. (2011). Emotion and the processing of symbolic gestures: An event-related brain potential study. *Social Cognitive and Affective Neuroscience, 6*(1), 109–118.

Foti, D., & Hajcak, G. (2008). Deconstructing reappraisal: Descriptions preceding arousing pictures modulate the subsequent neural response. *Journal of Cognitive Neuroscience, 20*(6), 977–988.

Foti, D., Hajcak, G., & Dien, J. (2009). Differentiating neural responses to emotional pictures: Evidence from temporal–spatial PCA. *Psychophysiology, 46*(3), 521–530.

Foti, D., Olvet, D., Klein, D., & Hajcak, G. (2010). Reduced electrocortical response to threatening faces in major depressive disorder. *Depression and Anxiety, 27*(9), 813–820.

Fox, E., Derakshan, N., & Shoker, L. (2008). Trait anxiety modulates the electrophysiological indices of rapid spatial orienting towards angry faces. *NeuroReport, 19*(3), 259–263.

Franken, I. H. A., Hulstijn, K. P., Stam, C. J., Hendriks, V. M., & van den Brink, W. (2004). Two new neurophysiological indices of cocaine craving: Evoked brain potentials and cue modulated startle reflex. *Journal of Psychopharmacology, 18*(4), 544–552.

Franken, I. H. A., Stam, C. J., Hendriks, V. M., & van den Brink, W. (2003). Neurophysiological evidence for abnormal cognitive processing of drug cues in heroin dependence. *Psychopharmacology, 170*(2), 205–212.

Gable, P. A., & Adams, D. L. (2013). Nonaffective motivation modulates the sustained LPP (1,000–2,000 ms). *Psychophysiology, 50*(12), 1251–1254.

Gable, P. A., Adams, D. L., & Proudfit, G. H. (2014). Transient tasks and enduring emotions: The impacts of affective content, task relevance, and picture duration on the sustained late positive potential. *Cognitive, Affective, and Behavioral Neuroscience, 15*(1), 45–54.

Grasso, D. J., & Simons, R. F. (2010). Perceived parental support predicts enhanced late positive event-related brain potentials to parent faces. *Biological Psychology, 86*(1), 26–30.

Hajcak, G., Dunning, J., & Foti, D. (2009). Motivated and controlled attention to emotion: Time- course of the late positive potential. *Clinical Neurophysiology, 120*, 505–510.

Hajcak, G., MacNamara, A., Foti, D., Ferri, J., & Keil, A. (2013). The dynamic allocation of attention to emotion: Simultaneous and independent evidence from the late positive potential and steady state visual evoked potentials. *Biological Psychology, 92*(3), 447–455.

Hajcak, G., Moser, J., & Simons, R. (2006). Attending to affect: Appraisal strategies modulate the electrocortical response to arousing pictures. *Emotion, 6*(3), 517–522.

Hajcak, G., & Nieuwenhuis, S. (2006). Reappraisal modulates the electrocortical response to unpleasant pictures. *Cognitive, Affective and Behavioral Neuroscience, 6*, 291–297.

Hajcak, G., & Olvet, D. (2008). The persistence of attention to emotion: Brain potentials during and after picture presentation. *Emotion, 8*(2), 250–255.

Hajcak, G., Weinberg, A., MacNamara, A., & Foti, D. (2012). ERPs and the study of emotion. In S. Luck & E. Kappenman (Eds.), *Handbook of event-related potential components* (pp. 441–474). New York: Oxford University Press.

Hillyard, S., Vogel, E., & Luck, S. (1998). Sensory gain control (amplification) as a mechanism of selective attention: Electrophysiological and neuroimaging evidence. In G. W. Humphreys, J. Duncan, & A. Treisman (Eds.), *Attention, space, and action: Studies in cognitive neuroscience* (pp. 31–53). New York: Oxford University Press.

Ikeda, K. A. T. (2013). Fearful faces grab attention in the absence of late affective cortical responses. *Psychophysiology, 50*(1), 60–69.

Isaacowitz, D. M., Toner, K., & Neupert, S. D. (2009). Use of gaze for real-time mood regulation: Effects of age and attentional functioning. *Psychology and Aging, 24*(4), 989– 994.

Isaacowitz, D. M., Toner, K. F., Goren, D., & Wilson, H. R. (2008). Looking while unhappy: Mood-congruent gaze in young adults, positive gaze in older adults. *Psychological Science, 19*(9), 848–853.

Johnston, V., Miller, D., & Burleson, M. (1986). Multiple P3s to emotional stimuli and their theoretical significance. *Psychophysiology, 23*(6), 684–694.

Kappenman, E. S., MacNamara, A., & Proudfit, G. H. (2014). Electrocortical evidence for rapid allocation of attention to threat in the dot-probe task. *Social Cognitive and Affective Neuroscience, 10*(4), 577–583.

Keil, A., Bradley, M., Hauk, O., Rockstroh, B., Elbert, T., & Lang, P. (2002). Large-scale neural correlates of affective picture processing. *Psychophysiology, 39*(5), 641–649.

Kisley, M. A., Wood, S., & Burrows, C. L. (2007). Looking at the sunny side of life. *Psychological Science, 18*(9), 838.

Kissler, J., Herbert, C., Winkler, I., & Junghofer, M. (2009). Emotion and attention in visual word processing: An ERP study. *Biological Psychology, 80*(1), 75–83.

Krompinger, J., Moser, J., & Simons, R. (2008). Modulations of the electrophysiological response to pleasant stimuli by cognitive reappraisal. *Emotion, 8*(1), 132–137.

Kujawa, A., Hajcak, G., Torpey, D., Kim, J., & Klein, D. N. (2012). Electrocortical reactivity to emotional faces in young children and associations with maternal and paternal depression. *Journal of Child Psychology and Psychiatry, 53*(2), 207–215.

Kujawa, A., Klein, D. N., & Proudfit, G. H. (2013). Two-year stability of the late positive potential across middle childhood and adolescence. *Biological Psychology, 94*(2), 290–296.

Lang, P., & Bradley, M. (2010). Emotion and the motivational brain. *Biological Psychology, 84*(3), 437–450.

Lang, P., Bradley, M., & Cuthbert, B. (1997). Motivated attention: Affect, activation, and action. In P. J. Lang, R. F. Simons, & M. T. Balaban (Eds.), *Attention and orienting: Sensory and motivational processes* (pp. 97–135). Hillsdale, NJ: Erlbaum.

Lang, P., Bradley, M., & Cuthbert, B. (1998). Emotion, motivation, and anxiety: Brain mechanisms and psychophysiology. *Biological Psychiatry, 44*(12), 1248–1263.

Langeslag, S. J. E., & Van Strien, J. W. (2010). Comparable modulation of the late positive potential by emotion regulation in younger and older adults. *Journal of Psychophysiology, 24*(3), 186–197.

Larson, C. L., Aronoff, J., Sarinopoulos, I. C., & Zhu, D. C. (2009). Recognizing threat: A simple geometric shape activates neural circuitry for threat detection. *Journal of Cognitive Neuroscience, 21*(8), 1523–1535.

Lavie, N. (2005). Distracted and confused?: Selective attention under load. *Trends in Cognitive Sciences, 9*(2), 75–82.

Lavie, N., Beck, D. M., & Nikos, K. (2014). Blinded by the load: Attention, awareness and the role of perceptual load. *Philosophical Transactions of the Royal Society, B: Biological Sciences, 369*(1641), 1–10.

Leutgeb, V., Schäfer, A., & Schienle, A. (2009). An event-related potential study on exposure therapy for patients suffering from spider phobia. *Biological Psychology, 82*(3), 293–300.

Liberzon, I., Taylor, S., Fig, L., Decker, L., Koeppe, R., & Minoshima, S. (2000). Limbic activation and psychophysiologic responses to aversive visual stimuli: Interaction with cognitive task. *Neuropsychopharmacology, 23*(5), 508–516.

Lifshitz, K. (1966). The averaged evoked cortical response to complex visual stimuli. *Psychophysiology, 3*(1), 55–68.

Liu, Y., Huang, H., McGinnis-Deweese, M., Keil, A., & Ding, M. (2012). Neural substrate of the late positive potential in emotional processing. *Journal of Neuroscience, 32*(42), 14563–14572.

Luck, S. (2005). *An introduction to the event-related potential technique*. Cambridge, MA: MIT Press.

Luck, S. (2012). Electrophysiological correlates of the focusing of attention within complex visual scenes: N2pc and related ERP components. In S. Luck & E. Kappenman (Eds.), *Oxford handbook of event-related potential components* (pp. 329–360). New York: Oxford University Press.

Luck, S., & Hillyard, S. (1994). Electrophysiological correlates of feature analysis during visual search. *Psychophysiology, 31*, 291–308.

Luck, S. J., & Hillyard, S. A. (2000). The operation of selective attention at multiple stages of processing: Evidence from human and monkey electrophysiology. In M. S. Gazzaniga (Ed.), *The new cognitive neurosciences* (pp. 687–700). Cambridge, MA: MIT Press.

Luck, S., & Kappenman, E. (Eds.). (2012). *The Oxford handbook of event-related potential components*. New York: Oxford University Press.

MacNamara, A., Ferri, J., & Hajcak, G. (2011). Working memory load reduces the LPP and anxiety attenuates this effect. *Cognitive, Affective and Behavioral Neuroscience, 11*, 321– 331.

MacNamara, A., Foti, D., & Hajcak, G. (2009). Tell me about it: Neural activity elicited by emotional stimuli and preceding descriptions. *Emotion, 9*(4), 531–543.

MacNamara, A., & Hajcak, G. (2009). Anxiety and spatial attention moderate the electrocortical response to aversive pictures. *Neuropsychologia, 47*(13), 2975–2980.

MacNamara, A., & Hajcak, G. (2010). Distinct electrocortical and behavioral evidence for increased attention to threat in generalized anxiety disorder. *Depression and Anxiety, 27*(3), 234–243.

MacNamara, A., Kappenman, E. S., Black, S. R., Bress, J. N., & Hajcak, G. (2013). Integrating behavioral and electrocortical measures of attentional bias toward threat. In K. C. Barrett, N. A. Fox, G. A. Morgan, D. J. Fidler, & L. A. Daunhauer (Eds.), *Handbook of self-regulatory processes in development* (pp. 215–243). New York: Psychology Press.

MacNamara, A., Ochsner, K. N., & Hajcak, G. (2011). Previously reappraised: The lasting effect of description type on picture-elicited electrocortical activity. *Social Cognitive and Affective Neuroscience,* 6(3), 348–358.

Mesulam, M. M. (1998). From sensation to cognition. *Brain, 121*(6), 1013.

Mitchell, D., Richell, R., Leonard, A., & Blair, R. (2006). Emotion at the expense of cognition: Psychopathic individuals outperform controls on an operant response task. *Journal of Abnormal Psychology, 115*(3), 559.

Mocaiber, I., Pereira, M. G., Erthal, F. S., Machado-Pinheiro, W., David, I. A., Cagy, M., et al. (2010). Fact or fiction?: An event-related potential study of implicit emotion regulation. *Neuroscience Letters, 476*(2), 84–88.

Mogg, K., Bradley, B., Hyare, H., & Lee, S. (1998). Selective attention to food-related stimuli in hunger: Are attentional biases specific to emotional and psychopathological states, or are they also found in normal drive states? *Behaviour Research and Therapy, 36*(10), 1011.

Mohanty, A., Egner, T., Monti, J., & Mesulam, M. (2009). Search for a threatening target triggers limbic guidance of spatial attention. *Journal of Neuroscience, 29*(34), 10563.

Mohanty, A., Gitelman, D. R., Small, D. M., & Mesulam, M. M. (2008). The spatial attention network interacts with limbic and monoaminergic systems to modulate motivation- induced attention shifts. *Cerebral Cortex, 18*(11), 2604–2613.

Mohanty, A., & Sussman, T. J. (2013). Top-down modulation of attention by emotion. *Frontiers in Human Neuroscience, 7*, 102.

Moran, T. P., Jendrusina, A. A., & Moser, J. S. (2013). The psychometric properties of the late positive potential during emotion processing and regulation. *Brain Research, 1516*, 66–75.

Morris, J. S., & Dolan, R. J. (2001). Involvement of human amygdala and orbitofrontal cortex in hunger-enhanced memory for food stimuli. *Journal of Neuroscience, 21*(14), 5304–5310.

Namkoong, K., Lee, E., Lee, C. H., Lee, B. O., & An, S. K. (2004). Increased P3 amplitudes induced by alcohol-related pictures in patients with alcohol dependence. *Alcoholism: Clinical and Experimental Research, 28*(9), 1317–1323.

Naumann, E., Bartussek, D., Diedrich, O., & Laufer, M. E. (1992). Assessing cognitive and affective information processing functions of the brain by means of the late positive complex of the event-related potential. *Journal of Psychophysiology,* 6(4), 285–298.

Ochsner, K., Bunge, S., Gross, J., & Gabrieli, J. (2002). Rethinking feelings: An fMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience, 14*(8), 1215–1229.

Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology General, 130*(3), 466–478.

Öhman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: A threat advantage with schematic stimuli. *Journal of Personality and Social Psychology, 80*(3), 381–396.

Oliveira, L., Mocaiber, I., David, I. A., Erthal, F., Volchan, E., & Pereira, M. G. (2013). Emotion and attention interaction: A trade-off between stimuli relevance, motivation and individual differences. *Frontiers in Human Neuroscience, 7*, 1–5.

Olofsson, J., Nordin, S., Sequeira, H., & Polich, J. (2008). Affective picture processing: An integrative review of ERP findings. *Biological Psychology, 77*(3), 247–265.

Parkhurst, D., Law, K., & Niebur, E. (2002). Modeling the role of salience in the allocation of overt visual attention. *Vision Research, 42*(1), 107–123.

Pastor, M., Bradley, M., Löw, A., Versace, F., Moltó, J., & Lang, P. (2008). Affective picture perception: Emotion, context, and the late positive potential. *Brain Research, 1189*, 145–151.

Paul, S., Simon, D., Kniesche, R., Kathmann, N., & Endrass, T. (2013). Timing effects of antecedent- and response-focused emotion regulation strategies. *Biological Psychology, 94*(1), 136–142.

Pessoa, L. (2008). On the relationship between emotion and cognition. *Nature Reviews Neuroscience,* 9(2), 148–158.

Pessoa, L. (2010). Emotion and attention effects: Is it all a matter of timing? Not yet. *Frontiers in Human Neuroscience, 4*, 1–5.

Pessoa, L., & Adolphs, R. (2010). Emotion processing and the amygdala: From a "low road" to "many roads" of evaluating biological significance. *Nature Reviews Neuroscience, 11*(11), 773–783.

Pessoa, L., McKenna, M., Gutierrez, E., & Ungerleider, L. (2002). Neural processing of emotional faces requires attention. *Proceedings of the National Academy of Sciences USA,* 99(17), 11458.

Pessoa, L., Padmala, S., & Morland, T. (2005). Fate of unattended fearful faces in the amygdala is determined by both attentional resources and cognitive modulation. *NeuroImage, 28*(1), 249–255.

Phan, K., Fitzgerald, D., Nathan, P., Moore, G., Uhde, T., & Tancer, M. (2005). Neural substrates for voluntary suppression of negative affect: A functional magnetic resonance imaging study. *Biological Psychiatry, 57*(3), 210–219.

Piech, R. M., Hampshire, A., Owen, A. M., & Parkinson, J. A. (2009). Modulation of cognitive flexibility by hunger and desire. *Cognition and Emotion, 23*(3), 528–540.

Piech, R. M., Pastorino, M. T., & Zald, D. H. (2010). All I saw was the cake: Hunger effects on attentional capture by visual food cues. *Appetite, 54*(3), 579–582.

Polich, J. (1987). Task difficulty, probability, and interstimulus interval as determinants of P300 from auditory stimuli. *Electroencephalography and Clinical Neurophysiology, 68*(4), 311–320.

Proudfit, G. H., Dunning, J., Foti, D., & Weinberg, A. (2013). Temporal dynamics of emotion regulation. In J. J. Gross (Ed.), *Handbook of emotion regulation* (2nd ed., pp. 43–57). New York: Guilford Press.

Radilova, J. (1982). The late positive component of visual evoked response sensitive to emotional factors. *Activitas Nervosa Superior, 3*(Part 2), 334–337.

Raichle, M. E. (2010). Two views of brain function. *Trends in Cognitive Sciences, 14*(4), 180–190.

Rensink, R. A., O'Regan, J. K., & Clark, J. J. (1997). To see or not to see: The need for attention to perceive changes in scenes. *Psychological Science, 8*(5), 368.

Rock, I., & Gutman, D. (1981). The effect of inattention on form perception. *Journal of Experimental Psychology, 7*(2), 275–285.

Rottenberg, J. (2007). Major depressive disorder: Emerging evidence for emotion context insensitivity. In J. Rottenberg & S. L. Johnson (Eds.), *Emotion and psychopathology: Bridging affective and clinical science* (pp. 151–165). Washington, DC: American Psychological Association.

Rottenberg, J., Gross, J. J., & Gotlib, I. H. (2005). Emotion context insensitivity in major depressive disorder. *Journal of Abnormal Psychology, 114*(4), 627–639.

Sabatinelli, D., Keil, A., Frank, D. W., & Lang, P. J. (2013). Emotional perception: Correspondence of early and late event-related potentials with cortical and subcortical functional MRI. *Biological Psychology, 92*(3), 513–519.

Sabatinelli, D., Lang, P. J., Keil, A., & Bradley, M. M. (2007). Emotional perception: Correlation of functional MRI and event-related potentials. *Cerebral Cortex, 17*(5), 1085–1091.

Schupp, H., Cuthbert, B., Bradley, M., Cacioppo, J., Ito, T., & Lang, P. (2000). Affective picture processing: The late positive potential is modulated by motivational relevance. *Psychophysiology, 37*(2), 257–261.

Schupp, H., Cuthbert, B., Bradley, M., Hillman, C., Hamm, A., & Lang, P. (2004). Brain processes in emotional perception: Motivated attention. *Cognition and Emotion, 18*(5), 593–611.

Schupp, H., Cuthbert, B. N., Bradley, M. M., & Birbaumer, N. (1997). Probe P3 and blinks: Two measures of affective startle modulation. *Psychophysiology, 34*(1), 1–6.

Schupp, H., Junghöfer, M., Weike, A., & Hamm, A. (2003). Attention and emotion: An ERP analysis of facilitated emotional stimulus processing. *NeuroReport, 14*(8), 1107.

Schupp, H. T., Öhman, A., Junghöfer, M., Weike, A. I., Stockburger, J., & Hamm, A. O. (2004). The facilitated processing of threatening faces: An ERP analysis. *Emotion, 4*(2), 189–200.

Shaw, K., Lien, M.-C., Ruthruff, E., & Allen, P. A. (2011). Electrophysiological evidence of emotion perception without central attention. *Journal of Cognitive Psychology, 23*(6), 695–708.

Sheppes, G., & Gross, J. J. (2011). Is timing everything?: Temporal considerations in emotion regulation. *Personality and Social Psychology Review, 15*(4), 319–331.

Squires, K. C., Wickens, C., Squires, N. K., & Donchin, E. (1976). The effect of stimulus sequence on the waveform of the cortical event-related potential. *Science, 193*(4258), 1142.

Stockburger, J., Schmälzle, R., Flaisch, T., Bublatzky, F., & Schupp, H. T. (2009). The impact of hunger on food cue processing: An event-related brain potential study. *NeuroImage, 47*(4), 1819–1829.

Tacikowski, P., & Nowicka, A. (2010). Allocation of attention to self-name and self-face: An ERP study. *Biological Psychology, 84*(2), 318–324.

Theeuwes, J. (1994). Endogenous and exogenous control of visual selection. *Perception, 23*(4), 429–440.

Thiruchselvam, R., Blechert, J., Sheppes, G., Rydstrom, A., & Gross, J. J. (2011). The temporal dynamics of emotion regulation: An EEG study of distraction and reappraisal. *Biological Psychology, 87*(1), 84–92.

Thiruchselvam, R., Hajcak, G., & Gross, J. J. (2012). Looking inward: Shifting attention within working memory representations alters emotional responses. *Psychological Science, 23*(12), 1461–1466.

Tipper, S., Weaver, B., Jerreat, L., & Burak, A. (1994). Object-based and environment-based inhibition of return of visual attention. *Journal of Experimental Psychology: Human Perception and Performance, 20*(3), 478–499.

Treue, S. (2003). Visual attention: The where, what, how and why of saliency. *Current Opinion in Neurobiology, 13*(4), 428–432.

Urry, H. L. (2010). Seeing, thinking, and feeling: Emotion-regulating effects of gaze-directed cognitive reappraisal. *Emotion, 10*(1), 125–135.

van de Laar, M. C., Licht, R., Franken, I. H. A., & Hendriks, V. M. (2004). Event-related potentials indicate motivational relevance of cocaine cues in abstinent cocaine addicts. *Psychopharmacology, 177*(1–2), 121–129.

van Reekum, C. M., Johnstone, T., Urry, H. L., Thurow, M. E., Schaefer, H. S., Alexander, A. L., et al. (2007). Gaze fixations predict brain activation during the voluntary regulation of picture-induced negative affect. *NeuroImage, 36*(3), 1041–1055.

Verbruggen, F., & De Houwer, J. (2007). Do emotional stimuli interfere with response inhibition?: Evidence from the stop signal paradigm. *Cognition and Emotion, 21*(2), 391– 403.

Vuilleumier, P. (2005). How brains beware: Neural mechanisms of emotional attention. *Trends in Cognitive Sciences, 9*(12), 585–594.

Vuilleumier, P., Armony, J., Driver, J., & Dolan, R. (2001). Effects of attention and emotion on face processing in the human brain: An event-related fMRI study. *Neuron, 30*(3), 829–841.

Vuilleumier, P., & Driver, J. (2008). Modulation of visual processing by attention and emotion: Windows on causal interactions between human brain regions. In J. Driver, P. Haggard, & T. Shallice (Eds.), *Mental processes in the human brain* (pp. 123–153). New York: Oxford University Press.

Wang, L., Kennedy, B. L., & Most, S. B. (2012). When emotion blinds: A spatiotemporal competition account of emotion-induced blindness. *Frontiers in Psychology, 3*, 1–6.

Wangelin, B., Löw, A., McTeague, L., Bradley, M., & Lang, P. (2011). Aversive picture processing: Effects of a concurrent task on sustained defensive system engagement. *Psychophysiology, 48*(1), 112–116.

Weinberg, A., Ferri, J., & Hajcak, G. (2013). Bottom-up and top-down contributions to emotion: Reflections from ERP research. In M. Robinson, E. Watkins, & E. Harmon-Jones (Eds.), *Handbook of cognition and emotion* (pp. 35–54). New York: Guilford Press.

Weinberg, A., & Hajcak, G. (2010). Beyond good and evil: The time-course of neural activity elicited by specific picture content. *Emotion, 10*(6), 767–782.

Weinberg, A., & Hajcak, G. (2011a). Electrocortical evidence for vigilance-avoidance in generalized anxiety disorder. *Psychophysiology, 48*(6), 842–851.

Weinberg, A., & Hajcak, G. (2011b). The late positive potential predicts subsequent interference with target processing. *Journal of Cognitive Neuroscience, 23*(10), 2994–3007.

Weinberg, A., Hilgard, J., Bartholow, B., & Hajcak, G. (2012). Emotional targets: Evaluative categorization as a function of context and content. *Psychophysiology, 84*(2), 149–154.

Weinberg, A., Venables, N. C., Proudfit, G. H., & Patrick, C. J. (2014). Heritability of the neural response to emotional pictures: Evidence from ERPs in an adult twin sample. *Social Cognitive and Affective Neuroscience, 10*(3), 424–434.

West, G. L., Anderson, A., & Pratt, J. (2009). Motivationally significant stimuli show visual prior entry: Evidence for attentional capture. *Journal of Experimental Psychology: Human Perception and Performance, 35*(4), 1032–1042.

Wheaton, M. G., Holman, A., Rabinak, C. A., MacNamara, A., Proudfit, G. H., & Phan, K. L. (2013). Danger and disease: Electrocortical responses to threat- and disgust-eliciting images. *International Journal of Psychophysiology, 90*(2), 235–239.

PART VI

HEALTH-RELATED PERSPECTIVES

CHAPTER 36

EMOTIONS AND HEALTH

Laura D. Kubzansky and Ashley Winning

This big stout fellow had simply melted away. He had cares and worries a great many. He came up from the country moribund. Doses of optimism lavishly administered by the house physician cured him.
—SIR WILLIAM OSLER (in Bean, 1950, p. 84)

A Brief History of Emotions and Health

Links between emotion and health have long been observed and described. In ancient times, Hippocrates considered the four bodily humors (blood, black bile, yellow bile, and phlegm) to be the basis of personality and related emotional experiences (e.g., feeling melancholy), and these elements were also believed to influence disease (Allport, 1961). In the 12th century, Maimonides, a medieval Jewish philosopher, rabbi, and physician, wrote that the purpose of a physician was to help patients keep their emotions in balance at all times because cheerfulness can help to alleviate and cure illness (Rudavsky, 2010). William Harvey (1628/1928), a pioneer in cardiovascular physiology, wrote, "A mental disturbance provoking pain, excessive joy, hope or anxiety extends to the heart, where it affects its temper, and rate, impairing general nutrition and vigor" (p. 106).

In the middle of the 20th century, psychoanalysts suggested that psychological conflicts could trigger or contribute to disease processes, whereby somatic manifestations were considered to represent symbolic expressions of underlying repressed psychological conflicts. Particular types of unconscious conflict were linked with specific health outcomes. For example, conflicts about expressing anger were posited to lead to heart disease, and conflicts about dependency needs to ulcers (Alexander, French, & Pollack, 1968). Empirical tests of these psychoanalytically inspired hypotheses were inconsistent at best, and research on emotion and health fell out of favor. Around this time Hans Selye (1955), an endocrinologist, introduced the term "stress," and then described its physiology and its possible linkages to health and disease. The notion that the experience of stress may be linked to health and disease was taken up in a number of disciplines, and several formulations concerning the relationship between stress and health were put forward. Perhaps due in some measure to these discussions, interest in linkages between emotion and health was revitalized. Investigators with a primary interest in emotion noted several problems with the initial formulations of the stress–health relationship. Thus, research on emotion and health developed partly in parallel with, and partly in reaction to, research on stress and health. Consequently, a challenge for research on emotion and health has been to distinguish conceptual models of stress and health from those on emotion.

Another challenge for this research is that emotions are hypothesized to influence and be influenced by health in a number of ways. Perhaps the least controversial hypothesis is that illness causes distress and negative emotions in various forms. Distress might in turn affect the progression or exacerbation of the illness through effects on health-related behaviors or compliance with a recommended medical regimen (see Elderon & Whooley, 2013, for more discussion of these issues). The most controversial hypothesis is that emotions play a role in maintenance of health or development of disease. While this idea continues to reverberate across medical and psychological sciences, there is skepticism as to whether mental states can indeed influence physical health (Angell, 1985; Coyne & Tennen, 2010).

The focus of this chapter is on the role of emotions in the etiology of disease (and health), rather than as a consequence of disease or as part of the disease management process. While there are likely distinct pathways by which emotion influences the development, triggering, exacerbation, or progression of disease, there may also be overlap among mechanisms affecting these different stages of illness. However, effects of emotion in an already damaged biological system may be quite different from effects in an initially healthy system. Thus, careful consideration of both the affect experience (i.e., valence, intensity, duration, frequency) and the disease (type, stage, onset vs. progression, severity, and biological alterations) is needed when evaluating research in this area. Findings on effects of emotion on health in patient versus in healthy populations should not be considered to inform the same questions equally (although in practice, findings are often used interchangeably). As a result, we consider primarily research conducted with healthy populations aimed at understanding whether emotions influence the likelihood of developing disease. Over the last several decades investigators have amassed substantial empirical evidence strongly suggesting a causal relationship. The most recent findings suggest effects of emotion are not uniform in that negative emotions increase susceptibility to disease while positive emotions protect health beyond simply mitigating effects of negative emotions (Boehm & Kubzansky, 2012).

Theoretical Perspectives Informing the Relationship between Emotion and Health

While theories of emotion were not developed to address relationships between emotions and health, models that build on insights derived from these theories have been developed (described in more detail in the section "Differentiating Between Stress and Emotion"). Emotion theorists suggest that emotions may be conceptualized as having cognitive, neurobiological, and behavioral components (Frijda, 1986). Specific emotions are thought to be biologically based, arising as a product of the interaction between the person and the environment, and mediating between continually changing situations and the individual's behavior (Lazarus, 1968). Emotions, whether positive or negative, are functionally necessary. In part, this is because emotions serve to communicate a person's emotional state and likely behaviors to others in the social environment. The state of subjective feeling also serves to signal that the person is faced with a particular type of challenge and motivates a response (Frijda, 1986). For example, fear motivates escape from danger, sadness motivates disengagement from loss, and so on (Lazarus, 1991b). Emotions are associated with action tendencies that facilitate coping with environmental demands (Fredrickson, 1998; Frijda, 1986). In turn, specific action tendencies are associated with physiological activity patterns that support adaptive behavior (Frijda, 1986). Important to note, however, is that while particular urges to act may be associated with specific emotions, people do not invariably act out these urges.

Antecedents and consequences of emotions vary widely as a function of environmental demands; resources and constraints; by the imminence, duration, and uncertainty of events; and by individuals' motives and beliefs about themselves and the world (Lazarus, 1991b). Each emotion depends on the appraisals and evaluations individuals make in response to events that occur (Lazarus, 1991b). Individuals evaluate the importance of each event, as well as their ability to cope with the demands imposed, and if individuals feel taxed beyond the limits of their capability, emotions with dysfunctional consequences can emerge. It has also been theorized that specific patterns of physiological responses are associated with each emotion (Lazarus, 1991b), but empirical evidence has not conclusively identified such patterns. Despite this heterogeneity, the cognitive, neurobiological, and behavioral components of emotions do vary systematically, and can be identified (Smith & Pope, 1992).

Although emotions are considered separate psychological entities from moods or attitudes, health research sometimes refers to them interchangeably. Unlike moods that are more diffuse, lower in intensity, and of longer duration, emotions generally have a referent. Emotions can also be distinguished as one component of attitudes, defined as learned predispositions to respond in a consistent manner to a given object. Most emotions may be seen as transitory *states* brought on by specific situations, or as *traits* (i.e., stable dispositions to experience particular emotions). Certain personality types are hypothesized to be vulnerable to disease partly because these individuals are predisposed to experience particular emotions (Scheier & Bridges, 1995). Thus, because hostile individuals engage in cynical, mistrusting, and aggressive behavior, they create more opportunities to experience anger.

A separate line of theoretical work has specifically sought to understand positive emotion. The Broaden and Build Model (Fredrickson, 1998), a dominant theoretical perspective, suggests that positive emotions actually produce optimal functioning. This model identifies four positive emotion families including *joy*, *interest*, *contentment*, and *love*, and proposes that positive emotions lead to a broader range of thought and action tendencies. Broadening these tendencies over time builds personal resources and thereby facilitates successful adaptation to ongoing demands. Another relevant theory is the evaluative space model (ESM), which posits that the affect system is defined by separable systems that process positivity and negativity. The ultimate output of the affect systems are behavioral predispositions (Cacioppo, Gardner, & Berntson, 1999). The ESM assumes that positive affect is linked with appetitive motivation, while negative affect is linked with aversive motivation. What is relevant about these theories is that positive and negative emotions are posited to occur in a bivariate space not on a bipolar continuum. Thus, the absence of negative feelings may not be equivalent to the presence of positive feelings, and what is learned by studying negative emotional processes may not transfer to positive emotional processes. This suggests that studying each class of emotion may yield novel insights in relation to health.

Differentiating between Stress and Emotion

Because research on emotion and health has occurred in close conjunction with the stress–health research, it is useful to distinguish between these lines of work. The physiological basis of stress was first proposed by Hans Selye (1950), whose conceptualization had its origins in physics whereby stress was defined as the force exerted on a material structure. According to this definition, if the load is more than the structure can bear, it will lead to structural strain, damage, and possibly collapse (DeSteno, Gross, & Kubzansky, 2013). Following this formulation, Selye hypothesized that external circumstances or events characterized as environmental demands or stressors can cause psychological and/or physical stress, which in turn may cause physiological changes related to disease processes. Selye did not distinguish between physical and psychosocial stressors, and suggested that both elicit the same physiological response pattern (Selye, 1950). Further, stress is presumed harmful because repeated experience leads to the accumulation of damaging physiological changes.

This research played out in two lines of investigation that often clashed over which was more powerful: comparing health effects of the accumulation of stressors of high magnitude characterized by life events (e.g., moving house, birth of a baby), or of lower magnitude but high chronicity, characterized as daily hassles (e.g., concern about paying bills; DeLongis, Coyne, Dakof, Folkman, & Lazarus, 1982; Dohrenwend & Dohrenwend, 1974). In both domains, while findings supported some of the hypothesized associations, they were not as reliable as expected. Problems with the original theory have been identified: It focuses primarily on biological *response* to stressful experiences, makes no distinction between stressor types (e.g., loud noise vs. death of a spouse), and fails to address the psychological appraisals of the demands imposed by the stimulus, or the individual's capacity to meet those demands. A more psychologically oriented theory of stress was developed to explain *when* an individual will experience stress (Lazarus, 1990). In this formulation, stress is experienced when individuals perceive (appraise) that external demands exceed their ability to cope. Links to health occur because the interpretation of an event as stressful triggers a series of physiological changes. This theory incorporated greater emphasis on the capacity of the individual to meet the demands imposed. Because some individuals have more resources than others, the same stressor may be appraised and experienced differently. However, measures have not reliably captured when demands exceed an individual's capacity to cope; as a result, some individuals appear to undergo many stressful events with few health consequences, while others with seemingly trivial problems experience poor health. In fact, knowing an individual's interpretation of any given event and the meaning it has seems to provide stronger insight into predicting whether a stimulus is likely to have a negative impact. In his seminal article on measuring stress, Lazarus (1990) argued that activation of an emotional reaction indicates that an important value or goal has been engaged, which will be harmed, at risk, or advanced. He further posited that no other concept in psychology is as richly revealing of how an individual relates to the physical and social environment, and suggested considering emotions rather than stress per se in relation to health.

To be clear about the distinction between emotion and stress in this chapter, environmental events are considered stressors and emotions are considered responses to stressors. A negative emotion response occurs if demands are perceived to exceed one's ability to cope. Important to note is that any given stressor can be associated with different emotions. For example, losing one's job may provoke anger in some individuals and depression in others. Thus, emotions can be considered products of stressors as well as mediators of their effects. Theories of stress and emotion in relation to health are relatively silent on effects of positive emotions (Cohen, Kessler, & Gordon, 1995), and less detailed about the role of emotional traits. Lazarus (1990) noted that frequently recurring emotions indicate that emotion experience is partly due to properties of the individual (i.e., personality trait) where the trait may transcend specific events in the environment. Thus, emotional traits provide more information about how individuals interact with their environments over time.

Models of Emotion and Health

Figure 36.1 presents a heuristic model designed to illustrate the links among the social environment, emotion, and health. While it is not the focus of the current chapter, the figure incorporates an un-

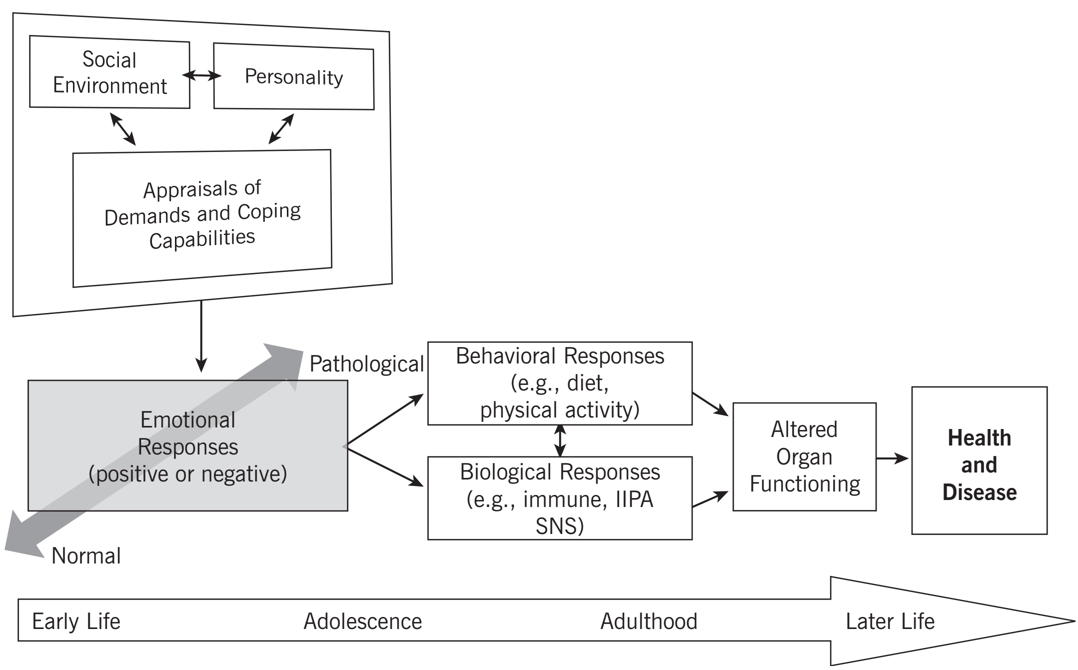

FIGURE 36.1. A model of the stress–emotion–health process. *Note*. HPA: hypothalamic–pituitary–adrenal; SNS: sympathetic nervous system.

derstanding that the social context plays an important role in determining which emotions are likely to be experienced, how they are expressed, and what their consequences will be (Kemper, 1993). Kemper has suggested that emotions also arise in response to power and status differentials embedded within social situations. As a result, even emotions that feel highly personal and unique to the individual can be conditioned by external social factors and are therefore socially patterned. To be parsimonious we have presented a unidirectional model, but failure to include alternative paths is not designed to imply these relations are static or to indicate hypotheses about their existence.

Emotions are hypothesized to influence health directly because they evoke physiological processes (e.g., activation of the hypothalamic–pituitary–adrenocortical [HPA] axis and the sympathetic nervous system [SNS]), and indirectly because they influence health-relevant behaviors via motivation and decision making (see Figure 36.1). Pathways by which negative emotions directly alter biological processes have been identified and evaluated in animal models and human populations. For example, elevated serum norepinephrine levels associated with negative emotions may increase blood lipids, free fatty acids, blood pressure, and heart rate, and lead to constriction of peripheral blood vessels. Negative emotions may also lead to altered autonomic regulation of the heart (e.g., Kawachi, Sparrow, Vokonas, & Weiss, 1995). Other direct biological effects of emotion on health may occur through altered immune functioning. Immune cells have receptors for cortisol, epinephrine, and norepinephrine. Thus, activation of the HPA axis and the SNS occurs, which results in elevated serum levels of cortisol and catecholamines and can also lead to immune function dysregulation. Over time, recurring activation of these systems may initiate disease-related physiological processes (Cohen, Janicki-Deverts, & Miller, 2007). Direct biological effects of positive emotions are less well studied, but emerging evidence points to salutary effects on several parameters like lipids, inflammation, and vagal tone (Boehm & Kubzansky, 2012).

Emotions may also have an indirect effect on health by influencing thoughts, decisions, and behaviors that in turn influence pathophysiology. By altering perceptions of risk, emotions can influence health-relevant decisions such as seeking medical treatment or screenings, or adhering to exercise or diet regimens, which in turn shape subsequent physical health (Rothman, Kelly, Hertel, & Salovey, 2003). Recent research has further suggested that emotion valence (i.e., positive vs. negative) alone cannot adequately capture the specificity of effects. Rather, a more fine-grained view of how specific emotions impact risk perception is needed (DeSteno et al., 2013). Emotions may influence decision making in other ways as well. Many health-relevant decisions are characterized by intertemporal choice, as they have different consequences depending on when they are enacted over time. For example, exercising now may provide health benefits later but may be less enjoyable in the moment than watching television. Emotions can influence how dilemmas of intertemporal choice are resolved—for example, recent research has suggested that positive social emotions increase the odds that people will accept short-term hedonic reductions to make future gains possible (DeSteno, 2009). Other effects may occur because emotions alter biological processes that influence decision making. For example, negative emotions may activate dopamine reward centers of the brain among smokers, leading them to take another cigarette (e.g., Brody et al., 2009). Emotions also influence social processes including the quality and quantity of an individual's social relationships, which in turn influence health (see Cohen & Rodriguez, 1995). Moreover, any affective state has the potential to influence several decision-relevant processes occurring concurrently, thereby leading to outcomes that can enhance, diminish, or even reverse the expected outcome resulting from any one isolated process (DeSteno et al., 2013).

While much of the initial research on emotions and health has focused on either positive or negative emotions, negative and positive emotions and the interplay between them are products of an *emotion regulation* process, which involves monitoring and managing one's emotional experience and response (Gross & Thompson, 2007). Recognizing that this process may provide insight into why positive and negative emotions both matter for health, investigators have increasingly focused on the importance of emotion regulation for health (see Appleton & Kubzansky, 2014, for a recent review of the literature). In fact, emotion regulation is a key component of the broader concept of "self-regulation," which encompasses the ability to focus attention, resist impulses, and delay gratification, and has also been identified as a critical factor influencing health. Early theories speculated that aspects of emotion regulation might be linked to health because the effort involved in suppressing or inhibiting (vs. expressing) emotions was posited to be biologically costly, thereby leading to increased susceptibility to illness over time (Pennebaker & Beall, 1986). Numerous studies suggest that inhibiting expression of emotion impairs symptom recognition, delays help-seeking behavior, and compromises communication about problems (e.g., de Ridder, Geenen, Kuijer, & van Middendorp, 2008). Studies have also examined if disclosing strong emotional feelings can improve health outcomes (broadly defined) by avoiding the cumulative stress of inhibition. Positive health effects have been demonstrated (Consedine, Magai, & Bonanno, 2002), with findings suggesting that health will be optimized when emotion regulatory strategies facilitate acknowledging, expressing, and processing emotions appropriately (de Ridder et al., 2008). More recent formulations have moved away from defining regulation as expression versus suppression, and suggest that emotion regulation is a dynamic process involving both up- and down-regulation of positive and negative emotions (Gross & John, 2003). Some strategies are antecedent focused, employed *before* an emotion occurs (e.g., reappraisal). In contrast, response-focused strategies are employed *after* an emotion has occurred (e.g., suppression), which may be taxing and fail to mitigate fully a negative emotional experience. The appropriateness of any given strategy is context dependent, though recent research has suggested that greater reliance on antecedent-oriented regulation may be more adaptive in the context of health (Appleton & Kubzansky, 2014).

Approaches for Investigating Emotion and Health

A number of study design issues present challenges for research on emotion and health. Some research has focused on immediate physiological responses posited to be relevant to health (e.g., cardiovascular reactivity) that are associated with emotion experiences. This work is informative if one assumes that short-term physiological effects as measured in the laboratory are related to long-term health consequences; recent work suggests that this may be a reasonable assumption (e.g., Chida & Steptoe, 2010).

Whether acute emotion states might trigger a health event or exacerbate underlying disease has also been considered, with most research conducted in the context of coronary heart disease (CHD) events. In contrast, research on emotion traits seeks to evaluate long-term health effects of recurring emotion experiences. Due to logistic and feasibility issues (i.e., it is difficult to assign individuals to experience chronically one emotion or another prior to disease development), true experiments cannot directly test if emotion is causally associated with increased risk of disease. Numerous randomized control trials have sought to alter emotional functioning (e.g., reduce anxiety or depression) within patient populations to see if effective treatment slows disease progression or reduces risk of a secondary event or early death (Elderon & Whooley, 2013). While important in their own right, such studies cannot directly assess the contribution of emotion to disease onset because they are conducted in patient as opposed to healthy populations and because they assess primarily the treatment of emotional disorders.

Epidemiological research, focused on the study of the distribution and determinants of disease, has rigorous methods for assessing and evaluating factors that contribute to health. As a result, many of the strongest studies on emotion and health have been conducted using epidemiological methods and frameworks. The most convincing designs measure emotions when individuals are healthy, include objective measures of health (reducing concerns about self-report bias), and include measures of an array of potential confounders. However, even these designs remain susceptible to concerns about hidden sources of reverse causality (i.e., prodromal disease influences emotion) and that some unmeasured variable (e.g., a genetic risk factor) in fact drives the apparent emotion–health relationship.

Emotion is most commonly measured via self-report, which can be subject to social desirability and assumes individuals have sufficient insight to give accurate reports of their emotional experience (Shedler, Mayman, & Manis, 1993). A further issue is that many measures of emotion include somatic symptoms (e.g., racing heart), which may confound assessment of the emotion–health relationship (Leventhal & Patrick-Miller, 2000). Because emotion is not commonly the focus of epidemiological research, psychological measures, when utilized, are limited. Thus, much of the work has been truly opportunistic, using whatever assessment may be available, ranging from measures of emotional disorders (e.g., major depressive disorder) to symptom measures to single-item measures. Epidemiological studies often consider depression and anxiety as representing single emotions; in contrast, psychologists have suggested that while these states are characterized by dysregulated emotion, they also reflect complex constellations of maladaptive cognitions and behaviors (Lazarus, 1991a). Given the primacy of the emotion component and the insight an emotion-oriented framework may bring to understanding their role in health, for the purposes of this chapter we refer to each of these states (depression and anxiety) simply as an "emotion." Moreover, because of the focus on pathophysiology, some epidemiological research has presumed that emotion-related effects on health are primarily due to psychopathology. However, the experience of most emotions occurs along a continuum (Kubzansky, 2007). For example, anxiety is a commonly experienced emotion that can also underlie a clinical disorder. Pathological and normal anxiety reactions are similar in their cognitive, neurobiological, and behavioral components (Frijda, 1994). This may help to understand why health effects are evident across the spectrum, and moreover, why emotions appear to have a dose–response (i.e., with higher frequency or intensity of emotional experience, effects are stronger) association with risk of disease onset.

Evidence for an Association between Emotion and Health

Experimental Research

The physiological impact of acute states of distress has largely been studied in relation to indicators of cardiovascular function and risk, such as heart rate and blood pressure reactivity, inflammatory responses, and vascular endothelial function, assessed under controlled laboratory conditions. By incorporating experimental manipulation of stress stimuli, and eliminating or monitoring confounding factors, the ability to make causal inferences is enhanced. Several studies have demonstrated that acute laboratory-induced mental stress impairs endothelial function (e.g., Spieker et al., 2002), although the finding is not uniform (see Poitras & Pyke, 2013, for a review). Other studies have examined whether acute mental stress influences inflammatory processes, considering increases in circulating proinflammatory cytokines. A meta-analysis of 30 studies reported robust effects of acute stress on several cytokines including significant increases in interleukin-1 beta (IL-1β) ($r = .58$, $p < .001$) and IL-6 ($r = .19$, $p = .001$), and marginal increases in C-reactive protein (CRP; $r = .12$, $p = .088$; Steptoe, Hamer, & Chida, 2007). In another meta-analysis, poorer cardiovascular outcomes were predicted by greater reactivity to laboratory-induced mental stress (36 articles; $r = .091$, $p < .001$) and poor poststress recovery (five articles; $r = .096$, $p < .001$; Chida & Steptoe, 2010). More recently, Carroll et al. (2012) demonstrated that exaggerated systolic and diastolic blood pressure reactions to acute mental stress were subsequently associated with cardiovascular disease (CVD) mortality over a 16-year follow-up. Findings suggest long-term (e.g., heightened reactivity on vasculature erosion) and short-term (e.g., acute event triggering) effects (Carroll et al., 2012).

Several studies have explored potential mediators and moderators of the acute stress–cardiovascular reactivity relationship. This work suggests that effects differ somewhat by age with older individuals exhibiting higher systolic blood pressure reactivity but lower heart rate reactivity in response to emotionally evocative laboratory tasks (Uchino, Birmingham, & Berg, 2010). Other studies suggest that individuals who are already distressed may have a stronger acute stress response (Miller, Rohleder, Stetler, & Kirschbaum, 2005). Stress reactivity in the laboratory has also been considered in relation to emotion regulation. Some studies suggest that actively inhibiting or suppressing emotion is associated with deleterious autonomic functioning, including increased activation of the autonomic system (Gross & Levenson, 1997) and reduced heart rate variability (Denson, Grisham, & Moulds, 2011); in contrast, actively expressing or disclosing emotions was associated with beneficial cardiovascular effects, including lower blood pressure (Willmott, Harris, Gellaitry, Cooper, & Horne, 2011) and lower levels of proinflammatory cytokines.

One limitation of laboratory-induced stress reactivity studies is that the acute stimuli may lack ecological validity. In response, some studies have used ambulatory monitors to capture cardiovascular responses to real-life stressors (such as school examinations), self-reported emotions, or perceived stress. A recent qualitative review of representative papers in this area concluded that cardiovascular responses to real-life stress are often larger than those obtained in laboratory settings, suggesting that laboratory findings may be conservative estimates of effects (Zanstra & Johnston, 2011).

Nonexperimental Research

Much of the research on the role of emotion in maintaining health or in the etiology of disease has been carried out in the context of CVD with a particular focus on CHD (i.e., myocardial infarction, sudden death, and angina). This is due to a number of factors: (1) CVD is the leading cause of death globally (World Health Organization, 2011); (2) onset, triggering, and exacerbation can be clearly identified; and (3) other CHD risk factors are well known and can be evaluated. Evidence for associations between emotions (particularly positive emotions or emotion regulation) and the development of other health outcomes is sparser. Thus, in the following sections we focus on the emotion–CHD relationship, recognizing that this research can serve as a strong model (albeit incomplete) for understanding the role of emotions in health more broadly.

Coronary Heart Disease

In the 1950s, two cardiologists, Friedman and Rosenman (1959), described a behavior pattern that seemed to increase risk of developing CHD, the type A behavioral (TAB) pattern. TAB was characterized as an action–emotion complex that requires an environmental challenge to serve as the trigger for expression. Overt manifestations of the behavior include a free-floating but well-rationalized hostility, hyperaggressiveness, and a sense of time urgency. While large-scale epidemiological studies conducted during the 1960s and 1970s appeared to corroborate the TAB hypothesis, a series of studies in the mid-1980s failed to find a relationship with CHD (see Matthews, 1988, for a review). As a result, investigators began to consider related factors that could explain the mixed findings, and the research focus shifted toward examining specific negative emotions. Associations between risk of incident CHD and specific emotions like anxiety, anger, and depression have now been reliably demonstrated. The volume of research on the topic increased dramatically in the last decade, leading to the publication of numerous reviews and meta-analyses on depression (e.g., Rugulies, 2002), anxiety (e.g., Roest, Martens, de Jonge, & Denollet, 2010), and anger (e.g., Chida & Steptoe, 2009). Research on positive emotion has also increased exponentially (Boehm & Kubzansky, 2012), though research on emotion regulation per se remains somewhat limited (but see Appleton & Kubzansky, 2014, for a detailed review of the findings).

Given the volume of work available, in the following sections we briefly describe the research on these emotions focusing on landmark studies and key findings (Kubzansky, Winning, & Kawachi, 2014). We prioritize studies using the strongest methods available. These are prospective studies designed to look at development of CHD, that consider objective measures of disease outcomes among individuals who are either disease free at the start of the study or whose initial health status is known and controlled in statistical analyses. By convention, demographic (e.g., gender), health-related (e.g., hypertension), and behavioral (e.g., cigarette smoking) risk factors are included in models evaluating the role of emotion in disease. However, if behaviors partially mediate the relation of emotion with CHD, then risk estimates derived from these studies are likely to be underestimates.

Anger. Chronic anger and hostility have long been implicated in the etiology of CHD. Anger and hostility are strongly associated with each other and have been identified as "toxic" components of the TAB pattern (Matthews, 1988). Hostility and anger are distinguishable, where hostility is a long-standing attitudinal disposition, while anger is the emotional component. Research in this area has focused more on hostility than on anger per se (see Chida & Steptoe, 2009, for a comprehensive review of this work). In an early study, Kawachi, Sparrow, Spiro, Vokonas, and Weiss (1996) examined the association between anger and incident CHD (including nonfatal myocardial infarction [MI], fatal CHD, and angina pectoris) using Cox proportional hazards models to estimate the relative risk of a cardiac event occurring in a 7-year follow-up of 1,305 men. Coronary events were over 2.5 times as likely during the follow-up period among men reporting the highest levels of anger compared with those reporting the lowest levels (hazard ratio [HR] = 2.66; 95% confidence interval [CI]: 1.26–5.61). A dose–response association was found between level of anger and overall CHD risk, even after taking account of other major cardiovascular risk factors. A 6-year follow-up study of 12,990 men and women also found that individuals with a strong tendency toward quick, minimally provoked or unprovoked anger had significantly increased risk of acute MI and fatal CHD over the follow-up period, with a multivariate adjusted HR of 2.28 (95% CI: 1.29–4.02; Williams, Nieto, Sanford, & Tyroler, 2001). However, not all studies find an effect of anger. Overall, while several meta-analyses suggest that chronic anger and hostility are independent risk factors for developing CHD (Chida & Steptoe, 2009; Miller, Smith, Turner, Guijarro, & Hallet, 1996), the overall effect size in the most recent meta-analysis was modest (HR = 1.19; 95% CI: 1.05–1.35). Moreover, effects were no longer significant when considering only studies that adjusted for key covariates, and the authors' suggested effects of anger on CVD may be primarily mediated by behavioral pathways (Chida & Steptoe, 2009).

Anxiety. The most recent meta-analysis of 20 prospective studies concluded that anxiety is an independent risk factor for CHD with a pooled HR for incident CHD of 1.26 (95% CI: 1.15–1.38; Roest et al., 2010). Five of the studies also adjusted for depression and in four of them an independent effect of anxiety was maintained. The Northwick Park Heart Study was one of the earliest studies to consider this association using a prospective design, following 1,457 initially healthy men over 10 years. This study reported a striking association between self-reported symptoms of phobic anxiety and fatal CHD, such that compared with men with the lowest level of anxiety, those with the highest levels had almost four times the risk of fatal CHD (HR = 3.77; 95% CI: 1.64–8.64; Haines, Imeson, & Meade, 1987). Findings have since been replicated in women. For example, in a substudy within the Women's Health Initiative Observational Study, 3,369 healthy postmenopausal women who reported their panic symptoms over the prior 6 months were followed for an average of 5 years (Smoller et al., 2007). Women reporting at least one full-blown panic attack were at three times the risk of developing CHD or a stroke (95% CI: 1.6–5.94) with increased risk still evident among women with less severe panic attacks. Findings were maintained after adjusting for standard risk factors as well as depression. Other research has reported elevated risk associated with different forms of anxiety, including worry, general symptoms of anxiety, and posttraumatic stress disorder (PTSD; Thurston, Rewak, & Kubzansky, 2013). For example, among 39,324 World Trade Center Health Registry participants followed for an average of 2.9 years, those who reported PTSD at study enrollment were at 60–70% excess risk of developing CHD over the follow-up (Jordan, Miller-Archie, Cone, Morabia, & Stellman, 2011). Of note, the effect sizes vary because the "dose" of anxiety is characterized differently across studies.

Depression. The majority of the research on negative emotions and CHD has focused on depression as a potential risk factor for both development and progression of the disease (see Elderon & Whooley, 2013, for an extensive review). Here we briefly highlight relevant research on the role of depression in CVD incidence. In an early prospective study, Anda and colleagues (1993) examined the relationship between depressed affect and ischemic heart disease incidence in 2,832 healthy adults. Depressed affect was associated with a significantly increased risk of fatal (HR = 1.5; 95% CI: 1.0–2.3) and nonfatal (HR = 1.6; 95% CI: 1.1–2.4) heart disease. In 2007, a meta-analysis including 28 published studies demonstrated a positive association with incident CHD, with a relative risk (RR) of 2.54 (95% CI: 2.07–3.10) for individuals with clinically relevant depression and an RR of 1.39 (95% CI: 1.26–1.54) for individuals with depressed mood (Van der Kooy et al., 2007). A meta-analysis of depression and incident stroke similarly reported a pooled adjusted HR of 1.45 (95% CI: 1.29–1.63; Pan, Sun, Okereke, Rexrode, & Hu, 2011). Generally, few studies have found evidence of a threshold effect; studies more commonly find a dose–response relationship whereby risk increases as depressive symptoms increase.

Positive Emotion. More recent epidemiologic work has begun to evaluate systematically whether positive emotions are health protective. Using rigorous methods, including adjustment for negative affect, studies have consistently reported reduced risk of incident CHD in relation to positive affect (see Boehm & Kubzansky, 2012, for a comprehensive review). For example, several population-based studies have considered emotional vitality (a composite measure capturing a sense of interest, enthusiasm, and capacity to regulate emotion) in relation to incident CHD and found a 20–30% reduction in risk after adjusting for potential confounders as well as psychological ill-being (Boehm, Peterson, Kivimaki, & Kubzansky, 2011; Kubzansky & Thurston, 2007). In another study, positive emotions were assessed based on structured interviews and evaluations of positivity displayed on participants' faces during these interviews (Davidson, Mostofsky, & Whang, 2010). In this sample of 1,739 men and women, those who displayed more positive affect were at 22% lower risk of developing heart disease over a 10-year period, after controlling for major coronary risk factors and negative affect. Investigators have suggested that continued effort to understand the role of positive psychological functioning in health is warranted, suggesting that such efforts will provide enhanced understanding of how mental and physical health processes interact, and give greater insight into how to build resilience (Boehm & Kubzansky, 2012).

Emotion Regulation. Early empirical work provided suggestive evidence that aspects of regulation matter for coronary health. For example, in the Framingham Heart Study, the single item "inability to discuss angry feelings" was associated with subsequent CHD risk (Haynes, Feinleib, & Kannel, 1980). Recently, researchers are considering the regulation of emotions more broadly as a higher-order feature of emotional functioning that might help to explain diverse findings linking both positive and negative emotions with cardiovascular outcomes (see Appleton & Kubzansky, 2014, for a more detailed review). A prospective study of 1,122 older men considered the relation between self-regulation and the development of CHD (Kubzansky, Park, Peterson, Vokonas, & Sparrow, 2011). Self-regulation was assessed by the men's ability to manage impulses, feelings, and behaviors, with emotion regulation identified as a central feature. Compared with men who had the lowest levels of self-regulation, those with the highest levels had 62% reduced risk of CHD over 13 years of follow-up. Findings were maintained after adjusting for known coronary risk factors and for positive and negative affect. Another study of middle-age adults found differential effects of two regulatory strategies, reappraisal and suppression, on CVD risk (Appleton et al., 2013). One standard deviation higher in reappraisal scores was associated with a 6.8% lower 10-year CVD risk, while 1 standard deviation higher in suppression scores was associated with an 11.6% higher risk. Associations were particularly robust for women. This emerging work suggests emotion regulation contributes significantly to cardiovascular health.

Acute Emotions and CHD

A separate set of mechanisms by which emotion may lead to CHD involves acute or "triggering" effects (see Bhattacharyya & Steptoe, 2007, for a comprehensive review). For example, acute anxiety states may lead to hyperventilation, which then may trigger coronary vasospasm. It has also been hypothesized that acute hemodynamic stress caused by transient, intense emotional states may lead to rupture of atherosclerotic plaques on the vessel wall of coronary arteries and initiate acute coronary events (Bhattacharyya & Steptoe, 2007). Triggering in this framework is hypothesized to occur in the context of existing damage, occurring as a result of stimuli that induce acute pathophysiological changes that in turn lead to a cardiac event (Tofler & Muller, 2006). A variety of studies have provided evidence that acute episodes of anger, anxiety, or depression (as well as stress) may serve as triggers for a cardiac event. For example, one study found increased risk of MI in the 2 hours after an acute anger episode (RR = 2.3; 95% CI: 1.7–3.2), and after an acute anxiety episode (RR = 1.6; 95% CI: 1.1–2.2; Mittleman et al., 1995). Investigators have also identified another form of acute myocardial dysfunction related to sudden emotional stress that appears to occur in the absence of significant coronary disease. This syndrome is commonly referred to as stress cardiomyopathy. Though the precise pathophysiologic mechanisms have not yet been delineated, there is increasing consensus that this is a recognizable clinical syndrome occurring often in the context of severe emotional stress (Wittstein, 2012).

Other Cardiometabolic Diseases

Hypertension. Numerous studies have observed elevated blood pressure levels and higher prevalence of hypertension among individuals with anxiety or depressive disorders (e.g., Hayward, 1995) or who report high levels of anxiety, depression, or anger (e.g., Yan et al., 2003). However, several recent studies have reported a null or inverse association (e.g., Hildrum, Romild, & Holmen, 2011). The mixed findings have prompted thought as to whether there may be circumstances whereby underlying pathophysiology alters both emotions and capacity to regulate blood pressure. Also worth noting is that many studies in this area are limited by methodologic problems (e.g., cross-sectional designs, low statistical power). A recent meta-analysis of nine prospective studies with 22,367 individuals and mean follow-up of 9.6 years found 42% excess risk of hypertension in depressed individuals (Meng, Chen, Yang, Zheng, & Hui, 2012). Results also suggested that effects are stronger as sample sizes increase and with longer duration of follow-up, but investigators noted inadequate control for confounding across studies. Moreover, they did not reconcile these findings with earlier work reporting inverse associations with blood pressure levels (regardless of hypertension status) over time. A more systematic consideration of negative emotions in relation to incident hypertension can provide additional insight. For example, one study was able to consider trajectories of depression in relation to incident hypertension over 24 years of follow-up (Nabi et al., 2011). Individuals with recurring depressive episodes compared with those with transient or persistently low depression had a faster age-related increase in hypertension. Such effects would not be detectable in a cross-sectional study. Overall, it appears poorly regulated blood pressure often occurs with dysregulated emotion, but the direction of effects is not yet conclusive.

Diabetes. Type 2 diabetes (T2D) is a serious health condition in its own right, a major risk factor for the development of CVD, and is also influenced by many of the risk factors associated with CVD, including inflammation, neuroendocrine dysfunction, poor diet, sedentary lifestyle, and excessive alcohol consumption. Thus, T2D has increasingly been a focus for investigators interested in the emotion–health relationship. Most work to date has investigated risk associated with depression. Three meta-analyses of the literature have been conducted, all reporting a consistent positive association (Knol et al., 2006; Mezuk, Eaton, Albrecht, & Golden, 2008; Rotella & Mannucci, 2013). The most recent meta-analysis summarized across 23 prospective studies, which included 424,557 participants, a mean follow-up of 8.3 years, and considered 19,977 incident diabetes cases. Results indicated an increased risk of developing T2D among depressed versus nondepressed individuals, with an RR of 1.56 (95% CI: 1.37–1.77) that attenuated somewhat after adjusting for other risk factors. Several meta-analyses also found evidence for bidirectional effects, whereby having diabetes was also associated with higher risk of developing depression. Less work has considered anxiety or anger in relation to T2D onset

Metabolic Syndrome and Obesity. Much of the work linking negative emotions with other cardiometabolic outcomes has focused on depression, and directionality of effects are debated (e.g., Goldbacher, Bromberger, & Matthews, 2009). A small meta-analysis of four prospective studies, with a total sample size of 3,834 participants, reported a 52% (95% CI: 1.20–1.91) excess risk of developing metabolic syndrome associated with depressive symptoms. However, a meta-analysis of studies examining possible effects of metabolic syndrome on depression also reported a significant effect (RR = 1.49; 95% CI: 1.19–1.89; Pan et al., 2012). Findings for depression and obesity are similar (Luppino et al., 2010). Anxiety and anger are less well studied in relation to metabolic syndrome and its component conditions, but given the work to date bidirectional effects are also likely (Goldbacher & Matthews, 2007). Somewhat surprisingly, studies in this area remain limited. Few studies have considered anger in relation to weight status changes or developing obesity; somewhat more have considered anxiety, suggesting elevated obesity risk among highly anxious individuals (Kubzansky, Bordelois, et al., 2014).

Cancer

Despite the long-held beliefs about a link between emotion and cancer, empirical support for the role of emotion in the *development* of cancer continues to be sparse. There is evidence that distress influences the progression of and adjustment to cancer (e.g., Mitchell et al., 2011), but mechanisms linking emotion to cancer etiology may differ from those related to progression or survival. For instance, disease progression may be related to psychosocial adjustment to the diagnosis and illness, treatment adherence, and the availability of social support. Based on work with cancer patients, Temoshok (1987) proposed a model of the cancer-prone individual (Type C personality), as one who is stoic, has difficulty expressing emotions, and has an attitude of resignation or helplessness. Empirical support for this model was reported in several studies (Grossarth-Maticek, Kanazir, Schmit, & Vetter, 1985); however, subsequent work has failed to replicate the findings and identified serious methodological problems with these studies (Ranchor, Sanderman, & Coyne, 2010).

Methodologically rigorous examination of the role of psychological factors in cancer incidence is challenging because of the long latency in the development of cancer and difficulty in ascertaining the true date of onset. In addition, cancer comprises a heterogeneous group of diseases of multiple etiologies that vary in their tissue of origin, cell type, biological behavior, anatomic site, and degree of differentiation. Because it takes 18 years for tumor cells to develop into detectable tumors, a minimum of 18 years follow-up has been recommended for studies of cancer incidence (Possel, Adams, & Valentine, 2012). That said, stress-related biological alterations may be detectable prior to tumor development. For example, extensive research, largely molecular and animal studies, has shown that psychosocial stress and related distress is associated with alterations in a range of processes that play an important role in carcinogenesis, including immunity, inflammation, insulin resistance, DNA repair capacity, cellular apoptosis, proliferation, angiogenesis, and telomere shortening (Thaker & Sood, 2008). Such findings suggest that studies investigating emotional processes directly in relation to biological processes known to be relevant in carcinogenesis may provide additional insight.

Numerous studies of depression and cancer mortality have shown that higher depression levels predict cancer mortality even after adjusting for potentially confounding medical variables (Pinquart & Duberstein, 2010). However, these studies cannot distinguish between the effects of emotion on *incidence* versus *survival* following a cancer diagnosis. Prospective studies of negative emotions and cancer incidence are suggestive but limited, with most studies focused on depression. For example, one study found higher depressive symptoms associated with increased colorectal cancer incidence (HR = 1.43; 95% CI: 0.9 –2.11) among 81,612 initially healthy women followed for 8 years (Kroenke et al., 2005). Several meta-analyses have considered the literature. One reported increased risk of incident cancer associated with depression when looking across multiple cancers, with effects stronger in studies with large sample sizes ($n \geq$ 100,000) and a longer follow-up period (≥ 10 years; Chida, Hamer, Wardle, & Steptoe, 2008). Findings, however, varied depending on the specific cancer considered.

Some studies have considered positive emotional functioning in relation to cancer progression or survival (Chida & Steptoe, 2008), but the idea that positive feeling and a "fighting spirit" can slow the progression and rate of disease development has been controversial (e.g., Aspinwall & Tedeschi, 2010; Coyne & Tennen, 2010). Almost no work has considered positive emotions effects in relation to incident cancer. Overall, direct evidence that emotions, either positive or negative, are involved in the etiology of cancer in humans is limited. Most work positing a relation between emotion and cancer incidence hypothesizes that effects are mediated either through health behavior or altered immune functioning. However, other mechanisms are possible, and the known biological consequences of recurring distress and their relevance to cancer initiation and promotion suggest this relationship deserves closer attention.

Infectious or Immune-Mediated Diseases and Other Health Outcomes

Negative emotions are thought to alter susceptibility to infectious diseases via effects on immune function (Cohen, Doyle, et al., 1995). Psychological distress and stressors appear to be reliably associated with immune function down-regulation (O'Leary, 1990). For example, one study of healthy middle-age adults examined levels of psychological distress in relation to changes in markers of immune function over a 1-year period, including natural killer (NK) cell, B, and T cell counts (Nakata, Irie, & Takahashi, 2011). Higher distress was associated with suppression of NK cell immunity (and not the other cell types), but not the reverse, suggesting that emotions may induce alterations in cellular immunity.

Whether findings with immune functioning provide insight into likely effects of distress on immune-related health outcomes has been tested among healthy individuals in several ways. One line of work has used a viral challenge methodology to examine associations between emotion and the common cold. In these studies, healthy subjects are exposed to a common cold virus, quarantined, and monitored for the development of biologically verified clinical illness. Prior to exposure, emotion levels are measured. Results demonstrate that after controlling for various potential confounders, individuals with higher negative emotion levels are more likely to develop clinical illness (Cohen, Tyrrell, & Smith, 1993), while those expressing more positive emotions are at reduced risk (Cohen, Alper, Doyle, Treanor, & Turner, 2006). Other work has found that psychological distress is associated with a less robust immune response to vaccination (Segerstrom, Hardy, Evans, & Greenberg, 2012) and an amplified inflammatory response after vaccination (Glaser, Robles, Sheridan, Malarkey, & Kiecolt-Glaser, 2003). Due to methodological and logistical complexities, research in this area is not extensive and few studies have examined emotions other than general distress or depressive symptoms in relation to these outcomes.

Most research on emotion and other immune-mediated outcomes (e.g., HIV/AIDS, herpes simplex virus, asthma) has considered disease progression, recurrence, or exacerbation, with less work assessing disease onset. Several studies have suggested that early-onset mental disorders (specifically anxiety and depression) are associated with increased risk of adult-onset arthritis (Von Korff et al., 2009) and asthma (Scott et al., 2011). These studies relied on retrospective reporting of mental disorder. Findings were corroborated in a prospective study that assessed mental health problems among boys ages 8 years and followed them into adulthood; boys with more depressive symptoms or other mental health problems in childhood demonstrated a higher risk of developing asthma (Goodwin et al., 2009).

Future Directions

Specificity in Emotion–Health Relationships

There has been long-standing debate as to whether effects of emotion might be largely systemic and nonspecific or if they are distinctive and relevant only to particular health outcomes (Friedman & Booth-Kewley, 1987; Macleod & Davey Smith, 2003). Many epidemiologists argue that lack of specificity in detectable effects signals confounded rather than causal associations (Macleod & Davey Smith, 2003), though others suggest that systemic effects are common (e.g., smoking influences both heart disease and lung cancer). A related debate is whether a specific emotion versus a dimensional approach is appropriate. Similar effects across multiple emotions have been noted for a number of health outcomes (Suls & Bunde, 2005). Shared effects could be due to overlap that occurs in the components of various emotions, but unique effects might also be possible due to nonshared aspects.

The notion that specific emotions could have distinctive health effects is partly predicated on the assumption that each emotion is associated with a unique physiological pattern. However, whether such differences reliably occur is a topic of ongoing debate. Proponents of the hypothesis suggest that with increased access to a broader array of biological parameters, differences will become more apparent. Regardless, even among emotions that seem to call forth similar physiological responses (e.g., heightened autonomic arousal) such as anxiety and elation, reliable distinctions can be made. For example, in the presence of a stressor, negative emotions are associated with appraisals of threat, while positive emotions are associated with appraisals of challenge (Tomaka, Blascovich, Kelsey, & Leitten, 1993). Laboratory studies have demonstrated that individuals who feel threatened by a stressful task exhibit less cardiac reactivity and more vascular resistance, whereas those who feel challenged exhibit more cardiac reactivity and less vascular resistance (Tomaka et al., 1993).

Whether or not specific emotions have distinct neurobiological profiles, the behaviors they motivate are often quite different, and thus effects on health may differ regardless of the underlying neurobiology. For example, anxiety is associated with heightened vigilance and active efforts to cope with difficult situations, whereas depression is more often characterized by behavioral retardation and withdrawal (Barlow, 1988). Anger is often associated with an impulse to approach others and be aggressive, while anxiety is more often associated the desire to escape. Appraisal tendency theory (Lerner & Keltner, 2000) further suggests that emotions with the same valence (e.g., fear and anger) can lead to differential judgments about risk as well as opposing action tendencies. For example, elicitation of fear leads to a heightened assessment of the risk associated with the behavior, whereas anger leads to a more optimistic appraisal of the future. Thus, if graphic warning labels on cigarettes elicit fear, individuals may assess smoking as more risky, but if they elicit anger, individuals may assess smoking as less problematic. These behavioral patterns have important implications for health as they may differentially influence the likelihood that individuals subsequently engage in health-promoting or -impairing behaviors.

Though emotions rarely occur in isolation, the majority of studies evaluate the effect of a single emotion in relation to a single health outcome. For example, while anxiety and depression often co-occur, studies that examine the association of anxiety with health outcomes often fail to account for their overlap (Suls & Bunde, 2005). This is partly due to methodological challenges—for example, considering multiple emotions in a single model presents issues of multicollinearity. More recent studies (largely in the realm of CHD) have begun to use creative methods to try to tease apart emotion-specific effects with some success. For example, a study of Vietnam veterans examined the effects of depression, anxiety, and their co-occurrence in relation to CVD mortality (Phillips et al., 2009). Each emotion was separately associated with increased risk, but high levels of both conferred the greatest risk for earlier death during follow-up. To date, there is sufficient evidence of separable effects to suggest it is prudent to continue to consider specific emotions separately, while acknowledging and actively investigating their shared components.

A Deeper Understanding of Mechanisms

Research on emotion–health links has consistently suggested both biological and nonbiological pathways as jointly explaining how recurring emotion experience may cumulatively influence health outcomes. Despite widespread agreement that behavioral pathways are relevant, strategies for influencing behavioral choices via the differential elicitation of emotions remain limited. In part this may be because emotions are rarely considered as modifiable upstream determinants of health-related behaviors. Moreover, behavior and biology are often considered as completely separable pathways, when in reality they are highly interconnected. Regardless, there is continued skepticism by many in mainstream biomedicine as to whether mental states can directly influence health-related biology. This perspective was most clearly articulated by a past editor of the *New England Journal of Medicine*:

> In my 1985 editorial (Angell, 1985) . . . I wrote "the literature contains very few scientifically sound studies of the relation, if there is one, between mental state and disease" . . . What I was talking about was the view that mental state can *directly* cause or substantially modify organic disease independent of personal habits . . . I am afraid my assessment of the literature has not changed very much in the 16 years since I wrote that. (Relman & Angell, 2002)

Skeptics claim that any apparent causal relationship between emotions and health is spurious or a result of wishful thinking, and that research fails to make a convincing case. Two critiques of the existing evidence have been offered: (1) lack of plausible biological mechanisms (despite recognized behavioral mechanisms) and (2) methodological concerns. Countless studies have documented associations of emotions with biological mediators that are arguably linked with health, such as inflammatory biomarkers, heart rate variability, and glucose control. Moreover, a great deal of work has considered links between stress-related physiological substrates (e.g., cortisol, catecholamines) and disease outcomes. But because studies rarely directly demonstrate biological mediation, such evidence may still be considered inconclusive. For example, anxiety is hypothesized to influence CHD in part via chronically elevated inflammation, but studies that evaluate anxiety in relation to altered inflammation levels along with subsequent development of disease have not been done. Perhaps as a result, the controversy around whether emotions directly influence disease development continues (Relman & Angell, 2002). That said, recent technological advances and more interdisciplinary cross-talk have led to exciting work on potential biological mechanisms. This includes exploring relevant neurobiological substrates or cellular processes, and examining the role of social and emotional processes in regulating gene products involved in human pathogenic resistance and disease development (see Kubzansky, Seeman, & Glymour, 2014, for a detailed discussion). Here we describe a few examples of this type of research.

Thayer and colleagues have proposed a theory of neurovisceral integration, based on the premise that when emotions are effectively regulated they provide the means for a flexible adaptation to constantly changing environmental demands (Thayer & Brosschot, 2005). This regulatory capacity has a biological counterpart, as reflected in the beat-to-beat variability in heart rate. Heart rate is determined by autonomic balance between two systems: the sympathetic and the parasympathetic nervous system. The sympathetic system is associated with energy mobilization, while the parasympathetic system (via inputs from the cardiac vagal nerve) is associated with restorative "calming" functions. In a healthy system, optimal functioning is associated with a high degree of variability to permit flexibility in meeting demands for energy expenditure. Less effective parasympathetic control is reflected in reduced heart rate variability, which has been linked with both poorer emotion regulation capacity (e.g., Di Simplicio et al., 2012) and higher risk of developing a range of diseases and premature mortality (Thayer & Brosschot, 2005). Thus, Thayer and colleagues have proposed that heart rate variability provides a biological link between poor emotion regulation and adverse health outcomes (Thayer, Yamamoto, & Brosschot, 2010).

Other recent work has considered emotion in relation to speed of cellular aging. Accelerated cellular aging, as measured by shortened telomere length and reduced telomerase activity in leukocytes, has been identified as a marker of increased risk for early morbidity and mortality across a range of disease outcomes (Aubert & Lansdorp, 2008). One study found that individuals with high levels of emotion dysregulation, as defined by chronic mood disorders, had significantly shorter telomere length as compared with age-matched controls without mood disorders. Another potentially relevant biological substrate is oxytocin, a hormone identified as being part of a key neurobiological system that may underlie the link between positive social and emotional processes and health (Singer, Friedman, Seeman, Fava, & Ryff, 2005). Research in humans has linked oxytocin to emotion and stress processes, noting its apparent stress-buffering effects (e.g., Heinrichs & Domes, 2008), though these effects do not occur uniformly (e.g., Kubzansky, Mendes, Appleton, Block, & Adler, 2012). Capacity for characterizing the mechanisms through which genes and their products function and interact with one another and with the environment has also increased. As a result, studies have begun mapping the actions of genes and their biochemical pathways to psychological phenomena, suggesting that psychological experiences can modulate the expression of specific genes, the proteins they code for, and the physiological pathways they regulate (Miller et al., 2008). For example, one study found highly versus less lonely individuals had increased expression of genes involved in immune activation, transcription control; and cell proliferation, and decreased expression of genes involved in innate antiviral resistance, supporting antibody production, and mature B lymphocyte function (Cole et al., 2007).

Within research on pathways linking emotions and health, a focus on deteriorative processes has overshadowed the potential role of restorative processes (Boehm & Kubzansky, 2012; Robles & Carroll, 2011). This has been the case even when thinking about positive emotions and related constructs (Boehm & Kubzansky, 2012). To date, most work has considered positive emotions as providing "antistress" effects or mitigating toxic effects of stress and distress. For example, such work has reported evidence that higher positive emotion levels are associated with reduced likelihood of chronic inflammation or hypertension (Steptoe & Wardle, 2005). However, greater consideration of restorative processes, either behavioral or biological, might provide important insight. For example, positive emotions may increase antioxidant activity (e.g., Boehm, Williams, Rimm, Ryff, & Kubzansky, 2013) or increase the likelihood of engaging in regular physical activity and getting better-quality sleep.

A Life Course Perspective: Emotions and Trajectories of Risk or Resilience

Research thus far has focused largely on emotion and health in adulthood. While informative, these studies may miss many processes already set in motion early in life. A life course perspective can help to clarify how and why emotions influence later health outcomes. Recent epidemiological and other work has begun to build compelling evidence that early childhood environments critically influence adult physical health. Repetti, Taylor, and Seeman (2002) proposed a framework for how early family environments influence physical health, and highlighted the critical nature of emotional processes that develop early in life. A major task of childhood is developing the capacity to regulate emotions, learned through socialization and experience over time. During childhood, temperament, biology, and social factors interact to build regulatory skills and strategies that are used over the life course (John & Gross, 2004).

Research on emotion regulation has been conducted both in the developmental and adult literatures, but integration among them is still limited, particularly regarding the relation with physical health. However, greater consideration of the role of emotion regulation in the maintenance of health or development of disease over the life course is warranted. Dysregulation in childhood emotional functioning has been demonstrated to persist well into adulthood (e.g., Caspi, 2000). These findings suggest that effects of emotions on adult disease processes may initiate much earlier in life than has generally been considered. For example, failure to learn appropriate strategies for emotion regulation in childhood may set up a lifelong pattern of yielding to temptation, immediate gratification, and the use of maladaptive behavioral coping responses to stress. Conversely, appropriate regulation may lead to accruing resilience. The classic marshmallow test suggests that variations in the ability to delay gratification is already apparent in 4-year-old preschoolers, and lower delay discounting predicts academic achievement and health behaviors (like smoking, drug abuse, obesity) more than a decade later (Mischel et al., 2011).

Studies examining the effects of emotion regulation on health starting in childhood are limited. However, to assess how early in the life course health risks associated with dysregulated emotion may manifest, a growing body of work considers emotional functioning assessed prior to midlife in relation to disease risk. In these studies, because individuals are too young to develop full-blown disease, biomarker outcomes provide a measure of risk. These biomarkers are often "silent"—that is, even in ranges considered to confer disease risk they often do not produce a sense of illness. Thus, such evidence can help to reduce concerns about reverse causality. Most work has focused on the relation between depression and inflammatory biomarkers, with studies primarily cross-sectional and conducted among adults. A meta-analysis of this relationship reported an overall effect size of 0.15 for CRP (95% CI: 0.10–0.21) and 0.25 for IL-6 (95% CI: 0.18–0.31) across 51 cross-sectional clinical and community studies (Howren, Lamkin, & Suls, 2009). Limited work has reported associations between anxiety or anger and higher levels of inflammation or coagulation factors (Pitsavos et al., 2006). While it is likely that effects are bidirectional, increasing evidence suggests that emotional distress, when it occurs earlier in life, may precede and trigger inflammatory processes. For example, one study reported that poor emotional functioning assessed at age 7 years was associated with higher inflammation levels at age 42 years even after adjustment for relevant covariates, including child health status (Appleton et al., 2011). One of the strongest studies reported a unidirectional effect of depression on CRP in a population-based study of youth with repeated measures of depression and CRP over nine waves of data; cumulative depressive episodes predicted subsequent CRP levels, but CRP levels were not associated with later depression status (Copeland, Shanahan, Worthman, Angold, & Costello, 2012). Similarly, another study found high distress levels at age 8 years were associated with elevated inflammation at age 10, but age 10 inflammatory levels were not associated with subsequent increases in distress (Slopen, Kubzansky, & Koenen, 2013).

Conclusions

Research increasingly supports the role of emotions in pathogenesis or disease protection. Much of the strongest evidence for the relationship is derived from longitudinal observational cohort studies that rely on self-report of emotion. To avoid concerns about self-report bias, studies have emphasized health outcomes that can be determined objectively and for which there is a relatively clear onset, leading to a preponderance of evidence in the domain of CVD. While emotions are almost certainly involved in the development of other outcomes such as cancer, autoimmune disease, or pain syndromes, because these outcomes are often diagnosed by self-reports of symptoms or have long latency periods, studies of these outcomes are more vulnerable to criticism and perhaps as a result have been pursued less vigorously. With the expansion of our capacity to measure biological surrogates for a range of disease outcomes, future work will be able to assess these relationships more systematically and rigorously. Another key question that is amenable to empirical inquiry (but has not yet been considered) is whether successful mitigation of emotional distress or setting up positive states within a healthy population effectively reduces risk of developing heart disease or other health conditions. Applying a life course perspective to this work will lead to important insights. Much of the field has focused on effects of negative emotions. However, significant gains in knowledge can be obtained from considering the full spectrum of emotions—both positive and negative—and the deteriorative or restorative processes they may initiate, as well as the critical role of emotion regulation in health. The effect of emotions on health maintenance or disease development has often appeared to be an emergent phenomenon. However, with technological and methodological advances and the integration of multiple disciplinary perspectives, we may better understand the underlying systems that give rise to these phenomena. This added insight may provide greater understanding into the nature of emotions as well as lead to new strategies for disease prevention and treatment.

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References

Alexander, F. G., French, T. M., & Pollack, G. H. (1968). *Psychosomatic specificity: Experimental study and results.* Chicago: University of Chicago Press.

Allport, G. W. (1961). *Pattern and growth in personality.* New York: Holt, Rinehart, & Winston.

Anda, R., Williamson, D., Jones, D., Macea, C., Eaker, E., Glassman, A., et al. (1993). Depressed affect, hopelessness, and the risk of ischemic heart disease in a cohort of U.S. adults. *Epidemiology, 4*, 285–294.

Angell, M. (1985). Disease as a reflection of the psyche. *New England Journal of Medicine, 312*, 1570–1572.

Appleton, A., & Kubzansky, L. D. (2014). Emotion regulation and cardiovascular disease risk. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 596–612). New York: Guildford Press.

Appleton, A. A., Buka, S. L., Loucks, E. B., Gilman, S. E., & Kubzansky, L. D. (2013). Divergent associations of adaptive and maladaptive emotion regulation strategies with inflammation. *Health Psychology, 32*(7), 748–756.

Appleton, A. A., Buka, S. L., McCormick, M. C., Koenen, K. C., Loucks, E. B., Gilman, S. E., et al. (2011). Emotional functioning at age 7 years is associated with C-reactive protein in middle adulthood. *Psychosomatic Medicine, 73*(4), 295–303.

Aspinwall, L. G., & Tedeschi, R. G. (2010). The value of positive psychology for health psychology: Progress and pitfalls in examining the relation of positive phenomena to health. *Annals of Behavioral Medicine, 39*(1), 4–15.

Aubert, G., & Lansdorp, P. M. (2008). Telomeres and aging. *Physiological Reviews, 88*(2), 557–579.

Barlow, D. H. (1988). *Anxiety and its disorders*. New York: Guilford Press.

Bean, W. B. (Ed.). (1950). *Sir William Osler: Aphorisms from his bedside teachings and writings. Collected by Robert Bennett Bean.* New York: Schuman.

Bhattacharyya, M. R., & Steptoe, A. (2007). Emotional triggers of acute coronary syndromes: Strength of evidence, biological processes, and clinical implications. *Progress in Cardiovascular Diseases, 49*(5), 353–365.

Boehm, J. K., & Kubzansky, L. D. (2012). The heart's content: The association between positive psychological well-being and cardiovascular health. *Psychological Bulletin, 138*(4), 655–691.

Boehm, J. K., Peterson, C., Kivimaki, M., & Kubzansky, L. (2011). A prospective study of positive psychological well-being and coronary heart disease. *Health Psychology, 30*(3), 259–267.

Boehm, J. K., Williams, D. R., Rimm, E. B., Ryff, C., & Kubzansky, L. D. (2013). Association between optimism and serum antioxidants in the midlife in the United States study. *Psychosomatic Medicine, 75*(1), 2–10.

Brody, A. L., Olmstead, R. E., Abrams, A. L., Costello, M. R., Khan, A., Kozman, D., et al. (2009). Effect of a history of major depressive disorder on smoking-induced dopamine release. *Biological Psychiatry,* 66(9), 898–901.

Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1999). The affect system has parallel and integrative processing components: Form follows function. *Journal of Personality and Social Psychology, 76*, 839–855.

Carroll, D., Ginty, A. T., Der, G., Hunt, K., Benzeval, M., & Phillips, A. C. (2012). Increased blood pressure reactions to acute mental stress are associated with 16-year cardiovascular disease mortality. *Psychophysiology, 49*(10), 1444–1448.

Caspi, A. (2000). The child is father of the man: Personality continuities from childhood to adulthood. *Journal of Personality and Social Psychology, 78*(1), 158–172.

Chida, Y., Hamer, M., Wardle, J., & Steptoe, A. (2008). Do stress-related psychosocial factors contribute to cancer incidence and survival? *Nature Clinical Practice Oncology, 5*(8), 466–475.

Chida, Y., & Steptoe, A. (2008). Positive psychological well-being and mortality: A quantitative review of prospective observational studies. *Psychosomatic Medicine, 70*(7), 741–756.

Chida, Y., & Steptoe, A. (2009). The association of anger and hostility with future coronary heart disease: A meta-analytic review of prospective evidence. *Journal of the American College of Cardiology, 53*(11), 936–946.

Chida, Y., & Steptoe, A. (2010). Greater cardiovascular responses to laboratory mental stress are associated with poor subsequent cardiovascular risk status: A meta-analysis of prospective evidence. *Hypertension, 55*(4), 1026–1032.

Cohen, S., Alper, C. M., Doyle, W. J., Treanor, J. J., & Turner, R. B. (2006). Positive emotional style predicts resistance to illness after experimental exposure to rhinovirus or influenza A virus. *Psychosomatic Medicine,* 68(6), 809–815.

Cohen, S., Doyle, W. J., Skoner, D. P., Fireman, P., Gwaltney, J. M., & Newsom, J. T. (1995). State and trait negative affect as predictors of objective and subjective symptoms of respiratory viral infections. *Journal of Personality and Social Psychology,* 68(1), 159–169.

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *JAMA, 298*(14), 1685–1687.

Cohen, S., Kessler, R. C., & Gordon, L. U. (1995). Strategies for measuring stress in studies of psychiatric and physical disorders. In S. Cohen, R. C. Kessler, & L. U. Gordon (Eds.), *Measuring stress: A guide for health and social scientists* (pp.1–26). New York: Oxford University Press.

Cohen, S., & Rodriguez, M. S. (1995). Pathways linking affective disturbances and physical disorders. *Health Psychology, 14*, 374–380.

Cohen, S., Tyrrell, D. A. J., & Smith, A. P. (1993). Negative life events, perceived stress, negative affect, and susceptibility to the common cold. *Journal of Personality and Social Psychology, 64*, 131–140.

Cole, S. W., Hawkley, L. C., Arevalo, J. M., Sung, C. Y., Rose, R. M., & Cacioppo, J. T. (2007). Social regulation of gene expression in human leukocytes. *Genome Biology, 8*(9), R189.

Consedine, N. S., Magai, C., & Bonanno, G. A. (2002). Moderators of the emotion inhibition–health relationship: A review and research agenda. *Review of General Psychology,* 6(2), 204–228.

Copeland, W. E., Shanahan, L., Worthman, C., Angold, A., & Costello, E. J. (2012). Cumulative depression episodes predict later C-reactive protein levels: A prospective analysis. *Biological Psychiatry, 71*(1), 15–21.

Coyne, J. C., & Tennen, H. (2010). Positive psychology in cancer care: Bad science, exaggerated claims, and unproven medicine. *Annals of Behavioral Medicine, 39*(1), 16–26.

Davidson, K. W., Mostofsky, E., & Whang, W. (2010). Don't worry, be happy: Positive affect and reduced 10-year incident coronary heart disease. The Canadian Nova Scotia Health Survey. *European Heart Journal, 31*, 1065–1070.

de Ridder, D., Geenen, R., Kuijer, R., & van Middendorp, H. (2008). Psychological adjustment to chronic disease. *Lancet, 372*(9634), 246–255.

DeLongis, A., Coyne, J. C., Dakof, G., Folkman, S., & Lazarus, R. S. (1982). Relationship of daily hassles, uplifts, and major life events to health status. *Health Psychology, 1*, 119–136.

Denson, T. F., Grisham, J. R., & Moulds, M. L. (2011). Cognitive reappraisal increases heart rate variability in response to an anger provocation. *Motivation and Emotion, 35*, 14–22.

DeSteno, D. (2009). Social emotions and intertemporal choice: "Hot" mechanisms for the building of social and economic capital. *Current Directions in Psychological Science, 18*, 280–284.

DeSteno, D., Gross, J. J., & Kubzansky, L. (2013). Affective science and health: The importance of emotion and emotion regulation. *Health Psychology, 32*(5), 474–486.

Di Simplicio, M., Costoloni, G., Western, D., Hanson, B., Taggart, P., & Harmer, C. J. (2012). Decreased heart rate variability during emotion regulation in subjects at risk for psychopathology. *Psychological Medicine, 42*(8), 1775–1783.

Dohrenwend, B. S., & Dohrenwend, B. P. (1974). *Stressful life events: Their nature and effects*. New York: Wiley.

Elderon, L., & Whooley, M. A. (2013). Depression and cardiovascular disease. *Progress in Cardiovascular Diseases, 55*(6), 511–523.

Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology, 2*(3), 300–319.

Friedman, H. S., & Booth-Kewley, S. (1987). The "disease-prone personality": A meta-analytic view of the construct. *American Psychologist, 42*(6), 539–555.

Friedman, M., & Rosenman, R. H. (1959). Association of specific overt behavior pattern with blood and cardiovascular findings. *Journal of the American Medical Association, 169*, 1286–1296.

Frijda, N. H. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.

Frijda, N. H. (1994). Emotions are functional, most of the time. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion* (pp. 112–122). New York: Oxford University Press.

Glaser, R., Robles, T. F., Sheridan, J., Malarkey, W. B., & Kiecolt-Glaser, J. K. (2003). Mild depressive symptoms are associated with amplified and prolonged inflammatory responses after influenza virus vaccination in older adults. *Archives of General Psychiatry, 60*(10), 1009–1014.

Goldbacher, E. M., Bromberger, J., & Matthews, K. A. (2009). Lifetime history of major depression predicts the development of the metabolic syndrome in middle-aged women. *Psychosomatic Medicine, 71*(3), 266–272.

Goldbacher, E. M., & Matthews, K. A. (2007). Are psychological characteristics related to risk of the metabolic syndrome?: A review of the literature. *Annals of Behavioral Medicine, 34*(3), 240–252.

Goodwin, R. D., Sourander, A., Duarte, C. S., Niemela, S., Multimaki, P., Nikolakaros, G., et al. (2009). Do mental health problems in childhood predict chronic physical conditions among males in early adulthood?: Evidence from a community-based prospective study. *Psychological Medicine, 39*(2), 301–311.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*(2), 348–362.

Gross, J. J., & Levenson, R. W. (1997). Hiding feelings: The acute effects of inhibiting negative and positive emotion. *Journal of Abnormal Psychology, 106*(1), 95–103.

Gross, J. J., & Thompson, R. (2007). Emotion regulation: Conceptual foundation. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 3–24). New York: Guilford Press.

Grossarth-Maticek, R., Kanazir, D. T., Schmit, P., & Vetter, H. (1985). Psychosocial and organic variables as predictors of lung cancer, cardiac infarct and apoplexy: Some differential predictors. *Personality and Individual Differences, 6*, 313–321.

Haines, A. P., Imeson, J. D., & Meade, T. W. (1987). Phobic anxiety and ischaemic heart disease. *British Medical Journal Clinical Research Edition, 295*(6593), 297–299.

Harvey, W. (1928). *Exercitatio anetomica de motu cordis et sanguinis* [An anatomical exercise conerning the movement of heart and blood]. London: Baillieve, Tindall, & Cox. (Original work published 1628)

Haynes, S. G., Feinleib, M., & Kannel, W. B. (1980). The relationship of psychosocial factors to coronary heart disease in the Framingham Study: III. Eight-year incidence of coronary heart disease. *American Journal of Epidemiology, 111*(1), 37–58.

Hayward, C. (1995). Psychiatric illness and cardiovascular disease risk. *Epidemiologic Reviews, 17*, 129–138.

Heinrichs, M., & Domes, G. (2008). Neuropeptides and social behavior: Effects of oxytocin and vasopressin in humans. *Progress in Brain Research, 170*, 337–350.

Hildrum, B., Romild, U., & Holmen, J. (2011). Anxiety and depression lowers blood pressure: 22-year follow-up of the population based HUNT Study, Norway. *BMC Public Health, 11*, 601.

Howren, M. B., Lamkin, D. M., & Suls, J. (2009). Associations of depression with C-reactive protein, IL-1, and IL-6: A meta-analysis. *Psychosomatic Medicine, 71*(2), 171–186.

John, O. P., & Gross, J. J. (2004). Healthy and unhealthy emotion regulation: Personality processes, individual differences, and life span development. *Journal of Personality, 72*(6), 1301–1333.

Jordan, H. T., Miller-Archie, S. A., Cone, J. E., Morabia, A., & Stellman, S. D. (2011). Heart disease among adults exposed to the September 11, 2001 World Trade Center disaster: Results from the World Trade Center Health Registry. *Preventive Medicine, 53*(6), 370–376.

Kawachi, I., Sparrow, D., Spiro, A., Vokonas, P., & Weiss, S. T. (1996). A prospective study of anger and coronary heart disease: The Normative Aging Study. *Circulation, 94*(9), 2090–2095.

Kawachi, I., Sparrow, D., Vokonas, P. S., & Weiss, S. T. (1995). Decreased heart rate variability in men with phobic anxiety (data from the Normative Aging Study). *American Journal of Cardiology, 75*(14), 882–885.

Kemper, T. D. (1993). Sociological models in the explanation of emotions. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 41–52). New York: Guilford Press.

Knol, M. J., Twisk, J. W., Beekman, A. T., Heine, R. J., Snoek, F. J., & Pouwer, F. (2006). Depression as a risk factor for the onset of type 2 diabetes mellitus: A meta-analysis. *Diabtologia, 49*(5), 837–845.

Kroenke, C. H., Bennett, G. G., Fuchs, C., Giovannucci, E., Kawachi, I., Schernhammer, E., et al. (2005). Depressive symptoms and prospective incidence of colorectal cancer in women. *American Journal of Epidemiology, 162*(9), 839–848.

Kubzansky, L. D. (2007). Sick at heart: The pathophysiology of negative emotions. *Cleveland Clinic Journal of Medicine, 74*(Suppl. 1), S67–S72.

Kubzansky, L. D., Bordelois, P., Jun, H. J., Roberts, A. L., Cerda, M., Bluestone, N., et al. (2014). The weight of traumatic stress: A prospective study of posttraumatic stress disorder symptoms and weight status in women. *JAMA Psychiatry, 71*(1), 44–51.

Kubzansky, L. D., Mendes, W. B., Appleton, A. A., Block, J., & Adler, G. K. (2012). A heartfelt response: Oxytocin effects on response to social stress in men and women. *Biological Psychology, 90*(1), 1–9.

Kubzansky, L. D., Park, N., Peterson, C., Vokonas, P., & Sparrow, D. (2011). Healthy psychological functioning and incident coronary heart disease: The importance of self-regulation. *Archives of General Psychiatry, 68*(4), 400–408.

Kubzansky, L. D., Seeman, T. E., & Glymour, M. M. (2014). Biological pathways linking social conditions and health: Plausible mechanisms and emerging puzzles. In L. Berkman, I. Kawachi, & M. M. Glymour (Eds.), *Social epidemiology: New perspectives on social determinants of global population health* (pp. 512–561). New York: Oxford University Press.

Kubzansky, L. D., & Thurston, R. C. (2007). Emotional vitality and incident coronary heart disease: Benefits of healthy psychological functioning. *Archives of General Psychiatry, 64*(12), 1393–1401.

Kubzansky, L. D., Winning, A., & Kawachi, I. (2014). Affective states and health. In L. Berkman, I. Kawachi, & M. M. Glymour (Eds.), *Social epidemiology: New perspectives on social determinants of global population health*. New York: Oxford University Press.

Lazarus, R. S. (Ed.). (1968). *Emotions and adaptation: Conceptual and empirical relations*. Lincoln: University of Nebraska Press.

Lazarus, R. S. (1990). Target article: Theory-based stress measurement. *Psychological Inquiry, 1*(1), 3–13.

Lazarus, R. S. (1991a). *Emotion and adaptation*. New York: Oxford University Press.

Lazarus, R. S. (1991b). Progress on a cognitive–motivational–relational theory of emotion. *American Psychologist, 46*(8), 819–834.

Lerner, J., & Keltner, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgment and choice. *Cognition and Emotion, 14*(4), 473–493.

Leventhal, H., & Patrick-Miller, L. (2000). Emotions and physical illness: Causes and indicators of vulnerability. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed., pp. 523–537). New York: Guilford Press.

Luppino, F. S., de Wit, L. M., Bouvy, P. F., Stijnen, T., Cuijpers, P., Penninx, B. W., et al. (2010). Overweight, obesity, and depression: A systematic review and meta-analysis of longitudinal studies. *Archives of General Psychiatry, 67*(3), 220–229.

Macleod, J., & Davey Smith, G. (2003). Psychosocial factors and public health: A suitable case for treatment? *Journal of Epidemiology and Community Health, 57*(8), 565–570.

Matthews, K. A. (1988). Coronary heart disease and type A behaviors: Update on and alternative to the Booth-Kewley and Friedman (1987) quantitative review. *Psychological Bulletin, 104*, 373–380.

Meng, L., Chen, D., Yang, Y., Zheng, Y., & Hui, R. (2012). Depression increases the risk of hypertension incidence: A meta-analysis of prospective cohort studies. *Journal of Hypertension, 30*(5), 842–851.

Mezuk, B., Eaton, W. W., Albrecht, S., & Golden, S. H. (2008). Depression and type 2 diabetes over the lifespan: A meta-analysis. *Diabetes Care, 31*(12), 2383–2390.

Miller, G. E., Chen, E., Sze, J., Marin, T., Arevalo, J. M., Doll, R., et al. (2008). A functional genomic fingerprint of chronic stress in humans: Blunted glucocorticoid and increased NF-kappaB signaling. *Biological Psychiatry, 64*(4), 266–272.

Miller, G. E., Rohleder, N., Stetler, C., & Kirschbaum, C. (2005). Clinical depression and regulation of the inflammatory response during acute stress. *Psychosomatic Medicine, 67*(5), 679–687.

Miller, T. Q., Smith, T. W., Turner, C. W., Guijarro, M. L., & Hallet, A. J. (1996). A meta-analytic review of research on hostility and physical health. *Psychological Bulletin, 119*(2), 322–348.

Mischel, W., Ayduk, O., Berman, M. G., Casey, B. J., Gotlib, I. H., Jonides, J., et al. (2011). "Willpower" over the life span: Decomposing self-regulation. *Social Cognitive and Affective Neuroscience, 6*(2), 252–256.

Mitchell, A. J., Chan, M., Bhatti, H., Halton, M., Grassi, L., Johansen, C., et al. (2011). Prevalence of depression, anxiety, and adjustment disorder in oncological, haematological, and palliative-care settings: A meta-analysis of 94 interview-based studies. *Lancet Oncology, 12*(2), 160–174.

Mittleman, M. A., Maclure, M., Sherwood, J. B., Mulry, R. P., Tofler, G. H., Jacobs, S. C., et al. (1995). Triggering of acute myocardial infarction onset by episodes of anger: Determinants of Myocardial Infarction Onset Study investigators. *Circulation, 92*(7), 1720–1725.

Nabi, H., Chastang, J. F., Lefevre, T., Dugravot, A., Melchior, M., Marmot, M. G., et al. (2011). Trajectories of depressive episodes and hypertension over 24 years: The Whitehall II Prospective Cohort Study. *Hypertension, 57*(4), 710–716.

Nakata, A., Irie, M., & Takahashi, M. (2011). Psychological distress, depressive symptoms, and cellular immunity among healthy individuals: A 1-year prospective study. *International Journal of Psychophysiology, 81*(3), 191–197.

O'Leary, A. (1990). Stress, emotion, and human immune function. *Psychological Bulletin, 108*, 363–382.

Pan, A., Keum, N., Okereke, O. I., Sun, Q., Kivimaki, M., Rubin, R. R., et al. (2012). Bidirectional association between depression and metabolic syndrome: A systematic review and meta-analysis of epidemiological studies. *Diabetes Care, 35*(5), 1171–1180.

Pan, A., Sun, Q., Okereke, O. I., Rexrode, K. M., & Hu, F. B. (2011). Depression and risk of stroke morbidity and mortality: A meta-analysis and systematic review. *JAMA, 306*(11), 1241–1249.

Pennebaker, J., & Beall, S. K. (1986). Confronting a traumatic event: Toward an understanding of inhibition and disease. *Journal of Abnormal Psychology, 95*, 274–281.

Phillips, A. C., Batty, G. D., Gale, C. R., Deary, I. J., Osborn, D., MacIntyre, K., et al. (2009). Generalized anxiety disorder, major depressive disorder, and their comorbidity as predictors of all-cause and cardiovascular mortality: The Vietnam Experience Study. *Psychosomatic Medicine, 71*(4), 395–403.

Pinquart, M., & Duberstein, P. R. (2010). Depression and cancer mortality: A meta-analysis. *Psychological Medicine, 40*(11), 1797–1810.

Pitsavos, C., Panagiotakos, D. B., Papageorgiou, C., Tsetsekou, E., Soldatos, C., & Stefanadis, C. (2006). Anxiety in relation to inflammation and coagulation markers, among healthy adults: The ATTICA Study. *Atherosclerosis, 185*(2), 320–326.

Poitras, V. J., & Pyke, K. E. (2013). The impact of acute mental stress on vascular endothelial function: Evidence, mechanisms and importance. *International Journal of Psychophysiology, 88*(2), 124–135.

Possel, P., Adams, E., & Valentine, J. C. (2012). Depression as a risk factor for breast cancer: Investigating methodological limitations in the literature. *Cancer Causes and Control, 23*(8), 1223–1229.

Ranchor, A. V., Sanderman, R., & Coyne, J. C. (2010). Invited commentary: Personality as a causal factor in cancer risk and mortality—Time to retire a hypothesis? *American Journal of Epidemiology, 172*(4), 386–388.

Relman, A. S., & Angell, M. (2002). Resolved: Psychosocial interventions can improve clinical outcomes in organic disease. *Psychosomatic Medicine, 64*(4), 558–563.

Repetti, R. L., Taylor, S. E., & Seeman, T. E. (2002). Risky families: Family social environments and the mental and physical health of the offspring. *Psychological Bulletin, 128*(2), 330–336.

Robles, T. F., & Carroll, J. E. (2011). Restorative biological processes and health. *Social and Personality Psychology Compass, 5*(8), 518–537.

Roest, A. M., Martens, E. J., de Jonge, P., & Denollet, J. (2010). Anxiety and risk of incident coronary heart disease: A meta-analysis. *Journal of the American College of Cardiology, 56*(1), 38–46.

Rotella, F., & Mannucci, E. (2013). Depression as a risk factor for diabetes: A meta-analysis of longitudinal studies. *Journal of Clinical Psychiatry, 74*(1), 31–37.

Rothman, A. J., Kelly, K. M., Hertel, A. W., & Salovey, P. (2003). Message frames and illness representations: Implications for interventions to promote and sustain healthy behavior. In L. D. Cameron & H. Leventhal (Eds.), *The self-regulation of health and illness behaviour* (pp. 278–296). New York: Routledge.

Rudavsky, T. M. (2010). *Maimonides*. West Sussex, UK: Wiley.

Rugulies, R. (2002). Depression as a predictor for coronary heart disease. *American Journal of Preventive Medicine, 23*(1), 51–61.

Scheier, M. F., & Bridges, M. W. (1995). Person variables and health: Personality predispositions and *acute psychological states as shared determinants for disease. Psychosomatic Medicine, 57*, 255–268.

Scott, K. M., Von Korff, M., Angermeyer, M. C., Benjet, C., Bruffaerts, R., de Girolamo, G., et al. (2011). Association of childhood adversities and early-onset mental disorders with adult-onset chronic physical conditions. *Archives of General Psychiatry, 68*(8), 838–844.

Segerstrom, S. C., Hardy, J. K., Evans, D. R., & Greenberg, R. N. (2012). Vulnerability, distress, and immune response to vaccination in older adults. *Brain, Behavior, and Immunity, 26*(5), 747–753.

Selye, H. (1950). *The physiology and pathology of exposure to stress*. Montreal: Acta.

Selye, H. (1955). Stress and disease. *Science, 122*(3171), 625–631.

Shedler, J., Mayman, M., & Manis, M. (1993). The illusion of mental health. *American Psychologist, 48*(11), 1117–1131.

Singer, B., Friedman, E., Seeman, T., Fava, G. A., & Ryff, C. D. (2005). Protective environments and health status: Cross-talk between human and animal studies. *Neurobiology of Aging, 26*(Suppl. 1), 113–118.

Slopen, N., Kubzansky, L. D., & Koenen, K. C. (2013). Internalizing and externalizing behaviors predict elevated inflammatory markers in childhood. *Psychoneuroendocrinology, 38*(12), 2854–2862.

Smith, C. A., & Pope, L. K. (1992). Appraisal and emotion: The interactional contributions of dispositional and situational factors. In M. S. Clark (Ed.), *Emotion and social behavior* (Vol. 14, pp. 32–62). Newbury Park, CA: Sage.

Smoller, J. W., Pollack, M. H., Wassertheil-Smoller, S., Jackson, R. D., Oberman, A., Wong, N. D., et al. (2007). Panic attacks and risk of incident cardiovascular events among postmenopausal women in the Women's Health Initiative Observational Study. *Archives of General Psychiatry, 64*(10), 1153–1160.

Spieker, L. E., Hurlimann, D., Ruschitzka, F., Corti, R., Enseleit, F., Shaw, S., et al. (2002). Mental stress induces prolonged endothelial dysfunction via endothelin-A receptors. *Circulation, 105*(24), 2817–2820.

Steptoe, A., Hamer, M., & Chida, Y. (2007). The effects of acute psychological stress on circulating inflammatory factors in humans: A review and meta-analysis. *Brain, Behavior, and Immunity, 21*(7), 901–912.

Steptoe, A., & Wardle, J. (2005). Positive affect and biological function in everyday life. *Neurobiology of Aging, 26*(Suppl. 1), 108–112.

Suls, J., & Bunde, J. (2005). Anger, anxiety, and depression as risk factors for cardiovascular disease: The problems and implications of overlapping affective dispositions. *Psychological Bulletin, 131*(2), 260–300.

Temoshok, L. (1987). Personality, coping style, emotion, and cancer: Toward an integrative model. *Cancer Surveys, 6*, 545–567.

Thaker, P. H., & Sood, A. K. (2008). Neuroendocrine influences on cancer biology. *Seminars in Cancer Biology, 18*(3), 164–170.

Thayer, J. F., & Brosschot, J. F. (2005). Psychosomatics and psychopathology: Looking up and down from the brain. *Psychoneuroendocrinology, 30*(10), 1050–1058.

Thayer, J. F., Yamamoto, S. S., & Brosschot, J. F. (2010).

The relationship of autonomic imbalance, heart rate variability and cardiovascular disease risk factors. *International Journal of Cardiology, 141*(2), 122–131.
Thurston, R. C., Rewak, M., & Kubzansky, L. D. (2013). An anxious heart: Anxiety and the onset of cardiovascular diseases. *Progress in Cardiovascular Diseases, 55*(6), 524–537.
Tofler, G. H., & Muller, J. E. (2006). Triggering of acute cardiovascular disease and potential preventive strategies. *Circulation, 114*(17), 1863–1872.
Tomaka, J., Blascovich, J., Kelsey, R. M., & Leitten, C. L. (1993). Subjective, physiological, and behavioral effects of threat and challenge appraisal. *Journal of Personality and Social Psychology, 65*(2), 248–260.
Uchino, B. N., Birmingham, W., & Berg, C. A. (2010). Are older adults less or more physiologically reactive?: A meta-analysis of age-related differences in cardiovascular reactivity to laboratory tasks. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 65B*(2), 154–162.
Van der Kooy, K., van Hout, H., Marwijk, H., Marten, H., Stehouwer, C., & Beekman, A. (2007). Depression and the risk for cardiovascular diseases: Systematic review and meta analysis. *International Journal of Geriatric Psychiatry, 22*(7), 613–626.
Von Korff, M., Alonso, J., Ormel, J., Angermeyer, M., Bruffaerts, R., Fleiz, C., et al. (2009). Childhood psychosocial stressors and adult onset arthritis: Broad spectrum risk factors and allostatic load. *Pain, 143*(1–2), 76–83.
Williams, J. E., Nieto, F. J., Sanford, C. P., & Tyroler, H. A. (2001). Effects of an angry temperament on coronary heart disease risk : The Atherosclerosis Risk in Communities Study. *American Journal of Epidemiology, 154*(3), 230–235.
Willmott, L., Harris, P., Gellaitry, G., Cooper, V., & Horne, R. (2011). The effects of expressive writing following first myocardial infarction: A randomized controlled trial. *Health Psychology, 30*(5), 642–650.
Wittstein, I. S. (2012). Stress cardiomyopathy: A syndrome of catecholamine-mediated myocardial stunning? *Cellular and Molecular Neurobiology, 32*(5), 847–857.
World Health Organization. (2011). *Global status report on noncommunicable diseases 2010*. Geneva, Switzerland: Author.
Yan, L. L., Liu, K., Matthews, K. A., Daviglus, M. L., Ferguson, T. F., & Kiefe, C. I. (2003). Psychosocial factors and risk of hypertension: The Coronary Artery Risk Development in Young Adults (CARDIA) Study. *JAMA, 290*(16), 2138–2148.
Zanstra, Y. J., & Johnston, D. W. (2011). Cardiovascular reactivity in real life settings: Measurement, mechanisms and meaning. *Biological Psychology, 86*(2), 98–105.

CHAPTER 37

Neuroendocrine and Neuroimmunological Mechanisms of Emotion

Aric A. Prather

Affective experiences are intimately related to physical states of the body. Whether one subscribes to a top-down or bottom-up (or somewhere in between) theory of emotion (reviewed in Barrett & Lindquist, 2008), basal levels and acute fluctuations in peripheral biology play a role in the emotional process. Advances in neuroscience continue to illuminate the neural circuitry that underlies emotion generation and regulation, and while anatomical pathways linking the brain and body have been readily identified (e.g., autonomic nervous system [ANS], hypothalamic–pituitary–adrenal [HPA] axis), surprisingly less is known about how emotions affect downstream biology. This is especially true for outputs of the neuroendocrine and immune systems. In part, this may be due to the fact that the bulk of the empirical research has been carried out under the auspice of "stress" with less attention paid to the emotional responses that arise during stressful experience (Cohen, Kessler, & Gordon, 1997; Lazarus & Folkman, 1984). As such, this undifferentiated view of stress may fail to reveal the nuanced, affect-driven pathways through which stress impairs health (Kemeny, 2003; Weiner, 1992).

Emotions refer to a narrowly defined set of states that arise in response to specific challenges and goals, and are shaped through incorporation of conceptual and contextual information (Barrett, 2012). Emotions fall along various dimensions, such as by valence (positive vs. negative), arousal (high vs. low), and approach–avoidance motivation. In regard to the latter dimension, approach motivation facilitates approach toward stimuli (as would be observed in response to excitement or anger), while avoidance motivation leads an individual to avoid stimuli (as would be observed in response to fear, anxiety, and disgust). Inevitably, emotions are constituted by multiple, situationally defined and individually variable processes comprising experiential, physiological, and behavioral factors (Mauss & Robinson, 2009).

Several decades of research informs our understanding of how emotions affect health. Both large-scale epidemiological investigations and well-controlled experimental trials suggest that emotional processes are associated with the incidence and progression of numerous health conditions, including coronary heart disease, metabolic ailments (e.g., type 2 diabetes), autoimmune conditions, and infectious illness (DeSteno, Gross, & Kubzansky, 2013; Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002). The underlying biological mechanisms through which emotions contribute to illness are complicated and not well understood. However, the neuroendocrine and immune systems serve as prime candidates (Miller, Chen, & Cole, 2009).

The connections between emotions and the neuroendocrine and immune systems are dynamic and recursive and do not run in only one direction (i.e., only top-down). Rather, harking back to the pioneering work of William James and Carl Lange (James, 1884; Lange, 1887), physiological states have substantial influence on the brain and, consequently, affective experience and behavior. Innovations in the pharmacological manipulation of certain physiological states can provide new insight into how specific biological processes influence emotion. This chapter focuses on both directions in the context of the neuroendocrine and immune systems. It is notable that the ANS also plays an important part in the embodiment of emotion; however, that discussion can be found in Chapter 9, "Emotion and the Autonomic Nervous System," in this volume.

In this chapter, a selective overview of the literature linking negative and positive emotional states with neuroendocrine and immune outcomes is provided. Due to the constraints of what can be included in a chapter, this vast literature has been distilled down to the key biological processes for which emotions appear to be most strongly related. In this regard, a focus is placed on cortisol, testosterone, and oxytocin (OT), as well as enumerative/functional parameters of the immune system, inflammation, and *in vivo* models of immunity (e.g., vaccination responsiveness). It should be noted, however, that other biological outcomes (e.g., estradiol, progesterone) also play a role in these growing literatures. While cross-sectional (i.e., nonlongitudinal) studies make up a large portion of the extant literature, this review is largely devoted to findings from laboratory-based studies that either attempt to manipulate emotional experience so as to measure changes in neuroendocrine and immune outcomes *or* experimentally manipulate neuroendocrine and immune systems, pharmacologically or otherwise, to investigate effects on emotional states. A brief discussion of the literature as a whole, including criticisms and future directions, is provided at the end of this chapter. First, however, a brief overview of the neuroendocrine and immune systems is provided to orient the reader.

A Brief Overview of the Neuroendocrine and Immune Systems

Neuroendocrine System

The neuroendocrine system plays a critical role in adaptation to environmental challenges, such as stress, and is necessary for survival. Under nonstressful conditions, this system facilitates growth, development, and reproduction. In response to a stressor, the neuroendocrine system undergoes a series of steps leading to the release of cortisol, a primary hormone of the neuroendocrine system. In response to a perceived challenge, the hypothalamus secretes corticotropin-releasing hormone (CRH) into the pituitary stalk where it travels to the pituitary gland. The anterior pituitary then secretes adrenocorticotropic hormone (ACTH) into peripheral circulation, which stimulates the release of cortisol from the adrenal cortex into the blood stream. Cortisol regulates the production, storage, and utilization of glucose, one of the body's primary sources of energy, as well as modulates the magnitude of the immune system response. Cortisol shows a distinct circadian pattern with the highest level occurring in response to awakening (i.e., cortisol-awakening response) that declines precipitously over the remainder of the day. Cortisol is regulated via a negative feedback loop. Glucocorticoid receptors are replete in many areas of the brain, including the hypothalamus and hippocampus. Binding of cortisol to these receptors signals the brain to discontinue the production and release of CRH and ACTH, which ultimately leads to a decrease in cortisol release from the adrenals. Importantly, it is postulated that prolonged stress or psychopathology (e.g., depression) can lead to dysregulation of this feedback system.

The anterior pituitary is the source of a host of other hormones, including growth hormone, prolactin, thyroid-stimulating hormone, luteinizing hormone, and follicle-stimulating hormone. OT and arginine vasopressin, in contrast, are produced by neurons of the hypothalamus and stored in the posterior pituitary until they are released into peripheral circulation. OT is a neuromodulator in the brain important for sexual reproduction and, in females, released in high amounts during childbirth to stimulate contractions and postpartum to facilitate maternal–child bonding and lactation. As described later in this chapter, OT has also been implicated in social behavior.

The reproductive system is closely related to the neuroendocrine system, and its reproductive hormones fluctuate in response to challenge and emotion. While all of the reproductive hormones (e.g., progesterone, estrogen) have some influence on stress and emotion, the strongest evidence involves testosterone (T). T is an androgen steroid hormone produced in the testes in men and ovaries in women. Despite the fact that men produce substantially higher levels of T than women, it serves important roles across gender, including growth of muscle mass and bone density. T also facilitates the development of secondary sex characteristics in men. Androgen receptors exist in the brain providing means for T to influence emotion and behavior. In this regard, T is believed to modulate anger experience and aggressive behavior, the latter of which has been most clearly substantiated in animals (e.g., Trainor, Bird, & Marler, 2004).

Immune System

The immune system comprises cells and soluble molecules that work together to protect the body from insult and injury. Though intimately related, the immune system is typically separated into two arms: the innate and acquired immune system. The innate arm is present at birth and acts as the body's first line of defense against microbial infection and tissue damage. Components of the innate immune system include macrophages and granulocytes, such as neutrophils and basophils, among others. Macrophages are phagocytic, meaning that they eat their targets (i.e., unwanted invaders). They also release proteins known as cytokines that facilitate inflammation. During an inflammatory response, innate immune cells congregate at an area of injury (e.g., a wound) releasing toxic molecules and signaling proteins to neutralize the threat and call other surrounding immune cells to their aid. Natural killer (NK) cells are another type of innate immune cell. NK cells play an important role in halting the early phases of viral infections and attacking cells that have become malignant. NK cells release a toxic substance to lyse unwanted cells. Laboratory techniques have been developed to quantify the ability of NK cells to lyse, known as NK cell cytotoxicity (NKCC).

The acquired immune system, as the name suggests, develops over time in response to antigen exposure. This arm of the immune system is slower acting compared to the innate immune system and comprises various lymphocytes (e.g., helper T cells, cytotoxic T cells, and B cells) with receptors on their cell surfaces that respond to one and only one invader. Once activated, these lymphocytes divide (i.e., proliferate) to mount an army of cells to help clear the body of the invader. The primary function of helper T cells is to produce cytokines that modulate the rest of the immune response. In contrast, cytotoxic T cells seek out and lyse infected cells (e.g., virally infected cells). Finally, B cells produce antibodies, which are soluble proteins important for neutralizing bacterial toxins and tagging free-floating viruses and infected cells so as to signal to the innate arm a need for destruction. Antibodies levels are clinically meaningful as they are the end product of vaccinations. Activated T and B cells maintain immunological memory and can circulate in the blood for years to provide a rapid response if challenged by the same antigen once again.

Communication between the brain and the immune system is facilitated primarily via the ANS and the HPA axis (Irwin & Cole, 2011). Immune cells have receptors specific to catecholamines and cortisol, among other hormones. Communication between different aspects of the immune system is also facilitated through cytokines. Of particular relevance to stress and emotion are proinflammatory cytokines (PICs). As noted above, PICs, such as interleukin (IL)-6, IL-1 beta, and tumor necrosis factor (TNF) alpha, play an integral role in wound healing and destroying foreign pathogens; however, when overactive (i.e., prolonged elevations of PICs), systemic damage can occur leading to early onset of chronic health conditions (e.g., coronary heart disease; Ridker, Rifai, Stampfer, & Hennekens, 2000; Ross, 1999). Regulation of the inflammatory system occurs at multiple levels. Activated immune cells release anti-inflammatory cytokines (e.g., IL-10) and receptor antagonists that down-regulate PIC production locally. Cortisol also down-regulates inflammation by binding to glucocorticoid receptors (GRs) on activated immune cells that then translocate to the nucleus to down-regulate inflammatory gene transcription. Finally, the parasympathetic nervous system (PNS) regulates inflammation (Tracey, 2002) via the vagus nerve. It is believed that the vagus nerve serves as a primary pathway through which systemic levels of PICs influence the brain.

Emotions and Neuroendocrine Function

Cortisol

Effects of Emotions on Cortisol

There is some evidence to suggest that negative emotions can serve as instigators of HPA axis activation and subsequent cortisol release; however, the data are far from conclusive. Within clinical samples, exaggerated HPA axis functioning (i.e., higher cortisol, especially in the evening) is observed in some but not all patients with depression (Stetler & Miller, 2011), with stronger evidence for subtypes of depression (e.g., melancholic depression). Patients with posttraumatic stress disorder (PTSD) also show alterations in cortisol, often marked by a blunted diurnal cortisol rhythm (Daskalakis, Lehrner, & Yehuda, 2013). In the context of stress, accruing evidence indicates that timing and severity of stressors play a role in driving deviations in cortisol rhythms (Miller, Chen, & Zhou, 2007). Data from a meta-analytic review of 107 studies demonstrated that cortisol rises in response to a chronic stressor but decreases as that stressor persists. Further, contextual factors, such as how an individual responds to the stressful situation and the extent to which the stressor is socially evaluative in nature and perceived as uncontrollable, significantly shapes cortisol dynamics.

In nonclinical samples, changes in daily affect have been linked to alterations in cortisol rhythms in a number of studies. For example, in a large sample of midlife adults, higher cortisol levels across the day were associated with higher levels of average negative affect; however, this was true only for older adults (Piazza, Charles, Stawski, & Almeida, 2013). Adam and colleagues (2006) found that negative affective states, such as loneliness, sadness, threat, and lack of control, on any given day predicted higher cortisol-awakening responses the following day. In addition, a flatter cortisol slope across the day was associated with same-day feelings of tension and anger (Adam et al., 2006). Other studies, however, have failed to observe associations between state negative affect and cortisol (e.g., Polk, Cohen, Doyle, Skoner, & Kirschbaum, 2005).

Diurnal cortisol tends to be lower in those reporting more positive emotions (reviewed in (Dockray & Steptoe, 2010; Pressman & Cohen, 2005). Using daily diaries, higher reports of happiness were related to lower cortisol levels early in the day and increased cortisol upon awakening in a small sample of 72 healthy men (Steptoe, Gibson, Hamer, & Wardle, 2007). Similar associations were observed in several larger samples (Steptoe, O'Donnell, Badrick, Kumari, & Marmot, 2008; Steptoe, Wardle, & Marmot, 2005). Like neuroendocrine links with negative emotions, these associations between positive affect and cortisol often vary as a function of age and gender (Dockray & Steptoe, 2010). For instance, Polk and colleagues (2005) found that higher positive affect, aggregated over 7 days, was associated with higher flatter diurnal rhythm in men but a lower flatter rhythm in women. This finding among women is consistent with prior research (Ryff, Singer, & Dienberg Love, 2004).

Cortisol is acutely responsive to changes in environmental demands. The largest and most robust effects on cortisol reactivity are observed in response to acute threats, often modeled in humans using acute laboratory tasks. The most common of these tasks is the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993). The TSST is a laboratory task where a participant is exposed to a social evaluative speech task and mental arithmetic in front of a panel of evaluators. This paradigm, and modified versions of it, results in high levels of perceived social evaluation and reliably induces HPA activation, including a significant increase in cortisol (Dickerson & Kemeny, 2004; Kirschbaum et al., 1993).

Understanding the task characteristics and stress-related affective experiences that predict HPA responsiveness has been an area of active scientific inquiry (see Campbell & Ehlert, 2012; Denson, Spanovic, & Miller, 2009; Dickerson & Kemeny, 2004, for reviews). A seminal meta-analysis of 208 acute laboratory studies suggested that two key task characteristics contributed to greater HPA activation: the uncontrollability of the task and the extent to which the task was social evaluative in nature (Dickerson & Kemeny, 2004). Importantly, type of task (i.e., being a public speaking/cognitive task vs. not), duration of task, and the subjective distress and negative affect initiated by the tasks did not explain these findings. These results align with social self-preservation theory that argues that one of the central motives of humans and other animals is to maintain social status (Dickerson, Gruenewald, & Kemeny, 2004). Within this framework, shame has been proposed as the affective experience driving HPA functioning in response to acute social threat (Dickerson et al., 2004; Gruenewald, Kemeny, Aziz, & Fahey, 2004). A subsequent study supported this notion such that increases in self-reported shame and decreases in social self-esteem corresponded to greater cortisol reactivity to a social evaluative stressor (Gruenewald et al., 2004). Of note, a more recent meta-analysis of the cortisol reactivity literature failed to find strong support for the role of self-conscious emotions predicting cortisol responses (Denson et al., 2009).

It is well documented that self-report measures of emotion are often weakly correlated with objectively assessed measures of physiology, including cortisol (Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). One explanation for this is that self-reported emotions, by their very nature, rely on conscious self-reflection. Implicit measures of affect, in contrast, may improve this coherence. For instance, emotional facial expressions, which are thought to reflect automatic unconscious processes, may yield more consistent findings. In this regard, Lerner, Dahl, Hariri, and Taylor (2007) investigated the coherence between facial expressions in response to the TSST and cortisol reactivity. Participants displaying more fearful facial expressions during the task showed a greater increase in salivary cortisol. In contrast, those displaying expressions of anger and/or disgust showed a blunted cortisol response. Self-report measures of emotion were largely unrelated to cortisol. In a separate study of implicit negative affectivity, participants completed the Implicit Positive and Negative Affect Test (IPANAT) and found that those who displayed more implicit (i.e., presumably below conscious awareness) negative affect showed greater cortisol responsiveness to an uncontrollable noise stressor (Quirin, Kazen, Rohrmann, & Kuhl, 2009).

Effects of Cortisol on Emotions

There is a long and storied literature implicating HPA hyperactivity and the pathogenesis of psychiatric conditions. For instance, patients with Cushing's syndrome, which is marked by unregulated and excessive cortisol release, are at increased risk of anxiety disorders (generalized anxiety and panic) and major depression (Pereira, Tiemensma, & Romijn, 2010). Further, prospective evidence in otherwise healthy participants also supports such associations, with higher diurnal cortisol, particularly a greater cortisol-awakening response, related to incidence of depression and anxiety disorders (Adam et al., 2010, 2014; Vrshek-Schallhorn et al., 2013).

GRs densely populate brain regions critical to emotional processing, providing a mechanism through which cortisol could influence emotion. Attempts to document the effects of exogenous cortisol on emotion have been mixed, however (reviewed in Putman & Roelofs, 2011). Several trials have failed to find effects of synthetic cortisol on measures of affect (Abercrombie, Kalin, & Davidson, 2005; Buchanan, Brechtel, Sollers, & Lovallo, 2001; Wachtel & de Wit, 2001). However, one study found that acute treatment with cortisol led to mood improvement (Reuter, 2002). In the context of an acute laboratory stressor, exogenous cortisol was found to attenuate negative affective responses to stress in several studies (Het & Wolf, 2007; Soravia et al., 2006). These data suggest that perhaps cortisol aids in effective coping with stress. Unfortunately, variability in study designs and dosages of cortisol make it difficult to draw any strong conclusions.

There is growing evidence that the effects of cortisol on emotion are situationally dependent. For instance, Wirth, Scherer, Hoks, and Abercrombie (2011) found that participants who received intravenous hydrocortisone and were exposed to unpleasant pictures reported more negative affect compared with those on placebo when they were in a familiar environment. In contrast, when in a novel environment, participants reported elevated levels of negative affect similarly regardless of study condition (i.e., hydrocortisone or placebo; Wirth et al., 2011). In addition, sex effects have also been observed. Women exposed to intravenous hydrocortisone showed reductions in attentional bias toward positively valenced stimuli; this effect was not observed in men (Breitberg et al., 2013). Dose of cortisol also appears important in some circumstances (Buchanan et al., 2001).

Summary

Cortisol remains one of the most consistently measured neuroendocrine outcomes in stress and emotion research. While there is fairly robust evidence that cortisol increases acutely under socially evaluative stress, too few studies exist to know whether specific negative emotions, such as shame, truly drive these fluctuations. Findings in support of affect-related changes in diurnal cortisol are also promising; however, evidence that these associations can vary by gender and age suggest that more granular investigations are needed. Similarly, more studies employing cortisol administration are required to make sense of how increases drive situationally dependent changes in emotion, and how such changes fit with the existing literature linking cortisol and psychopathology.

Testosterone

Effects of Emotions on T

T is a critical sex hormone that contributes to the development of secondary sex characteristics and facilitates mating behavior; however, emerging evidence suggests that T also plays an important role in socioemotional functioning. In this regard, much of the existing literature on T has focused on responses to and anticipations of competitive and aggressive interactions, which are closely tied to anger (Carre, McCormick, & Hariri, 2011; Eisenegger, Haushofer, & Fehr, 2011). It is well accepted that T helps drive aggressive behavior in animals (Gleason, Fuxjager, Oyegbile, & Marler, 2009; Trainor et al., 2004). In humans, however, aggressive behavior is incredibly complex, as most aggressive behaviors are not overtly violent. As such, correlations between self-reports of aggression and T are weak, though positive (Archer, Graham-Kevan, & Davies, 2005).

A handful of studies have investigated whether competitive interactions contribute to reactivity in T and related aggressive behaviors. Overall, the findings suggest that among participants who show an increase in T, there is a related increase in either willingness to engage in further competition (if the task was competitive in nature) and/or aggressive behavior (reviewed in Carre et al., 2011). This may have clinical implications as a recent study found that T reactivity in response to a social provocation task statistically mediated the effects of an early life intervention on future aggressive behavior (Carre, Iselin, Welker, Hariri, & Dodge, 2014).

Importantly, not all participants in these laboratory studies display the expected increases in T, and in fact, in some cases there were no main effects of the task on changes in T (e.g., (Mehta & Josephs, 2006). Accordingly, there is increasing interest in identifying individual differences and contextual factors that modulate these associations. Characteristics that may explain some of the variability in T reactivity range from differences in gender, contextual cues, basal levels of T, and social status (Carre et al., 2011; Josephs, Sellers, Newman, & Mehta, 2006; Klinesmith, Kasser, & McAndrew, 2006; Mehta & Beer, 2010). For instance, participants with low basal T report more emotional arousal and worse cognitive functioning when placed in an experimentally manipulated high-status position, while those with high T show more decrements when placed in a low-status position (Josephs et al., 2006). In addition, researchers have proposed a dual-hormone hypothesis, which posits that levels of cortisol moderate the effects of T on aggression such that the effects are stronger when levels of cortisol are low (Mehta & Josephs, 2010). Support for this hypothesis comes from data on several highly aggressive male clinical populations (i.e., violent offenders and adolescents with conduct disorder; Dabbs, Jurkovic, & Frady, 1991; Popma et al., 2007), and experimental studies of dominance (Mehta & Josephs, 2010). Interestingly, there is some evidence for a reverse pattern in females such that greater aggression is seen in women with high T and high cortisol (Denson, Mehta, & Ho Tan, 2013). The extent to which other hormones or biological processes may further modulate social processes remains a fruitful area of investigation.

Surprisingly little is known about the relationship between T and emotional experience beyond aggressive behavior. There is cross-sectional evidence that shows that higher levels of self-reported anger and hostility are associated with higher T (Hohlagschwandtner, Husslein, Klier, & Ulm, 2001; Persky, Smith, & Basu, 1971). Indeed, one study of 32 healthy student volunteers found that higher salivary T obtained 4 and 6 hours prior to a mood assessment was associated with greater self-reported anger (van Honk et al., 1999). However, other studies fail to find associations (e.g., King, Rosal, Ma, & Reed, 2005). In the laboratory, men exposed to an acute stressor showed increases in T and this increase was positively correlated with trait hostility (Girdler, Jammer, & Shapiro, 1997). More recently, a study examining social rejection supported a link between anger and T. Here, individuals who participated in a cyberball task reported increases in self-reported anger, the magnitude of which was associated with increasing levels of salivary T (Peterson & Harmon-Jones, 2012). In another study, a task designed to induce anger (Engebretson, Sirota, Niaura, Edwards, & Brown, 1999) was also related to increasing T. Participants read a series of anger-laden phrases. This resulted in the expected increases in anger as well as significant increases in T (Herrero, Gadea, Rodriguez-Alarcon, Espert, & Salvador, 2010). Notably, there was no significant relationship between increases in anger and T, again highlighting the lack of coherence across self-report and physiologic measures.

Effects of T on Emotions

The implementation of single and multidose sublingual administration of T has led to careful inquiry into how T affects complex social interactions and the behaviors and emotions that arise in response. In laboratory studies of "reactive aggression," where a participant has the opportunity to "steal away" points from a fictitious opponent, higher basal T is associated with a greater likelihood of carrying out such a "harm" behavior in some (reviewed in Carre et al., 2011) but not all studies (Eisenegger, Naef, Snozzi, Heinrichs, & Fehr, 2010). T administration also appears to have some effect on self-reported emotion. O'Connor, Archer, and Wu (2004) found that men treated for 8 weeks with T in a cross-over design reported modest, but significant, increases in anger and hostility on T compared with placebo; however, there were no increases in aggressive behavior. Such mood changes are consistent with the fact that some anabolic steroid abusers develop steroid rage, hypomania, irritability, and in some cases, depressive episodes (Hartgens & Kuipers, 2004).

While the effects of T on aggressive behavior remain controversial, there is more consistent data suggesting that T drives motivation behaviors related to obtaining higher social status (i.e., dominance; Mazur & Booth, 1998). Using an approach–avoidance framework, it is hypothesized that T administration can lead to increased anger and social vigilance (approach) and reduction in fear (avoidance) in contexts where social status can be promoted (Terburg & van Honk, 2013). In regard to the latter, behavioral and neuroimaging studies in animals and humans suggest that T administration reduces fear processing and behavior (van Honk, Peper, & Schutter, 2005). Additionally, T administration leads to suppressed facial mimcry in response to emotional facial expression (Hermans, Putman, & van Honk, 2006), decreased trust in others, and decrements in emotional inference capacity (van Honk et al., 2011). In a sample of women, T administration compared with placebo led to a modest reduction in emotional inference (i.e., cognitive empathy), which was assessed using the Reading the Mind in the Eyes Test (RMET). This finding was moderated by fetal T exposure, such that higher fetal exposure resulted in further reduction in cognitive empathy for those receiving exogenous T (van Honk et al., 2011). While reduction in cognitive empathy in the face of competition for status is likely adaptive, the moderation effect is notable as it further highlights contextual and/or biological factors that can illuminate otherwise minor associations.

T also appears to affect the way our brains interpret potential threats, with implications for emotional processing. In a recent neuroimaging study, those who received an acute dose of T showed heighted reactivity of the amygdala, hypothalamus, and periaqueductal gray in response to viewing angry faces compared with those on placebo (Goetz et al., 2014). The amygdala is rich with androgen receptors, as are other brain regions implicated in threat processing (Sarkey, Azcoitia, Garcia-Segura, Garcia-Ovejero, & DonCarlos, 2008). Animal studies also support that T has anxiolytic effects, mediated by gamma-aminobutyric acid A ($GABA_a$) receptors (Fernandez-Guasti & Martinez-Mota, 2005). Additionally, exogenous T has been shown to increase the heart rate of participants when exposed to angry faces but not happy facial expressions (van Honk et al., 2001), providing evidence that T confers effects of peripheral physiology in the context of threat.

Summary

There is clear animal evidence that T modulates behavior, particularly aggression. Investigation of T in humans, however, has been hampered by available methods and the complexity of the human experience. While there is some evidence that suggests negative emotions, particularly anger, can lead to increased T, experimental studies that use T administration and measure downstream effects are more compelling. In this regard, there is mounting evidence that T affects the brain to modulate emotion, decision making, and ultimately, behavior. The relationship among T and emotional experience and behavior are complex and appear moderated by basal levels of T, context and demands, gender, and other biological processes, including cortisol.

Oxytocin

Effects of Emotions on OT

Over the past decade, research on the actions of OT in facilitating social interaction and emotion has exploded. In public forums, oxytocin has become known as a "love hormone" as well as a virtual panacea for treating loneliness, mistrust and social disconnection. This has led to interest in using OT as a pharmacological treatment for improving social functioning and prosocial behavior in a variety of clinical populations where social functioning is compromised, including schizophrenia, autism, anxiety, and depression (Bakermans-Kranenburg & van IJzendoorn, 2013). While often exaggerated, such claims are founded on elegant animal research and emerging human studies. OT may play an important role in regulating the stress response with implications for emotional experience.

To date, only a handful of studies have investigated the effects of stress or negative emotion on downstream levels of OT in peripheral blood. In part, this is because OT in peripheral blood is challenging to measure accurately (McCullough, Churchland, & Mendez, 2013). Nevertheless, several cross-sectional studies show that greater relationship distress in women is associated with higher peripheral levels of oxytocin (Taylor et al., 2006; Taylor, Saphire-Bernstein, & Seeman, 2010; Turner, Altemus, Enos, Cooper, & McGuinness, 1999). Higher levels of oxytocin are also associated with greater anxiety, depressive severity, and history of childhood maltreatment (Cyranowski et al., 2008; Hoge, Pollack, Kaufman, Zak, &

Simon, 2008; Holt-Lunstad, Birmingham, & Light, 2011; Olff et al., 2013). While on the surface one would expect that OT levels would be inversely related with negative emotion given the large literature supporting OT as a prosocial hormone, Taylor and colleagues (2010) speculate that OT rises in response to distress as a signal to increase affiliation with others. OT is also at the center of the "tend and befriend" response posited to explain sex differences in responses to stress (Taylor et al., 2000). More specifically, it is proposed that OT, along with estrogen and endogenous opioids, facilitate increased caring, especially for offspring, and enhanced affiliation under stress in females.

The effects of acute laboratory stress on peripheral levels of OT have been mixed with a couple of studies reporting significant stress related increases (Moons, Way, & Taylor, 2014; Sanders, Freilicher, & Lightman, 1990), while other studies fail to find an effect (Altemus et al., 2001; Cyranowski et al., 2008; Taylor et al., 2006). There is also emerging evidence that genetic factors may modulate the link between OT and emotion, at least in response to stress. In a recent study of men and women exposed to a TSST, women who showed a greater stress-related increase in OT and were GG homozygous for the rs53576 polymorphism of the oxytocin receptor gene (OXTR) reported higher levels of positive affect post stressor (Moons et al., 2014). Interestingly, men who showed increases in vasopressin, a hormone similar to OT, and were a carrier for the RS1 polymorphism of the vasopressor receptor gene reported more anger in response to the TSST. While this finding requires further replication, such genetic effects point to yet another factor that can significantly modulate associations between biological outcomes, in this case OT, and affective experience.

Effects of OT on Emotions

Whether OT administration affects emotions continues to be an area of active scientific inquiry. Accruing evidence demonstrates that OT promotes positive social emotions such as trust and altruism (Israel, Weisel, Ebstein, & Bornstein, 2012; Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005), and better emotion recognition (Domes, Heinrichs, Michel, Berger, & Herpertz, 2007), which have led many to associate OT as a prosocial hormone. In animals, exogenous OT administration results in enhanced sedation and relaxation, reduced fearfulness, and attenuated sympathetic arousal (reviewed in Carter, 2014).

Intranasal OT can also modulate responses to acute laboratory stressors. OT administration prior to a public-speaking task resulted in decreased anticipatory anxiety compared with placebo and increased feelings of sedation (de Oliveira, Zuardi, Graeff, Queiroz, & Crippa, 2012). Increased calmness was also observed in another study (Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003). Kubzansky, Mendes, Appleton, Block, and Adler (2012) found the OT administration prior to the TSST resulted in physiological indices that characterize a more "challenged" (vs. "threatened") state compared with placebo. Moreover, OT promoted lower levels of stress-induced negative emotion in men but not women. More specifically, men showed reduced levels in stress-induced anger in the OT condition compared with placebo, while women experienced an increase in anger compared with placebo. While the decrease in distress observed in men is consistent with a prior study (Heinrichs et al., 2003), the authors speculate that the increase observed in women aligns with the notion that OT may promote approach-related behavior, of which anger often facilitates.

Neuroimaging studies tend to support threat-reducing effects of intranasal OT. Several studies have found that OT reduces amygdala reactivity to threatening stimuli (e.g., angry and fearful faces; reviewed in Meyer-Lindenberg, Domes, Kirsch, & Heinrichs, 2011). The effect of OT on attenuating the amygdala has also been shown to mediate OT-related increases in trust during an economic trust game (Baumgartner, Heinrichs, Vonlanthen, Fischbacher, & Fehr, 2008). Importantly, other brain areas have also been implicated in mediating OT effects, including the caudate and other subcortical regions (Kanat, Heinrichs, & Domes, 2013), which suggests the influence of OT on the brain is complex and likely context specific.

Recent studies suggest that OT can also facilitate negative emotions, such as envy (Shamay-Tsoory et al., 2009), and reduce an individual's willingness to help "outgroup" members (De Dreu et al., 2010; Shalvi & De Dreu, 2014). Explanations for the OT-related enhancement of negatively valenced emotions include thoughts that OT increases social salience as well as reflect approach–avoidance behavior (Kemp & Guastella, 2010, 2011). Future studies testing these competing explanations and related contextual factors will go a long way in illuminating the influence of OT on human behavior.

Summary

The evidence linking OT to emotion is accruing but not without controversy. Intranasal administration studies demonstrate that OT affects self-reported emotion, behavior, and brain activity; however, many of these findings are context specific. Consequently, competing theories about how OT is related to socioemotional functioning have emerged. While OT can reduce anxiety and fear, it has also been shown to enhance negatively valenced constructs, such as envy. Additional studies are needed to clarify the nature of these findings. In regard to the effects of emotion on peripheral OT, another story emerges. Overall, the data suggest that greater negative emotion is related to higher levels of peripheral OT. Like the OT administration data, findings are often a function of gender and, in some cases, genetics. Challenges in measuring peripheral OT accurately likely contribute to some of the mixed findings in this literature.

Emotions and the Immune System

Effects of Emotions on the Immune System

Enumerative and Functional Immune Measures

Like cortisol, much of what is known about emotion and the immune system falls under the umbrella of stress research (Glaser & Kiecolt-Glaser, 2005; Herbert & Cohen, 1993b; Marsland, Bachen, Cohen, & Manuck, 2001; Segerstrom & Miller, 2004). The biological mediators of the stress response (i.e., HPA and ANS activity) modulate the immune system to adapt to challenges and environmental demands; however, under prolonged stress, the efficiency of the immune system begins to wane. As reviewed by Segerstrom and Miller (2004), there are a number of consistent findings linking stress and immunity. In response to acute laboratory stressors, such as the TSST, there are transient increases in total number of lymphocytes, cytotoxic T cells, and NK cells as well as concomitant reductions in the ability for T cells to proliferate when challenged *in vitro*. This pattern suggests an up-regulation in innate immunity and suppression of acquired immunity. Studies employing brief naturalistic stressors, such as assessing students immediately prior to and following academic examinations, demonstrate reductions in NKCC and T cell proliferative capacity along with increased reactivation of latent viruses, the latter of which indicates suppression of cell-mediated immunity. To date, the most robust immune effects are observed in those undergoing chronic stress, such as being a caregiver of a spouse with dementia (e.g., Kiecolt-Glaser, Glaser, Gravenstein, Malarkey, & Sheridan, 1996; Kiecolt-Glaser et al., 2003). These individuals show substantial immune suppression, including decreased T cell proliferative capacity and enhanced latent virus reactivation, along with increased levels of inflammation.

Depression is another area where enumerative and functional measures of immunity have been extensively investigated. Overall, compared with a nondepressed control group, individuals diagnosed with clinical depression show fewer NK cells and T cells but higher levels of B cells and T helper cells (Zorrilla et al., 2001). Depressed patients also show lower NKCC and a reduced capacity for cell proliferation (Herbert & Cohen, 1993a; Zorrilla et al., 2001). Beyond depression, there is some evidence that anger and hostility are related to functional measures of immunity. For instance, in a sample of cardiac patients, better anger control was associated with higher NKCC (Ishihara, Makita, Imai, Hashimoto, & Nohara, 2003), whereas lower NKCC was associated with higher anger suppression in a separate cancer population (Penedo et al., 2006).

Positive emotions have been related to aspects of immunity (reviewed in Dockray & Steptoe, 2010; Marsland, Pressman, & Cohen, 2007). Higher dispositional positive affect was associated with greater NKCC in a sample of older adults (Lutgendorf et al., 2001). In addition, several mood induction studies have found that humorous stories or films result in increased NKCC, increased number of T and B cells, and increased T cell proliferation (Berk, Felten, Tan, Bittman, & Westengard, 2001; Futterman, Kemeny, Shapiro, & Fahey, 1994); methodological considerations, such as the lack of control conditions in some cases and lack of specificity (i.e., modulation by both positive and negative emotion conditions), should temper interpretations of these findings.

The degree to which enumerative and functional immune measures respond to acute changes in emotions has not been well studied. In a recent meta-analysis of the literature using high-inference coding, Denson and colleagues (2009) reported that sadness and disgust were associated with decreases in numbers of NK cells. Studies designed to elicit embarrassment and rumination, specifically brooding, were associated with reductions in total T cell number while anticipation was associated with reductions in number of T helper cells. None of the emotional variables considered were related to acute changes in cytotoxic T cell or B cell numbers. In contrast, emotions related to immediate threats, including anticipation and surprise, were associated with an increase in total number of lymphocytes. Unfortunately, the only functional measure included in this meta-analysis was NKCC; none of the emotional variables were associated with NKCC. It is unclear what to make of these findings. While there is theoretical grounding for expecting that emotions, such as fear or anger, may be coupled with immune changes related to immediate threats in the environment (e.g., possible wounding from a predator; Kemeny, 2003), transient changes in cell type number are unlikely candidates to substantiate such a theory (see Miller, 2009, for a commentary). Additional integration of other functional immune measures, including cellular production of proinflammatory cytokines and the proliferative capacity of T cells, will aid in future investigations.

Inflammation

Inflammation, as indexed by levels of PICs in peripheral circulation, has emerged as a biological pathway linking psychological phenomenon and health. There is a large literature linking higher levels of state and trait measures of negative emotions with elevated inflammatory activity, including self-reported anger/hostility, anxiety, and depression (Howren, Lamkin, & Suls, 2009; Kiecolt-Glaser et al., 2002). Further, a series of studies have documented increases in systemic inflammation and cellular production of PICs in response to acute laboratory stressors (Dickerson, Gable, Irwin, Aziz, & Kemeny, 2009; Steptoe, Hamer, & Chida, 2007). Regarding positive emotions, higher levels of dispositional positive affect have been related to lower levels of systemic inflammation (e.g, IL-6) and attenuated cellular production of PICs (Prather, Marsland, Muldoon, & Manuck, 2007; Steptoe et al., 2008); however, an association was observed in women alone in one study (Steptoe et al., 2008). Types of positive emotion may matter more than others when it comes to inflammation. For instance, Ryff and colleagues (2004) found that higher eudaimonic well-being (i.e., striving toward a purpose in life) was associated with lower levels of the IL-6 soluble receptor. This is in line with a recent study that found eudaimonic well-being was related to a down-regulated proinflammatory gene profile, while hedonic well-being was associated with an up-regulation in these genes (Fredrickson et al., 2013).

To date, only a couple of studies have carefully investigated the extent to which stress-related changes in specific emotions drive concomitant changes in inflammation. Moons, Eisenberger, and Taylor (2010) reported that greater levels of self-reported fear following a speech task were associated with statistically significant increases in levels of IL-6 and a marginal increase in the soluble receptor for TNF alpha, both measured in oral mucosal transudate (OMT). Self-reported anger, in contrast, was unrelated to cytokine levels. This is in contrast to two other recent studies. In a sample of 102 healthy midlife adults, greater reports of anxiety and anger, but not fear, in response to a similar speech task were associated with greater task-related increases in circulating levels of IL-6 measured in blood (Carroll et al., 2011). This association between task-related increases in anger and levels of IL-6 was recently replicated (Puterman, Epel, O'Donovan, Prather, Aschbacher, et al., 2014). Notably, the latter finding linking anger and IL-6 reactivity was true only for those reporting low social support, which may suggest a need to more carefully assess contextual variables when investigating affect-immune relationships.

Suarez, Boyle, Lewis, Hall, and Young (2006) employed an anger recall interview (ARI) to investigate the effects of negative arousal on inflammation. Analyses revealed an intriguing three-way interaction such that greater negative affect in response to the ARI predicted greater increases in stimulated production of IL-6 and TNF alpha among those with high levels of insulin resistance. Using a similar paradigm, greater negative emotional arousal was related to greater increases in C-reactive protein but unrelated to changes in levels of IL-6 (Brummett et al., 2010). Finally, elevated levels of IL-1beta, obtained in saliva, were observed in grieving participants who carried out a grief-elicitation task (i.e., describing how their loved one died), and these levels of IL-1 beta were related to activation of brain regions implicated in emotional processing (subgenual anterior cingulate cortex [sACC] and orbitofrontal cortex [OFC]; M. F. O'Connor, Irwin, & Wellisch, 2009). Unfortunately, the lack of a control condition or baseline assessment of inflammatory activity prior to grief task makes it impossible to know whether this grief paradigm resulted in enhanced inflammatory activity.

In Vivo *Immune Processes*

The immune system is more than the sum of its parts. Accordingly, documenting whether changes in emotion or stress result in concomitant changes in cell number or function often have limited clinical utility. Therefore, researchers have turned to *in vivo* models of the immune system—such as estimating one's susceptibility to the common cold following viral challenge, response to immunization, and proficiency in wound healing—to better characterize the role of negative emotions.

In a series of experimental studies, Sheldon Cohen and colleagues have investigated the psychosocial predictors of upper respiratory infections (URIs) using a viral challenge model. Here, participants are experimentally exposed to a cold or influenza virus or placebo and then quarantined and monitored for the development of infection and illness. Findings from these studies largely support more stressful life events and greater perceptions of current stress, and greater reports of negative affect increase the probability of a biologically verified cold (Cohen, Tyrrell, & Smith, 1993; Cohen & Williamson, 1991). Several factors have also been effective in lowering the probability of cold development, including a larger social network size, greater sociability, more social support, and a positive emotional style (Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997; Cohen, Doyle, Turner, Alper, & Skoner, 2003a, 2003b).

Antibody levels mounted in response to immunization provides another clinically relevant metric of immune function. To date, the strongest psychosocial predictors of vaccination response tend to be long-lasting experiences rather than acute changes in emotion. For instance, poorer antibody responses have been observed among chronically stressed individuals, those reporting more stressful life events and higher levels of perceived stress compared with less stressed participants (Cohen, Miller, & Rabin, 2001; Pedersen, Zachariae, & Bovbjerg, 2009). Individual differences in negative affect have also been linked to immunization response (A. L. Marsland, Cohen, Rabin, & Manuck, 2001; Phillips, Carroll, Burns, & Drayson, 2005). For instance, Marsland and colleagues (2001) found that greater trait negative affect predicted lower antibody responses to the hepatitis B (HB) vaccination series. In another study of HB vaccination, more depressive symptoms were associated with increased likelihood of being a nonresponder (anti-HB < 10 IU/L [International Units/Liter]) to the vaccine (Afsar, Elsurer, Eyileten, Yilmaz, & Caglar, 2009). Similarly, Petry, Weems, and Livingstone (1991) observed associations among depression, anxiety, and irascibility with peak antibody titers in an earlier study. Finally, greater reports of loneliness, measured by daily diary over 2 weeks, were associated with poorer antibody response to the influenza vaccine in a sample of college students (Pressman et al., 2005). Notably, greater dispositional positive affect has also been related to higher antibody production to the HB vaccine (Marsland, Cohen, Rabin, & Manuck, 2006).

One of the primary roles of the immune system is to facilitate wound healing. There is now a large body of evidence supporting the role of stress, particularly prolonged or chronic stress, in slowing the healing of wounds (Christian, Graham, Padgett, Glaser, & Kiecolt-Glaser, 2006). In a seminal example, chronically stressed women caring for a spouse with dementia showed healing of a punch biopsy wound 24% slower than low-stress noncaregivers (Kiecolt-Glaser, Marucha, Malarkey, Mercado, & Glaser, 1995). In addition, slower wound healing has been observed in individuals reporting more depressive symptoms and lower anger control (Bosch, Engeland, Cacioppo, & Marucha, 2007; Gouin, Kiecolt-Glaser, Malarkey, & Glaser, 2008). Using a martial interaction paradigm, couples characterized as having high hostile interactions showed blister wound healing at 60% the rate of couples with low hostile interactions (Kiecolt-Glaser et al., 2005). Lower local wound-specific levels of cytokines (e.g., IL-8, IL-1 alpha) are thought to mediate some of the effects of emotion on healing (Glaser et al., 1999). In addition, recent evidence supports the mechanistic role of cortisol and OT (Christian et al., 2006; Gouin et al., 2010). For instance, again using a martial interaction paradigm, participants with higher OT had more positive couple interactions and faster healing times compared to those with low OT (Gouin et al., 2010).

Effects of Immune System on Emotions

Perhaps the most impressive advance made in the field of human psychoneuroimmunology (PNI) in the last decade has been recognition and empirical substantiation of the influence inflammatory mediators have on the brain and affective experience (Dantzer, O'Connor, Freund, Johnson, &

Kelley, 2008; Miller, Maletic, & Raison, 2009). Clinical data have long suggested that inflammatory activity is up-regulated in individuals with psychopathology, most notably, major depression (Dowlati et al., 2010; Smith, 1991) and to some extent anxiety (O'Donovan et al., 2010; Vogelzangs, Beekman, de Jonge, & Penninx, 2013). Animals treated with PICs or agents that activate the inflammatory response, such as systemic administration of endotoxin, display a characteristic "depression" behavioral phenotype termed "sickness behavior." These behaviors include reduced motor activity, social withdrawal, decreased interest and consumption of food and water, increased slow-wave sleep, and altered cognition (Dantzer et al., 2008).

Experimental human studies employing endotoxin administration results in similar affective changes in humans. Indeed, participants treated with low-dose endotoxin show increased levels of systemic inflammation (TNF, IL-6) and related, transient, increases in symptoms of anxiety and depression (Reichenberg et al., 2001); however, some evidence suggests these findings may be stronger in women than men (Eisenberger, Inagaki, Rameson, Mashal, & Irwin, 2009). Endotoxin-treated participants also display attenuated activation of neural correlates that underlie reward (e.g., ventral striatum activity, which has implications for anhedonia—a hallmark of depression; Eisenberger et al., 2010). Other researchers have used typhoid vaccination to study the effects of immune activation on mood. In this regard, compared with placebo, individuals who received a single typhoid injection report more negative mood (Wright, Strike, Brydon, & Steptoe, 2005) in some but not all studies (Paine, Ring, Bosch, Drayson, & Veldhuijzen van Zanten, 2013; Strike, Wardle, & Steptoe, 2004).

Administration of interferon (IFN) alpha, which is routinely utilized to treat chronic hepatitis C and some cancers, produces larger inflammatory effects relative to those observed in response to acute endotoxin. Though efficacious, a substantial proportion of patients (10–40%) develop clinical depression during IFN alpha treatment (Capuron & Miller, 2004; Prather, Rabinovitz, Pollock, & Lotrich, 2009). Higher basal levels of inflammation, such as IL-6, increase the likelihood of developing depression during IFN alpha therapy (Prather et al., 2009). Pretreatment with selective serotonin reuptake inhibitors (SSRIs), like paroxetine, are effective in reducing onset of major depressive disorder in these patients (Musselman et al., 2001), suggesting that PICs may interact with the serotonergic system to disturb mood. Relatedly, use of a PIC antagonist (infliximab), specific to TNF alpha, has shown some success in reducing depressive symptoms among patients with elevated levels of C-reactive protein, another index of systemic inflammation (Raison, Rutherford, Woolwine, Shuo, Schettler, et al., 2013).

Summary

The immune system is sensitive to environmental demands. Enumerative and functional measures change rapidly in response to acute stress and there is also some evidence to suggest group differences between those with and without depression. The role of particular emotions on immune function is less well characterized. While there is accruing data that suggest that aspects of the immune system, particularly inflammation, may be modulated by acute changes in emotions such as anger and anxiety, too few studies are available to make any strong conclusions. Dispositional differences in emotion, including trait-positive and -negative affect, have been linked to susceptibility to infectious illness and modulation of vaccination responses, both of which have important clinical implications. In regard to bottom-up effects, inflammation can modify affect in ways that mimic depressive symptomatology. While this early evidence is promising, mechanistic work identifying how immune parameters get in the brain to alter affective experience is needed. Furthermore, like other neuroendocrine and immune measures, additional clarity is needed to explain the variability in links between emotions and immunity.

Discussion

The belief that emotions push and pull on our bodily systems is embedded in our collective psyche. Empirical evidence to support such associations is emerging but incredible challenges lie ahead. As reflected in this review, there are some well-documented effects of stress on neuroendocrine and immune outcomes, but isolating strong influences of specific emotions have been less successful. As highlighted by OT, T, and inflammatory challenge studies, the ability to experimentally manipulate biology to examine emotional effects has led to new theory and innovative studies that continue to transform our understanding of the mind–body union. Nevertheless, methodological inconsistencies and contextual effects make it difficult to draw clear conclusions.

Some of the inconsistency in coherence between emotions and biology may be due to a reliance on self-report measures that confound affective experience with expectations, motivations, and regulatory processes. Further, individual differences in emotional intensity, duration, frequency, and sensitivity to context in response to emotional stimuli (Gross & Jazaieri, 2014) may result in varied effects on biology. Future research incorporating more objective measures of emotional behavior (e.g., facial coding) and paradigms that take advantage of unconscious processes (e.g., implicit tasks) may aid in obviating self-report concerns. Similarly, based on the extant literature, tasks designed to produce particular emotions, such as anger inductions, have been underutilized in neuroendocrine and immune research. While such paradigms often rely on self-report, correlations between emotions and biological outcomes will likely be improved by this more targeted approach.

Advances in neuroimaging may aid in illuminating the neural networks of emotion. A recent meta-analytic review argues against the idea that discrete emotions are embedded in local distinct brain areas, in favor of the idea that interacting brain regions contribute to emotional processing across all emotions (Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012). With this framework, the next step may be to integrate brain data with task-related changes in neuroendocrine and immune outcomes. Some of this work is currently being conducted. For instance, Muscatell and colleagues (2014) reported greater coupling of the amygdala and dorsal medial prefrontal cortex (DMPFC) in response to a social rejection task that was related to task-related increases in inflammation. Similar brain–body links are being made in the cardiovascular psychophysiology arena (e.g., Gianaros & Sheu, 2009).

As highlighted throughout this review, the data reveal that greater care is needed in the accounting of potential moderating factors. This includes invariant group differences (e.g., sex), contextual factors, and underlying biology (e.g., genetics, basal levels, interactions with other biological systems). Of course this is not always possible, but strides toward integrating such factors will aid in making sense of this rapidly growing literature. Relatedly, because the associations between emotions and biology are bidirectional and recursive, future investigators will benefit from integrating the "systems" literature that is only recently becoming more visible in affective science and stress research. Understanding the system dynamics (e.g., kinetics) through which emotional experience drives physiology—and in turn affects emotion generation, regulation, and perception—will provide a fuller picture of the mind–body connection (Aschbacher & Kemeny, 2011).

It is without question an exciting time for the convergence of the biological and affective sciences. There is a clear need to move beyond "stress" to understand how emotional processes contribute to health and disease risk. New technologies and innovative methods are providing unique windows into the embodiment of emotion. As we move forward, a focus on systematic scientific inquiry with an eye toward careful assessment of key moderators will aid in illuminating the incredible connections between emotions and the neuroendocrine and immune systems.

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References

Abercrombie, H. C., Kalin, N. H., & Davidson, R. J. (2005). Acute cortisol elevations cause heightened arousal ratings of objectively nonarousing stimuli. *Emotion, 5*(3), 354–359.

Adam, E. K., Doane, L. D., Zinbarg, R. E., Mineka, S., Craske, M. G., & Griffith, J. W. (2010). Prospective prediction of major depressive disorder from cortisol awakening responses in adolescence. *Psychoneuroendocrinology, 35*(6), 921–931.

Adam, E. K., Hawkley, L. C., Kudielka, B. M., & Cacioppo, J. T. (2006). Day-to-day dynamics of experience—Cortisol associations in a population-based sample of older adults. *Proceedings of the National Academy of Sciences of the United States of America, 103*(45), 17058–17063.

Adam, E. K., Vrshek-Schallhorn, S., Kendall, A. D., Mineka, S., Zinbarg, R. E., & Craske, M. G. (2014). Prospective associations between the cortisol awakening response and first onsets of anxiety disorders over a six-year follow-up. *Psychoneuroendocrinology, 44*, 47–59.

Afsar, B., Elsurer, R., Eyileten, T., Yilmaz, M. I., & Caglar, K. (2009). Antibody response following hepatitis B vaccination in dialysis patients: Does depression and life quality matter? *Vaccine, 27*(42), 5865–5869.

Altemus, M., Redwine, L. S., Leong, Y. M., Frye, C. A., Porges, S. W., & Carter, C. S. (2001). Responses to laboratory psychosocial stress in postpartum women. *Psychosomatic Medicine, 63*(5), 814–821.

Archer, J., Graham-Kevan, N., & Davies, M. (2005). Testosterone and agression: A reanalysis of Book, Starzyk, and Quinsey's (2001) study. *Aggression and Violent Behavior, 10*, 241–261.

Aschbacher, K., & Kemeny, M. E. (2011). New directions in linking the dynamics of affective and stress-arousal systems. *Brain, Behavior, and Immunity, 25*(2), 230–231.

Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2013). Sniffing around oxytocin: Review and meta-analyses of trials in healthy and clinical groups with implications for pharmacotherapy. *Translational Psychiatry, 3*, e258.

Barrett, L. F. (2012). Emotions are real. *Emotion, 12*(3), 413–429.

Barrett, L. F., & Lindquist, K. (2008). The embodiement of emotion. In G. Semin & E. Smith (Eds.), *Embodied grounding: Social, cognitive, affective, and neuroscience approaches* (pp. 237–262). New York: Cambridge University Press.

Baumgartner, T., Heinrichs, M., Vonlanthen, A., Fischbacher, U., & Fehr, E. (2008). Oxytocin shapes the neural circuitry of trust and trust adaptation in humans. *Neuron, 58*(4), 639–650.

Berk, L. S., Felten, D. L., Tan, S. A., Bittman, B. B., & Westengard, J. (2001). Modulation of neuroimmune parameters during the eustress of humor-associated mirthful laughter. *Alternative Therapies in Health and Medicine, 7*(2), 62–72, 74–66.

Bosch, J. A., Engeland, C. G., Cacioppo, J. T., & Marucha, P. T. (2007). Depressive symptoms predict mucosal wound healing. *Psychosomatic Medicine, 69*(7), 597–605.

Breitberg, A., Drevets, W. C., Wood, S. E., Mah, L., Schulkin, J., Sahakian, B. J., et al. (2013). Hydrocortisone infusion exerts dose- and sex-dependent effects on attention to emotional stimuli. *Brain and Cognition, 81*(2), 247–255.

Brummett, B. H., Boyle, S. H., Ortel, T. L., Becker, R. C., Siegler, I. C., & Williams, R. B. (2010). Associations of depressive symptoms, trait hostility, and gender with C-reactive protein and interleukin-6 response after emotion recall. *Psychosomatic Medicine, 72*(4), 333–339.

Buchanan, T. W., Brechtel, A., Sollers, J. J., & Lovallo, W. R. (2001). Exogenous cortisol exerts effects on the startle reflex independent of emotional modulation. *Pharmacolology Biochemistry and Behavior,* 68(2), 203–210.

Campbell, J., & Ehlert, U. (2012). Acute psychosocial stress: Does the emotional stress response correspond with physiological responses? *Psychoneuroendocrinology, 37*(8), 1111–1134.

Capuron, L., & Miller, A. H. (2004). Cytokines and psychopathology: Lessons from interferon-alpha. *Biological Psychiatry, 56*(11), 819–824.

Carre, J. M., Iselin, A. M., Welker, K. M., Hariri, A. R., & Dodge, K. A. (2014). Testosterone reactivity to provocation mediates the effect of early intervention on aggressive behavior. *Psychological Science, 25*(5), 1140–1146.

Carre, J. M., McCormick, C. M., & Hariri, A. R. (2011). The social neuroendocrinology of human aggression. *Psychoneuroendocrinology, 36*(7), 935–944.

Carroll, J. E., Low, C. A., Prather, A. A., Cohen, S., Fury, J. M., Ross, D. C., et al. (2011). Negative affective responses to a speech task predict changes in interleukin (IL)-6. *Brain, Behavior, and Immunity, 25*(2), 232–238.

Carter, C. S. (2014). Oxytocin pathways and the evolution of human behavior. *Annual Review of Psychology, 65*, 17–39.

Christian, L. M., Graham, J. E., Padgett, D. A., Glaser, R., & Kiecolt-Glaser, J. K. (2006). Stress and wound healing. *Neuroimmunomodulation, 13*(5-6), 337–346.

Cohen, S., Doyle, W. J., Skoner, D. P., Rabin, B. S., & Gwaltney, J. M., Jr. (1997). Social ties and susceptibility to the common cold. *JAMA, 277*(24), 1940–1944.

Cohen, S., Doyle, W. J., Turner, R., Alper, C. M., & Skoner, D. P. (2003a). Sociability and susceptibility to the common cold. *Psychological Science, 14*(5), 389–395.

Cohen, S., Doyle, W. J., Turner, R. B., Alper, C. M., & Skoner, D. P. (2003b). Emotional style and susceptibility to the common cold. *Psychosomatic Medicine, 65*(4), 652–657.

Cohen, S., Kessler, R. C., & Gordon, L. U. (Eds.). (1997). *Measuring stress: A guide for health and social scientists*. New York: Oxford University Press.

Cohen, S., Miller, G. E., & Rabin, B. S. (2001). Psychological stress and antibody response to immunization: A critical review of the human literature. *Psychosomatic Medicine, 63*(1), 7–18.

Cohen, S., Tyrrell, D. A., & Smith, A. P. (1993). Negative life events, perceived stress, negative affect, and susceptibility to the common cold. *Journal of Personality and Social Psychology, 64*(1), 131–140.

Cohen, S., & Williamson, G. M. (1991). Stress and infectious disease in humans. *Psychological Bulletin, 109*(1), 5–24.

Cyranowski, J. M., Hofkens, T. L., Frank, E., Seltman, H., Cai, H. M., & Amico, J. A. (2008). Evidence of dysregulated peripheral oxytocin release among depressed women. *Psychosomatic Medicine, 70*(9), 967–975.

Dabbs, J. M., Jr., Jurkovic, G. J., & Frady, R. L. (1991). Salivary testosterone and cortisol among late adolescent male offenders. *Journal of Abnormal Child Psychology, 19*(4), 469–478.

Dantzer, R., O'Connor, J. C., Freund, G. G., Johnson, R. W., & Kelley, K. W. (2008). From inflammation to sickness and depression: When the immune system subjugates the brain. *Nature Reviews Neuroscience, 9*(1), 46–56.

Daskalakis, N. P., Lehrner, A., & Yehuda, R. (2013). Endocrine aspects of post-traumatic stress disorder and implications for diagnosis and treatment. *Endocrinology and Metabolic Clinics of North America, 42*(3), 503–513.

De Dreu, C. K., Greer, L. L., Handgraaf, M. J., Shalvi, S., Van Kleef, G. A., Baas, M., et al. (2010). The neuropeptide oxytocin regulates parochial altruism in intergroup conflict among humans. *Science, 328*(5984), 1408–1411.

de Oliveira, D. C., Zuardi, A. W., Graeff, F. G., Queiroz, R. H., & Crippa, J. A. (2012). Anxiolytic-like effect of oxytocin in the simulated public speaking test. *Journal of Psychopharmacology, 26*(4), 497–504.

Denson, T. F., Mehta, P. H., & Ho Tan, D. (2013). Endogenous testosterone and cortisol jointly influence reactive aggression in women. *Psychoneuroendocrinology, 38*(3), 416–424.

Denson, T. F., Spanovic, M., & Miller, N. (2009). Cognitive appraisals and emotions predict cortisol and immune responses: A meta-analysis of acute laboratory social stressors and emotion inductions. *Psychological Bulletin, 135*(6), 823–853.

DeSteno, D., Gross, J. J., & Kubzansky, L. (2013). Affective science and health: The importance of emotion and emotion regulation. *Health Psychology, 32*(5), 474–486.

Dickerson, S. S., Gable, S. L., Irwin, M. R., Aziz, N., & Kemeny, M. E. (2009). Social-evaluative threat and proinflammatory cytokine regulation: An experimental laboratory investigation. *Psychological Science, 20*(10), 1237–1244.

Dickerson, S. S., Gruenewald, T. L., & Kemeny, M. E. (2004). When the social self is threatened: Shame, physiology, and health. *Journal of Personality, 72*(6), 1191–1216.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin, 130*(3), 355–391.

Dockray, S., & Steptoe, A. (2010). Positive affect and psychobiological processes. *Neuroscience and Biobehavioral Reviews, 35*(1), 69–75.

Domes, G., Heinrichs, M., Michel, A., Berger, C., & Herpertz, S. C. (2007). Oxytocin improves "mind-reading" in humans. *Biological Psychiatry, 61*(6), 731–733.

Dowlati, Y., Herrmann, N., Swardfager, W., Liu, H., Sham, L., Reim, E. K., et al. (2010). A meta-analysis of cytokines in major depression. *Biological Psychiatry, 67*(5), 446–457.

Eisenberger, N. I., Berkman, E. T., Inagaki, T. K., Rameson, L. T., Mashal, N. M., & Irwin, M. R. (2010). Inflammation-induced anhedonia: Endotoxin reduces ventral striatum responses to reward. *Biological Psychiatry, 68*(8), 748–754.

Eisenberger, N. I., Inagaki, T. K., Rameson, L. T., Mashal, N. M., & Irwin, M. R. (2009). An fMRI study of cytokine-induced depressed mood and social pain: The role of sex differences. *NeuroImage, 47*(3), 881–890.

Eisenegger, C., Haushofer, J., & Fehr, E. (2011). The role of testosterone in social interaction. *Trends in Cognitive Science, 15*(6), 263–271.

Eisenegger, C., Naef, M., Snozzi, R., Heinrichs, M., & Fehr, E. (2010). Prejudice and truth about the effect of testosterone on human bargaining behaviour. *Nature, 463*(7279), 356–359.

Engebretson, T. O., Sirota, A. D., Niaura, R. S., Edwards, K., & Brown, W. A. (1999). A simple laboratory method for inducing anger: A preliminary investigation. *Journal of Psychosomatic Research, 47*(1), 13–26.

Fernandez-Guasti, A., & Martinez-Mota, L. (2005). Anxiolytic-like actions of testosterone in the burying behavior test: Role of androgen and GABA-benzodiazepine receptors. *Psychoneuroendocrinology, 30*(8), 762–770.

Fredrickson, B. L., Grewen, K. M., Coffey, K. A., Algoe, S. B., Firestine, A. M., Arevalo, J. M., et al. (2013). A functional genomic perspective on human well-being. *Proceedings of the Naional Academy of Sciences of the United States of America, 110*(33), 13684–13689.

Futterman, A. D., Kemeny, M. E., Shapiro, D., & Fahey, J. L. (1994). Immunological and physiological changes associated with induced positive and negative mood. *Psychosomatic Medicine, 56*(6), 499–511.

Gianaros, P. J., & Sheu, L. K. (2009). A review of neuroimaging studies of stressor-evoked blood pressure reactivity: Emerging evidence for a brain–body pathway to coronary heart disease risk. *NeuroImage, 47*(3), 922–936.

Girdler, S. S., Jammer, L. D., & Shapiro, D. (1997). Hostility, testosterone, and vascular reactivity to stress: Effects of sex. *International Journal of Behavioral Medicine, 4*(3), 242–263.

Glaser, R., & Kiecolt-Glaser, J. K. (2005). Stress-induced immune dysfunction: implications for health. *Nature Reviews Immunology, 5*(3), 243–251.

Glaser, R., Kiecolt-Glaser, J. K., Marucha, P. T., MacCallum, R. C., Laskowski, B. F., & Malarkey, W. B. (1999). Stress-related changes in proinflammatory cytokine production in wounds. *Archives in General Psychiatry, 56*(5), 450–456.

Gleason, E. D., Fuxjager, M. J., Oyegbile, T. O., & Marler, C. A. (2009). Testosterone release and social context: When it occurs and why. *Frontiers in Neuroendocrinology, 30*(4), 460–469.

Goetz, S. M., Tang, L., Thomason, M. E., Diamond, M. P., Hariri, A. R., & Carre, J. M. (2014). Testosterone rapidly increases neural reactivity to threat in healthy men: A novel two-step pharmacological challenge paradigm. *Biological Psychiatry, 76*(4), 324–331.

Gouin, J. P., Carter, C. S., Pournajafi-Nazarloo, H., Glaser, R., Malarkey, W. B., Loving, T. J., et al. (2010). Marital behavior, oxytocin, vasopressin, and wound healing. *Psychoneuroendocrinology, 35*(7), 1082–1090.

Gouin, J. P., Kiecolt-Glaser, J. K., Malarkey, W. B., & Glaser, R. (2008). The influence of anger expression on wound healing. *Brain, Behavior, and Immunity, 22*(5), 699–708.

Gross, J. J., & Jazaieri, H. (2014). Emotion, emotion regulation, and psychopathology: An affective science perspective. *Clinical Psychological Science, 2*(4), 387–401.

Gruenewald, T. L., Kemeny, M. E., Aziz, N., & Fahey, J. L. (2004). Acute threat to the social self: Shame, social self-esteem, and cortisol activity. *Psychosomatic Medicine, 66*(6), 915–924.

Hartgens, F., & Kuipers, H. (2004). Effects of androgenic–anabolic steroids in athletes. *Sports Medicine, 34*(8), 513–554.

Heinrichs, M., Baumgartner, T., Kirschbaum, C., & Ehlert, U. (2003). Social support and oxytocin interact to suppress cortisol and subjective responses to psychosocial stress. *Bioiogical Psychiatry, 54*(12), 1389–1398.

Herbert, T. B., & Cohen, S. (1993a). Depression and immunity: A meta-analytic review. *Psychological Bulletin, 113*(3), 472–486.

Herbert, T. B., & Cohen, S. (1993b). Stress and immunity in humans: A meta-analytic review. *Psychosomatic Medicine, 55*(4), 364–379.

Hermans, E. J., Putman, P., & van Honk, J. (2006). Testosterone administration reduces empathetic behavior: A facial mimicry study. *Psychoneuroendocrinology, 31*(7), 859–866.

Herrero, N., Gadea, M., Rodriguez-Alarcon, G., Espert, R., & Salvador, A. (2010). What happens when we get angry? Hormonal, cardiovascular and asymmetrical brain responses. *Hormones and Behavior, 57*(3), 276–283.

Het, S., & Wolf, O. T. (2007). Mood changes in response to psychosocial stress in healthy young women: Effects of pretreatment with cortisol. *Behavioral Neuroscience, 121*(1), 11–20.

Hoge, E. A., Pollack, M. H., Kaufman, R. E., Zak, P. J., & Simon, N. M. (2008). Oxytocin levels in social anxiety disorder. *CNS Neuroscience and Therapeutics, 14*(3), 165–170.

Hohlagschwandtner, M., Husslein, P., Klier, C., & Ulm, B. (2001). Correlation between serum testosterone levels and peripartal mood states. *ACTA Obstetricia Gynecologica Scandinavica, 80*(4), 326–330.

Holt-Lunstad, J., Birmingham, W., & Light, K. C. (2011). The influence of depressive symptomatology and perceived stress on plasma and salivary oxytocin before, during and after a support enhancement intervention. *Psychoneuroendocrinology, 36*(8), 1249–1256.

Howren, M. B., Lamkin, D. M., & Suls, J. (2009). Associations of depression with C-reactive protein, IL-1, and IL-6: A meta-analysis. *Psychosomatic Medicine, 71*(2), 171–186.

Irwin, M. R., & Cole, S. W. (2011). Reciprocal regulation of the neural and innate immune systems. *Nature Reviews Immunology, 11*(9), 625–632.

Ishihara, S., Makita, S., Imai, M., Hashimoto, T., & Nohara, R. (2003). Relationship between natural killer activity and anger expression in patients with coronary heart disease. *Heart and Vessels, 18*(2), 85–92.

Israel, S., Weisel, O., Ebstein, R. P., & Bornstein, G. (2012). Oxytocin, but not vasopressin, increases both parochial and universal altruism. *Psychoneuroendocrinology, 37*(8), 1341–1344.

James, W. (1884). What is emotion? *Mind, 9*, 188–205.

Josephs, R. A., Sellers, J. G., Newman, M. L., & Mehta, P. H. (2006). The mismatch effect: When testosterone and status are at odds. *Journal of Personality and Social Psychology, 90*(6), 999–1013.

Kanat, M., Heinrichs, M., & Domes, G. (2013). Oxytocin and the social brain: Neural mechanisms and perspectives in human research. *Brain Research, 1580*, 160–171.

Kemeny, M. (2003). The psychobiology of stress. *Current Directions in Psychological Science, 12*(4), 124–129.

Kemp, A. H., & Guastella, A. J. (2010). Oxytocin: Prosocial behavior, social salience, or approach-related behavior? *Biological Psychiatry, 67*(6), e33–e34; author reply e35.

Kemp, A. H., & Guastella, A. J. (2011). The role of oxytocin in human affect: A novel hypothesis. *Current Directions in Psychological Science, 20*(4), 222–231.

Kiecolt-Glaser, J. K., Glaser, R., Gravenstein, S., Malarkey, W. B., & Sheridan, J. (1996). Chronic stress alters the immune response to influenza virus vaccine in older adults. *Proceedings of the National Academy of Sciences of the United States of America, 93*(7), 3043–3047.

Kiecolt-Glaser, J. K., Loving, T. J., Stowell, J. R., Malarkey, W. B., Lemeshow, S., Dickinson, S. L., et al. (2005). Hostile marital interactions, proinflammatory cytokine production, and wound healing. *Archives of General Psychiatry, 62*(12), 1377–1384.

Kiecolt-Glaser, J. K., Marucha, P. T., Malarkey, W. B., Mercado, A. M., & Glaser, R. (1995). Slowing of wound healing by psychological stress. *Lancet, 346*(8984), 1194–1196.

Kiecolt-Glaser, J. K., McGuire, L., Robles, T. F., & Glaser, R. (2002). Emotions, morbidity, and mortality: New perspectives from psychoneuroimmunology. *Annual Review of Psychology, 53*, 83–107.

Kiecolt-Glaser, J. K., Preacher, K. J., MacCallum, R. C., Atkinson, C., Malarkey, W. B., & Glaser, R. (2003). Chronic stress and age-related increases in the proinflammatory cytokine IL-6. *Proceedings of the National Academy of Sciences of the United States of America, 100*(15), 9090–9095.

King, J. A., Rosal, M. C., Ma, Y., & Reed, G. W. (2005). Association of stress, hostility and plasma testosterone levels. *Neuroendocrinology Letters, 26*(4), 355–360.

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The "Trier Social Stress Test": A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology, 28*(1–2), 76–81.

Klinesmith, J., Kasser, T., & McAndrew, F. T. (2006). Guns, testosterone, and aggression: An experimental test of a mediational hypothesis. *Psychological Science, 17*(7), 568–571.

Kosfeld, M., Heinrichs, M., Zak, P. J., Fischbacher, U., & Fehr, E. (2005). Oxytocin increases trust in humans. *Nature, 435*(7042), 673–676.

Kubzansky, L. D., Mendes, W. B., Appleton, A. A., Block, J., & Adler, G. K. (2012). A heartfelt response: Oxytocin effects on response to social stress in men and women. *Biological Psychology, 90*(1), 1–9.

Lange, C. (1887). Ueber. *Gemuthsbewgungen, 3*, 8.

Lazarus, R., & Folkman, S. (1984). *Stress, appraisal and coping.* New York: Springer.

Lerner, J. S., Dahl, R. E., Hariri, A. R., & Taylor, S. E. (2007). Facial expressions of emotion reveal neuroendocrine and cardiovascular stress responses. *Biological Psychiatry, 61*(2), 253–260.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*(3), 121–143.

Lutgendorf, S. K., Reimer, T. T., Harvey, J. H., Marks, G., Hong, S. Y., Hillis, S. L., et al. (2001). Effects of housing relocation on immunocompetence and psychosocial functioning in older adults. *Journal of Gerontology Series A, Biological Sciences and Medical Sciences, 56*(2), M97–M105.

Marsland, A. L., Bachen, E. A., Cohen, S., & Manuck, S.

B. (2001). Stress, immunity, and susceptibility to infectious disease. In A. Baum, T. A. Revenson, & J. E. Singer (Eds.), *Handbook of health psychology* (pp. 683–695). Mahwah, NJ: Erlbaum.

Marsland, A. L., Cohen, S., Rabin, B. S., & Manuck, S. B. (2001). Associations between stress, trait negative affect, acute immune reactivity, and antibody response to hepatitis B injection in healthy young adults. *Health Psychology, 20*(1), 4–11.

Marsland, A. L., Cohen, S., Rabin, B. S., & Manuck, S. B. (2006). Trait positive affect and antibody response to hepatitis B vaccination. *Brain, Behavior, and Immunity, 20*(3), 261–269.

Marsland, A. L., Pressman, S. D., & Cohen, S. (2007). Positive affect and immune function. In R. Ader (Ed.), *Psychoneuroimmunology* (4th ed., Vol. 2, pp. 761–779). San Diego, CA: Elsevier.

Mauss, I. B., Levenson, R. W., McCarter, L., Wilhelm, F. H., & Gross, J. J. (2005). The tie that binds?: Coherence among emotion experience, behavior, and physiology. *Emotion, 5*(2), 175–190.

Mauss, I. B., & Robinson, M. D. (2009). Measures of emotion: A review. *Cognition and Emotion, 23*(2), 209–237.

Mazur, A., & Booth, A. (1998). Testosterone and dominance in men. *Behavioral and Brain Sciences, 21*(3), 353–363; discussion 363–397.

McCullough, M. E., Churchland, P. S., & Mendez, A. J. (2013). Problems with measuring peripheral oxytocin: Can the data on oxytocin and human behavior be trusted? *Neuroscience and Biobehavioral Reviews, 37*(8), 1485–1492.

Mehta, P. H., & Beer, J. (2010). Neural mechanisms of the testosterone–aggression relation: The role of orbitofrontal cortex. *Journal of Cognitive Neuroscience, 22*(10), 2357–2368.

Mehta, P. H., & Josephs, R. A. (2006). Testosterone change after losing predicts the decision to compete again. *Hormones and Behavior, 50*(5), 684–692.

Mehta, P. H., & Josephs, R. A. (2010). Testosterone and cortisol jointly regulate dominance: Evidence for a dual-hormone hypothesis. *Hormones and Behavior, 58*(5), 898–906.

Meyer-Lindenberg, A., Domes, G., Kirsch, P., & Heinrichs, M. (2011). Oxytocin and vasopressin in the human brain: Social neuropeptides for translational medicine. *Nature Reviews Neuroscience, 12*(9), 524–538.

Miller, A. H., Maletic, V., & Raison, C. L. (2009). Inflammation and its discontents: The role of cytokines in the pathophysiology of major depression. *Biological Psychiatry, 65*(9), 732–741.

Miller, G., Chen, E., & Cole, S. W. (2009). Health psychology: Developing biologically plausible models linking the social world and physical health. *Annual Review of Psychology, 60*, 501–524.

Miller, G. E. (2009). In search of integrated specificity: Comment on Denson, Spanovic, and Miller (2009). *Psychological Bulletin, 135*(6), 854–856; discussion 857–858.

Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down?: Chronic stress and the hypothalamic–pituitary–adrenocortical axis in humans. *Psychological Bulletin, 133*(1), 25–45.

Moons, W. G., Eisenberger, N. I., & Taylor, S. E. (2010). Anger and fear responses to stress have different biological profiles. *Brain, Behavior, and Immunity, 24*(2), 215–219.

Moons, W. G., Way, B. M., & Taylor, S. E. (2014). Oxytocin and vasopressin receptor polymorphisms interact with circulating neuropeptides to predict human emotional reactions to stress. *Emotion, 14*(3), 562–572.

Muscatell, K. A., Dedovic, K., Slavich, G. M., Jarcho, M. R., Breen, E. C., Bower, J. E., et al. (2014). Greater amygdala activity and dorsomedial prefrontal-amygdala coupling are associated with enhanced inflammatory responses to stress. *Brain, Behavior, and Immunity, 43*, 46–53.

Musselman, D. L., Lawson, D. H., Gumnick, J. F., Manatunga, A. K., Penna, S., Goodkin, R. S., et al. (2001). Paroxetine for the prevention of depression induced by high-dose interferon alfa. *New England Journal of Medicine, 344*(13), 961–966.

O'Connor, D. B., Archer, J., & Wu, F. C. (2004). Effects of testosterone on mood, aggression, and sexual behavior in young men: A double-blind, placebo-controlled, cross-over study. *Journal of Clinical Endocrinology and Metabolism, 89*(6), 2837–2845.

O'Connor, M. F., Irwin, M. R., & Wellisch, D. K. (2009). When grief heats up: Pro-inflammatory cytokines predict regional brain activation. *NeuroImage, 47*(3), 891–896.

O'Donovan, A., Hughes, B. M., Slavich, G. M., Lynch, L., Cronin, M. T., O'Farrelly, C., et al. (2010). Clinical anxiety, cortisol and interleukin-6: Evidence for specificity in emotion–biology relationships. *Brain, Behavior, and Immunity, 24*(7), 1074–1077.

Olff, M., Frijling, J. L., Kubzansky, L. D., Bradley, B., Ellenbogen, M. A., Cardoso, C., et al. (2013). The role of oxytocin in social bonding, stress regulation and mental health: An update on the moderating effects of context and interindividual differences. *Psychoneuroendocrinology, 38*(9), 1883–1894.

Paine, N. J., Ring, C., Bosch, J. A., Drayson, M. T., & Veldhuijzen van Zanten, J. J. (2013). The time course of the inflammatory response to the Salmonella typhi vaccination. *Brain, Behavior, and Immunity, 30*, 73–79.

Pedersen, A. F., Zachariae, R., & Bovbjerg, D. H. (2009). Psychological stress and antibody response to influenza vaccination: A meta-analysis. *Brain, Behavior, and Immunity, 23*(4), 427–433.

Penedo, F. J., Dahn, J. R., Kinsinger, D., Antoni, M. H., Molton, I., Gonzalez, J. S., et al. (2006). Anger suppression mediates the relationship between optimism and natural killer cell cytotoxicity in men treated for localized prostate cancer. *Journal of Psychosomatic Research, 60*(4), 423–427.

Pereira, A. M., Tiemensma, J., & Romijn, J. A. (2010). Neuropsychiatric disorders in Cushing's syndrome. *Neuroendocrinology, 92*(Suppl. 1), 65–70.

Persky, H., Smith, K. D., & Basu, G. K. (1971). Relation of psychologic measures of aggression and hostility to testosterone production in man. *Psychosomatic Medicine, 33*(3), 265–277.

Peterson, C. K., & Harmon-Jones, E. (2012). Anger and testosterone: Evidence that situationally-induced anger relates to situationally-induced testosterone. *Emotion, 12*(5), 899–902.

Petry, L. J., Weems, L. B., 2nd, & Livingstone, J. N., 2nd. (1991). Relationship of stress, distress, and the immunologic response to a recombinant hepatitis B vaccine. *Journal of Family Practice, 32*(5), 481–486.

Phillips, A. C., Carroll, D., Burns, V. E., & Drayson, M. (2005). Neuroticism, cortisol reactivity, and antibody response to vaccination. *Psychophysiology, 42*(2), 232–238.

Piazza, J. R., Charles, S. T., Stawski, R. S., & Almeida, D. M. (2013). Age and the association between negative affective states and diurnal cortisol. *Psychology and Aging, 28*(1), 47–56.

Polk, D. E., Cohen, S., Doyle, W. J., Skoner, D. P., & Kirschbaum, C. (2005). State and trait affect as predictors of salivary cortisol in healthy adults. *Psychoneuroendocrinology, 30*(3), 261–272.

Popma, A., Vermeiren, R., Geluk, C. A., Rinne, T., van den Brink, W., Knol, D. L., et al. (2007). Cortisol moderates the relationship between testosterone and aggression in delinquent male adolescents. *Biological Psychiatry, 61*(3), 405–411.

Prather, A. A., Marsland, A. L., Muldoon, M. F., & Manuck, S. B. (2007). Positive affective style covaries with stimulated IL-6 and IL-10 production in a middle-aged community sample. *Brain, Behavior, and Immunity, 21*(8), 1033–1037.

Prather, A. A., Rabinovitz, M., Pollock, B. G., & Lotrich, F. E. (2009). Cytokine-induced depression during IFN-alpha treatment: The role of IL-6 and sleep quality. *Brain, Behavior, and Immunity, 23*(8), 1109–1116.

Pressman, S. D., & Cohen, S. (2005). Does positive affect influence health? *Psychological Bulletin, 131*(6), 925–971.

Pressman, S. D., Cohen, S., Miller, G. E., Barkin, A., Rabin, B. S., & Treanor, J. J. (2005). Loneliness, social network size, and immune response to influenza vaccination in college freshmen. *Health Psychology, 24*(3), 297–306.

Puterman, E., Epel, E. S., O'Donovan, A., Prather, A. A., Aschbacher, K., & Dhabhar, F. S. (2014). Anger is associated with increased IL-6 stress reactivity in women, but only among those low in social support. *International Journal of Behavioral Medicine, 21*(6), 936–945.

Putman, P., & Roelofs, K. (2011). Effects of single cortisol administrations on human affect reviewed: Coping with stress through adaptive regulation of automatic cognitive processing. *Psychoneuroendocrinology, 36*(4), 439–448.

Quirin, M., Kazen, M., Rohrmann, S., & Kuhl, J. (2009). Implicit but not explicit affectivity predicts circadian and reactive cortisol: Using the implicit positive and negative affect test. *Journal of Personality, 77*(2), 401–425.

Raison, C. L., Rutherford, R. E., Woolwine, B. J., Shuo, C., Schettler, P., Drake, D. F., et al. (2013). A randomized controlled trial of the tumor necrosis factor antagonist infliximab for treatment-resistant depression: The role of baseline inflammatory biomarkers. *Archives of General Psychiatry, 70*(1), 31–41.

Reichenberg, A., Yirmiya, R., Schuld, A., Kraus, T., Haack, M., Morag, A., et al. (2001). Cytokine-associated emotional and cognitive disturbances in humans. *Archives of General Psychiatry, 58*(5), 445–452.

Reuter, M. (2002). Impact of cortisol on emotions under stress and nonstress conditions: A pharmacopsychological approach. *Neuropsychobiology, 46*(1), 41–48.

Ridker, P. M., Rifai, N., Stampfer, M. J., & Hennekens, C. H. (2000). Plasma concentration of interleukin-6 and the risk of future myocardial infarction among apparently healthy men. *Circulation, 101*(15), 1767–1772.

Ross, R. (1999). Atherosclerosis: An inflammatory disease. *New England Journal of Medicine, 340*(2), 115–126.

Ryff, C. D., Singer, B. H., & Dienberg Love, G. (2004). Positive health: Connecting well-being with biology. *Philosophical Transactions of the Royal Society London B, Biological Sciences, 359*(1449), 1383–1394.

Sanders, G., Freilicher, J., & Lightman, S. L. (1990). Psychological stress of exposure to uncontrollable noise increases plasma oxytocin in high emotionality women. *Psychoneuroendocrinology, 15*(1), 47–58.

Sarkey, S., Azcoitia, I., Garcia-Segura, L. M., Garcia-Ovejero, D., & DonCarlos, L. L. (2008). Classical androgen receptors in non-classical sites in the brain. *Hormones and Behavior, 53*(5), 753–764.

Segerstrom, S. C., & Miller, G. E. (2004). Psychological stress and the human immune system: A meta-analytic study of 30 years of inquiry. *Psychological Bulletin, 130*(4), 601–630.

Shalvi, S., & De Dreu, C. K. (2014). Oxytocin promotes group-serving dishonesty. *Proceedings of the National Academy of Sciemces of the United States of America, 111*(15), 5503–5507.

Shamay-Tsoory, S. G., Fischer, M., Dvash, J., Harari, H., Perach-Bloom, N., & Levkovitz, Y. (2009). Intranasal administration of oxytocin increases envy and schadenfreude (gloating). *Biological Psychiatry, 66*(9), 864–870.

Smith, R. S. (1991). The macrophage theory of depression. *Medical Hypotheses, 35*(4), 298–306.

Soravia, L. M., Heinrichs, M., Aerni, A., Maroni, C., Schelling, G., Ehlert, U., et al. (2006). Glucocorticoids reduce phobic fear in humans. *Proceedings of the National Acaddemy of Sciences of the United States of America, 103*(14), 5585–5590.

Steptoe, A., Gibson, E. L., Hamer, M., & Wardle, J. (2007). Neuroendocrine and cardiovascular correlates of positive affect measured by ecological momentary assessment and by questionnaire. *Psychoneuroendocrinology, 32*(1), 56–64.

Steptoe, A., Hamer, M., & Chida, Y. (2007). The effects of acute psychological stress on circulating inflammatory factors in humans: A review and meta-analysis. *Brain, Behavior, and Immunity, 21*(7), 901–912.

Steptoe, A., O'Donnell, K., Badrick, E., Kumari, M., & Marmot, M. (2008). Neuroendocrine and inflammatory factors associated with positive affect in healthy men and women: The Whitehall II Study. *American Journal of Epidemiology, 167*(1), 96–102.

Steptoe, A., Wardle, J., & Marmot, M. (2005). Positive affect and health-related neuroendocrine, cardiovascular, and inflammatory processes. *Proceedings of the National Academy of Sciences of the United States of America, 102*(18), 6508–6512.

Stetler, C., & Miller, G. E. (2011). Depression and hypothalamic–pituitary–adrenal activation: A quantitative summary of four decades of research. *Psychosomatic Medicine, 73*(2), 114–126.

Strike, P. C., Wardle, J., & Steptoe, A. (2004). Mild acute inflammatory stimulation induces transient negative mood. *Journal of Psychosomatic Research, 57*(2), 189–194.

Suarez, E. C., Boyle, S. H., Lewis, J. G., Hall, R. P., & Young, K. H. (2006). Increases in stimulated secretion of proinflammatory cytokines by blood monocytes following arousal of negative affect: The role of insulin resistance as moderator. *Brain, Behavior, and Immunity, 20*(4), 331–338.

Taylor, S. E., Gonzaga, G. C., Klein, L. C., Hu, P., Greendale, G. A., & Seeman, T. E. (2006). Relation of oxytocin to psychological stress responses and hypothalamic–pituitary–adrenocortical axis activity in older women. *Psychosomatic Medicine,* 68(2), 238–245.

Taylor, S. E., Klein, L. C., Lewis, B. P., Gruenewald, T. L., Gurung, R. A., & Updegraff, J. A. (2000). Biobehavioral responses to stress in females: Tend-and-befriend, not fight-or-flight. *Psychological Review, 107*(3), 411–429.

Taylor, S. E., Saphire-Bernstein, S., & Seeman, T. E. (2010). Are plasma oxytocin in women and plasma vasopressin in men biomarkers of distressed pair–bond relationships? *Psychological Science, 21*(1), 3–7.

Terburg, D., & van Honk, J. (2013). Approach-avoidance motivation and emotion: convergence and divergence. *Emotion review, 5*, 308–311.

Tracey, K. J. (2002). The inflammatory reflex. *Nature, 420*(6917), 853–859.

Trainor, B. C., Bird, I. M., & Marler, C. A. (2004). Opposing hormonal mechanisms of aggression revealed through short-lived testosterone manipulations and multiple winning experiences. *Hormones and Behavior, 45*(2), 115–121.

Turner, R. A., Altemus, M., Enos, T., Cooper, B., & McGuinness, T. (1999). Preliminary research on plasma oxytocin in normal cycling women: Investigating emotion and interpersonal distress. *Psychiatry, 62*(2), 97–113.

van Honk, J., Peper, J. S., & Schutter, D. J. (2005). Testosterone reduces unconscious fear but not consciously experienced anxiety: Implications for the disorders of fear and anxiety. *Biological Psychiatry, 58*(3), 218–225.

van Honk, J., Schutter, D. J., Bos, P. A., Kruijt, A. W., Lentjes, E. G., & Baron-Cohen, S. (2011). Testosterone administration impairs cognitive empathy in women depending on second-to-fourth digit ratio. *Proceedings of the National Academy of Sciences of the United States of America, 108*(8), 3448–3452.

van Honk, J., Tuiten, A., Hermans, E., Putman, P., Koppeschaar, H., Thijssen, J., et al. (2001). A single administration of testosterone induces cardiac accelerative responses to angry faces in healthy young women. *Behavioral Neuroscience, 115*(1), 238–242.

van Honk, J., Tuiten, A., Verbaten, R., van den Hout, M., Koppeschaar, H., Thijssen, J., et al. (1999). Correlations among salivary testosterone, mood, and selective attention to threat in humans. *Hormones and Behavior, 36*(1), 17–24.

Vogelzangs, N., Beekman, A. T., de Jonge, P., & Penninx, B. W. (2013). Anxiety disorders and inflammation in a large adult cohort. *Translational Psychiatry, 3*, e249.

Vrshek-Schallhorn, S., Doane, L. D., Mineka, S., Zinbarg, R. E., Craske, M. G., & Adam, E. K. (2013). The cortisol awakening response predicts major depression: Predictive stability over a 4-year follow-up and effect of depression history. *Psychological Medicine, 43*(3), 483–493.

Wachtel, S. R., & de Wit, H. (2001). Lack of effect of intravenous hydrocortisone on mood in humans: A preliminary study. *Behavioural Pharmacology, 12*(5), 373–376.

Weiner, H. (1992). *Perturbing the organism: The biology of stressful experience*. Chicago: University of Chicago Press.

Wirth, M. M., Scherer, S. M., Hoks, R. M., & Abercrombie, H. C. (2011). The effect of cortisol on emotional responses depends on order of cortisol and placebo administration in a within-subject design. *Psychoneuroendocrinology, 36*(7), 945–954.

Wright, C. E., Strike, P. C., Brydon, L., & Steptoe, A. (2005). Acute inflammation and negative mood: Mediation by cytokine activation. *Brain, Behavior, and Immunity, 19*(4), 345–350.

Zorrilla, E. P., Luborsky, L., McKay, J. R., Rosenthal, R., Houldin, A., Tax, A., et al. (2001). The relationship of depression and stressors to immunological assays: A meta-analytic review. *Brain, Behavior, and Immunity, 15*(3), 199–226.

CHAPTER 38

Emotion Disturbances as Transdiagnostic Processes in Psychopathology

Ann M. Kring and Jasmine Mote

Emotion disturbances are ubiquitous in psychopathology. Even a cursory glance at the most recent American diagnostic system—the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013)—reveals that nearly all the diagnostic categories include symptoms that tap one type of emotion disturbance or another (see Table 38.1). These disturbances span positive and negative emotions, and they have traditionally been described as excesses of emotion (as in the case of specific phobias, with marked and persistent fear); deficits in emotion (as in the case of narcissistic personality disorder, with a lack of empathy); social-emotional problems (as in autism spectrum disorder, with diminished emotional reciprocity); and regulation problems (as in borderline personality disorder, with difficulties in controlling anger). The pervasiveness of emotion disturbances in psychopathology suggests the potential for commonalities across disorders. In this chapter, we consider the utility of adopting a transdiagnostic approach to understanding emotion disturbances in psychopathology across several levels, including descriptive phenomenology, etiology, and treatment. We also consider the potential of the National Institute of Mental Health's Research Domain Criteria (RDoC) initiative, which at its core is conceived as a transdiagnostic means of (re) classifying mental disorders for research purposes based on neurobiology and behavior rather than clinical symptoms within diagnostic categories (Insel et al., 2010; Sanislow et al., 2010).

We argue that there are several advantages to a transdiagnostic approach, including the RDoC, with respect to identifying causal mechanisms and meaningful treatment targets. Nevertheless, the current research evidence and clinical utility to support a fully transdiagnostic approach are incomplete. Indeed, there are similar emotional disturbances that are central to different disorders; yet the manifestation of these disturbances may nevertheless differ from disorder to disorder, thus helping to account for the different symptom constellations across disorders. For example, diminished emotion awareness is associated with both depression and social anxiety symptoms. However, for depression symptoms, this linkage is mediated by difficulties in shifting attention, whereas for social anxiety symptoms, the linkage is mediated by difficulties in accepting emotions (Vine & Aldao, 2014). With the advent of the RDoC, the field is shifting more toward a transdiagnostic approach, and we also argue that affective science research has a great deal to offer with respect to the development of domains that will be clinically useful in psychopathology research and treatment.

TABLE 38.1. Emotion-Based Symptoms in DSM-5 Disorders

Disorders	Symptoms
Neurodevelopmental disorders	
Autism spectrum disorder	Deficits in social–emotional reciprocity; lack of facial expressions and nonverbal communication
Schizophrenia and other psychotic disorders	
Schizophrenia	
Schizoaffective disorder	
Schizophreniform disorder	Diminished emotional expression
Bipolar and related disorders	
Bipolar I disorder	Elevated, expansive, or irritable mood
Bipolar II disorder	
Cyclothymic disorder	
Depressive disorders	
Disruptive mood dysregulation disorder	Irritability
Major depressive disorder	Depressed mood, anhedonia
Persistent depressive disorder	Depressed mood
Premenstrual dysphoric disorder	Affective lability, irritability or anger, depressed mood
Anxiety disorders	
Separation anxiety disorder	Excessive fear or anxiety, persistent worry
Panic disorder	Intense fear or discomfort, persistent worry
Agoraphobia	Anxiety
Specific phobias, social anxiety disorder	Marked and persistent fear, anxious anticipation
Generalized anxiety disorder	Excessive anxiety and worry, irritability, restlessness
Obsessive–compulsive and related disorders	
Obsessive–compulsive disorder	Marked anxiety or distress
Body dysmorphic disorder	Significant distress
Hoarding disorder	Significant distress with thought of discarding objects
Trichotillomania, excoriation	Significant distress; boredom or anxiety
Trauma- and stressor-related disorders	
Reactive attachment disorder	Emotionally withdrawn behavior; limited positive affect; irritability, sadness, or fearfulness
Posttraumatic stress disorder	Distress, persistent negative emotional state, persistent inability to experience positive emotions, irritable behavior and angry outbursts
Acute stress disorder	Distress, persistent inability to experience positive emotions, irritable behavior, and angry outbursts
Somatic symptom and related disorders	
Somatic symptom disorder, and illness anxiety disorder	Persistently high level of anxiety about health or symptoms
Feeding and eating disorders	
Anorexia nervosa	Fear of gaining weight
Sleep–wake disorders	
Non-rapid-eye-movement sleep arousal disorders, sleep terror type	Intense fear and signs of autonomic arousal
Insomnia disorder, circadian rhythm sleep–wake disorders, restless legs syndrome	Clinically significant distress

(continued)

TABLE 38.1. *(continued)*

Disorders	Symptoms
Disruptive, impulse-control, and conduct disorders	
Oppositional defiant disorder	Angry/irritable mood, often loses temper, often touchy or easily annoyed
Intermittent explosive disorder	Recurrent aggressive outbursts
Pyromania	Tension or affective arousal; pleasure, gratification, or relief when setting fires
Kleptomania	Tension; pleasure, gratification, or relief at time of theft
Personality disorders	
Paranoid personality disorder	Quickness to react angrily
Schizoid personality disorder	Emotional coldness, detachment, or flattened affectivity
Schizotypal personality disorder	Inappropriate or constricted affect, excessive social anxiety
Antisocial personality disorder	Lack of remorse; irritability and aggressiveness
Borderline personality disorder	Affective instability due to marked reactivity of mood, inappropriate anger, or difficulty controlling anger
Histrionic personality disorder	Rapidly shifting and shallow expressions of emotion, exaggerated expression of emotion
Narcissistic personality disorder	Lack of empathy
Avoidant personality disorder	Fear of being shamed or ridiculed
Dependent personality disorder	Fear of loss of support or approval, being unable to care for self, being left alone
Substance-related and addictive disorders	
Alcohol withdrawal	Autonomic hyperactivity, anxiety
Caffeine intoxication	Restlessness, nervousness, excitement
Caffeine withdrawal	Dysphoric mood, depressed mood, or irritability
Cannabis intoxication	Euphoria, anxiety
Cannabis withdrawal	Irritability, anger, or aggression; nervousness or anxiety; restlessness; depressed mood
Other hallucinogen intoxication	Marked anxiety or depression
Phencyclidine intoxication	Belligerence
Inhalant intoxication	Belligerence; euphoria
Opioid intoxication	Initial euphoria followed by apathy, dysphoria
Opioid withdrawal	Dysphoric mood
Sedative, hypnotic, or anxiolytic intoxication	Mood lability
Sedative, hypnotic, or anxiolytic withdrawal	Autonomic hyperactivity; anxiety
Stimulant intoxication	Euphoria or affective blunting; anxiety, tension, or anger
Stimulant withdrawal	Dysphoric mood
Tobacco withdrawal	Irritability, frustration, or anger; anxiety; restlessness; depressed mood
Gambling disorder	Excitement; feeling restless or irritable
Amphetamine, cocaine intoxication	Euphoria or affective blunting; anxiety, tension, anger
Amphetamine, cocaine withdrawal	Dysphoric mood
Neurocognitive disorders	
Major or mild frontotemporal neurocognitive disorder	Apathy; loss of sympathy or empathy

Theoretical Advances in Emotion

Contemporary emotion theories share the perspective that emotions, under most circumstances, serve a number of important intra- and interpersonal functions (e.g., Barrett, 2006a; Frijda, 1986; Lang, Bradley, & Cuthbert, 1990; Levenson, 1994). Although these functions are the same for people with and without psychopathology (Keltner & Kring, 1998; Kring & Bachorowski, 1999), the most common emotion disturbances in psychopathology can interfere with the achievement of emotion-related functions. For example, diminished facial expressions in a person with schizophrenia may evoke negative responses from others (Krause, Steimer-Krause, & Hufnagel, 1992), thus adversely impacting his or her social relationships and interactions (e.g., Hooley, Richters, Weintraub, & Neale, 1987).

Traditional views of emotion suggest that emotions have multiple components, such as expression, experience, and physiology, and some functionalist accounts of emotion suggest that coherence among components is expected and adaptive (e.g., Levenson, 1994), but the empirical data supporting coherence are mixed (Barrett, 2006a; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). Although there are methodological reasons that might account for the mixed findings on coherence, at a more fundamental level, recent theoretical advances in emotion suggest that such variability in coherence specifically and in emotion more generally are in fact the essence of emotion (Barrett, 2006a; Barrett, Wilson-Mendenhall, & Barsalou, 2015). Indeed, in this view emotions (and their coherence) vary depending upon situational context, prior instances of emotions and contexts, different concepts and vocabularies for emotion, structure, and connectivity of core brain networks and regions that support our ability to make meaning of sensory input from the world and our bodies (Barrett, 2014; Barrett & Satpute, 2013; Barrett, Wilson-Mendenhall, & Barsalou, 2013; Barrett et al,2015; Lindquist & Barrett, 2012). Previous perspectives on emotion disturbances in psychopathology, including my own (e.g., Kring, 2001), that pointed to the lack of coherence across multiple emotions, situations, and contexts in different mental disorders (e.g., schizophrenia, psychopathy) as deficits, are perhaps better understood as descriptions of natural variation, albeit at the tail ends of the distribution.

The Transdiagnostic Approach

In a prescient and influential book, Harvey, Watkins, Mansell, and Shafran (2004) reviewed the literature on cognitive and behavioral maintaining processes in psychopathology. Rather than organizing their book by disorder, they adopted a transdiagnostic perspective, reviewing the evidence for common processes across different disorders. Their analysis reviewed the evidence of disruptions in processes—such as attention, memory, reasoning, and avoidance—that are common across more than one adult disorder and that serve to maintain or exacerbate the symptoms of these disorders. Similar conclusions have been reached regarding common cognitive maintaining processes across the eating disorders (Fairburn, Cooper, & Shafran, 2003), and treatment approaches that target transdiagnostic processes across disorders have been developed for depression, anxiety, and eating disorders (e.g., Barlow, Ellard, et al., 2011; Barlow, Farchione, et al., 2011; Fairburn et al., 2003; Norton, Hayes, & Hope, 2004).

Harvey et al. (2004) highlighted several advantages to adopting a transdiagnostic perspective in psychopathology, two of which we describe here. First, the transdiagnostic perspective may help to account for the high rates of comorbidity among the current DSM disorders. Indeed, comorbidity is the norm rather than the exception. In the National Comorbidity Survey (NCS), Kessler et al. (1994) found that nearly 80% of people with a lifetime diagnosis of one disorder had received at least one other lifetime diagnosis. In the NCS replication study, 45% of people who met criteria for one diagnosis in the prior 12 months met criteria for at least one more diagnosis (Kessler, Chiu, Demler, & Walters, 2005). The high level of comorbidity reflects problems in the current diagnostic system (e.g., poor discriminant validity). At the same time, the rampant comorbidity also suggests that there are likely common processes across disorders, including emotional processes.

Second, a transdiagnostic approach ought to be useful for developing and evaluating treatments. For example, theoretical and empirical evidence indicate that available treatments for anxiety and depression are changing common aspects of these disorders, rather than disorder-specific aspects (Barlow, 2004; Hayes, Strosahl, & Wilson, 1999; Kring, Persons, & Thomas, 2007; Persons, Roberts, & Zalecki, 2003). In addition, evidence from treatment outcome studies suggests that interventions for one disorder (e.g., depression) are also effective in treating other disorders (e.g., generalized anxiety disorder; e.g., Brown & Barlow, 1992; Tsao, Mystkowski, Zucker, & Craske, 2002). A transdiagnostic perspective may illuminate the common mechanisms or processes across disorders, which may then be more directly targeted in treatment.

Adoption of a transdiagnostic approach to emotion disturbances in psychopathology has gathered momentum in the past several years (e.g., Kring & Sloan, 2009), despite the fact that the prevailing paradigm in psychopathology research over the past several decades has been disorder centric—that is, most investigations are designed to answer questions about the symptoms, causes, and treatments of individual disorders. In the realm of emotion and psychopathology, studies are typically designed to study a particular emotion disturbance in a particular disorder. For example, the literature is packed with studies of particular emotion disturbances (e.g., facial emotion perception deficits) in putatively distinct disorders (e.g., depression, borderline personality disorder, schizophrenia), with little consideration of the possibility that the emotion disturbance may cut across these diagnostic categories. This disorder-centric research was perpetuated in part by the field's relatively greater emphasis on internal validity (e.g., tightly controlled study of one disorder) over external validity (e.g., naturalistic study of comorbid disorders), and was (and still is, to some extent) reflected in editorial practices at top-flight journals and funding priorities at granting agencies. The disorder-centric focus turned a blind eye to the fact that most disorders do not occur in "pure" form, and thus conclusions regarding specificity of emotion disturbances in *X* disorder may not be particularly informative with respect to understanding *X* disorder as it more commonly occurs in combination with *Y* disorder.

However, the winds have shifted, particularly with respect to granting agencies. Indeed, troubled by the fact that our current diagnostic systems have yet to lead to important breakthroughs in revealing causes and developing effective treatments for mental disorders, scientists at the National Institute of Mental Health (NIMH) have advocated for a new approach to classifying mental disorders, at least for research purposes, that leverages advances in neuroscience and genetics over the past two decades to identify behavioral and neurobiological mechanisms that cut across the current symptom-based diagnostic categories. The RDoC are currently conceived as a road map for research spanning molecules, genes, neural circuits, and behavior that will in turn lead to the development of a new classification system that is based, in part, on neuroscience and genetic data rather than just clinical description, which would then ideally shine a more direct light on treatment targets (Insel, 2009; Insel et al., 2010; Sanislow et al., 2010). The NIMH is taking the long view here, recognizing that although there have been many advances in neuroscience and genetics in the past decade, we are still a ways off from clearly linking disruptions in genes or brain circuits to psychopathology. Perhaps somewhat idealistic, the hope is that by "lumping" syndromes based on common genetic and neural problems rather than "splitting" syndromes based on clinical symptoms (as our current diagnostic system does), we will be better positioned to develop more effective treatments that directly target the neurobiological deficit(s) contributing to disorders.

The RDoC approach is at once transdiagnostic as it aspires to account for the full range of behavior from normal to abnormal and is untethered to current diagnostic categories. There are currently five broad RDoC domains or constructs that reflect particular functions, and these domains are expected to be relevant to many different diagnostic categories.[1] The domains are (1) negative valence systems (e.g., fear, anxiety), (2) positive valence systems (e.g., reward valuation, effort, reward prediction), (3) cognitive systems (e.g., attention, perception, cognitive control, working memory), (4) social processes (e.g., attachment, facial expression recognition, understanding others' mental states), and (5) arousal/regulatory systems (e.g., sleep, arousal). All domains can be studied across multiple units of analysis, including genes, molecules, cells, circuits, physiology, behavior, and self-report (see Table 38.2 for the RDoC domains and units of analysis). Importantly, NIMH is agnostic with respect to the primacy of any single unit of analysis—that is, all units of analysis are considered to be equally informative, and one (e.g., circuits) is not presumed to "underlie" or be more fundamental to another (e.g., self-report).

Each of the current RDoC constructs consists of several processes, and many of these processes have already been studied within diagnostic categories. For example, the positive valence systems domain includes processes such as reward valuation and expectancy/reward prediction; these have been separately studied in schizophrenia (Kring

TABLE 38.2. Research Domain Criteria Matrix

	Units of analysis						
Constructs	Genes	Molecules	Cells	Circuits	Physiology	Behavior	Self-report
Negative valence systems (*e.g. fear, anxiety*)							
Positive valence systems (*e.g., reward prediction, effort valuation*)							
Cognitive systems (*e.g., attention, cognitive control*)							
Social processes (*e.g., social communication, attachment*)							
Arousal and regulatory systems (*e.g., sleep*)							

& Barch, 2014), addiction (Berridge, Robinson, & Aldridge, 2009; Robinson & Berridge, 2008), depression (Bogdan, Nikolova, & Pizzagalli, 2013), attention-deficit/hyperactivity disorder (Nigg, 2013), and bipolar disorder (Caseras, Lawrence, Murphy, Wise, & Phillips, 2013; Gruber, 2011; Johnson, Edge, Holmes, & Carver, 2012). The next generation of research within the RDoC framework is examining these constructs and processes across diagnostic categories (e.g., Dillon et al., 2014) with the goal of identifying clearer treatment targets that will improve function in these domains, regardless of the symptom-based diagnostic category.

Although this is certainly an exciting time for transdiagnostic research, we note that it will be important to recognize that it is likely that some of our current symptom-based classifications may retain their clinical utility insofar as there may still be symptom domains that will benefit from distinct treatment approaches. For example, mindfulness meditation has become a more commonly employed intervention for mood and anxiety disorders. Yet, the mechanisms by which this treatment is effective appear to vary depending upon the symptom domain. Specifically, in one study worry mediated the relationship between mindfulness and anxiety symptoms, but reappraisal and rumination mediated the linkage between mindfulness and depression symptoms (Derosiers, Vine, Klemansky, & Nolen-Hoeksema, 2013). Similarly, Vine and Aldao (2014) found that the linkage between deficits in emotional clarity (i.e., awareness of emotional experience) and psychopathology symptoms is differentially mediated by different emotion regulation strategies (e.g., attention deployment, impulse control, acceptance) depending upon the symptom domain (i.e., anxiety, depression, alcohol, eating, personality).

Indeed, though the RDoC endeavor is transdiagnostic by design, it may not fully supplant our current diagnostic categories. For example, Shankman and colleagues (2013) examined whether physiological and self-report measures of two of the RDoC domains—threat (in negative valence systems) and reward sensitivity—cut across diagnostic boundaries of panic disorder and depression. The findings indicated specificity rather than unanimity. Specifically, people with panic disorder showed greater sensitivity to threat than people with depression, and people with depression showed less sensitivity to reward than people with panic disorder. Notably, this pattern of specificity was also observed for people who had both panic disorder and depression.

Furthermore, the current RDoC domains are not entirely distinct from one another, at least at the brain circuit unit of analysis. For example, positive valence systems and cognitive systems both involve circuits including frontal and striatal regions. Whether or not the RDoC constructs ought to be distinct across units of analyses is open for debate. However, if one of the goals of the RDoC is to reduce comorbidity, beginning with constructs that already overlap with one another will limit the achievability of this goal. However, it may not be possible to generate constructs with no overlap given what we know about brain circuits (e.g., Barrett & Satpute, 2013; Buckner & Carroll, 2007).

Nevertheless, with the advent of the RDoC, alongside the newer research on transdiagnostic processes, the promise of a transdiagnostic approach to emotion disturbances has already begun to be revealed. At the broadest level, a transdiagnostic approach can inform the ways in which different disorders are classified. In other words, examining emotion-related commonalities at the symptom level may help to account for the high levels of comorbidity in the current diagnostic system, and in turn may provide guidance on refining current clinical diagnostic categories. Second, a transdiagnostic approach can be informative with respect to identifying common emotion-related causal and/or maintaining processes across disorders. Third, a transdiagnostic approach can be useful for treatment development, with an emphasis on changing emotion processes. In the remaining sections of the chapter, we consider the relative merits of adopting a transdiagnostic approach to emotion disturbances in psychopathology across these three levels: descriptive phenomenology, etiology, and treatment.

Descriptive Psychopathology and Diagnosis

In an effort to spur the field toward greater attention to emotion and psychopathology, Berenbaum, Raghavan, Le, Vernon, and Gomez (2003) proposed a separate taxonomy of emotional disturbances as a companion to the current diagnostic system. Although this was not adopted in DSM-5, their articulation of three broad areas of emotion disturbances—"valence," "intensity/regulation," and "disconnections"—maps onto the newly conceived RDoC domains. For example, emotional valence disturbances can involve pleasant or unpleasant emotions (positive and negative valence systems in the RDoC), as well as too much or too little of these emotions. Emotional intensity/regulation disturbances are defined as over- or underregulation of both pleasant and unpleasant emotions. Emotion regulation difficulties can span nearly all of the RDoC domains. Disconnection disturbances reflect disconnections between the expressive component of emotion and other components, as in schizophrenia, where people experience strong feelings yet do not express them outwardly (see Kring & Elis, 2013, for a review). Disconnection disturbances also reflect a lack of conscious awareness of one's own emotional responses, and in the RDoC approach, this could reflect valence and cognitive systems difficulties.

Reconfiguring the current diagnostic categories based only on emotion-related disturbances would leave out much clinically relevant information. Indeed, mental disorders do not solely consist of emotion-related symptoms. Different symptoms reflect other, interrelated processes, including cognitive (e.g., inattention, thought disorder), behavioral (e.g., avoidance), and interpersonal (e.g., no close friends or confidants) processes. However, a transdiagnostic approach would not necessarily have to supplant the current diagnostic categories for it to inform our understanding of the symptoms of various disorders. Understanding the emotion-related symptoms that cut across disorders may help to refine the current diagnostic categories without necessarily reconfiguring them. At the level of descriptive psychopathology, a hybrid approach that combines transdiagnostic and disorder-specific approaches may be fruitful, at least in the short term until additional research more clearly illuminates the promise of a solely transdiagnostic approach.

This type of hybrid approach is consistent with some current neuroscience models of emotion that posit that emotion is not a "special case" with respect to its neural underpinnings. Instead, emotions are instantiated by the same neural networks that support perception, attention, cognition, and all other aspects of mental life (Barrett & Satpute, 2013; Lindquist & Barrett, 2012; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012). Emotions may be supported by the same neural networks (e.g., salience, default mode, executive control networks) that support other mental processes, but this does not obviate the utility of considering emotions in their own right (Barrett, 2012). In this view, both mental disorders and emotions are conceptualized in a "top-down" fashion such that the neural correlates of these are more domain/process general and variations in manifestations of disorders or emotions are understood as reflecting differential strength or engagement of neural networks alongside genetic, environmental, prior learning, and cultural influences. Although this approach appears to be similar to the RDoC approach, as we noted earlier, the RDoC have not yet grappled with the notion of how the units of analysis, at least at the level of brain circuits, may cut across the different constructs.

Causal and Maintaining Processes

There have been several reviews of emotion disturbances in psychopathology (e.g., Kring & Sloan, 2009; Rottenberg & Johnson, 2007). Instead of duplicating these efforts, we focus here on candidate transdiagnostic emotion disturbances that may reflect causal or maintaining processes. There are many points along the temporal course of disorders at which a transdiagnostic perspective may be informative (Barnett & Gotlib, 1988; Harvey et al., 2004). Specifically, transdiagnostic emotion disturbances may be antecedents (i.e., predisposing or vulnerability factors), concomitants, or consequences (i.e., perpetuating or maintaining factors). For an emotion disturbance to be considered an antecedent transdiagnostic process, it must be shown to precede the onset of a disorder. Disturbances that are observed during active episodes of disorders may be more accurately construed as concomitant transdiagnostic processes, and disturbances that persist after active episodes have abated might be considered consequences or maintaining processes.

Much of the evidence to date regarding specific emotion disturbances in particular disorders is most readily interpreted as evidence for maintaining processes. There has been less theoretical, conceptual, and empirical work on possible transdiagnostic causal or maintaining emotion processes than in the domains of phenomenology and treatment. Indeed, the disorder-centric focus of research has been particularly dominant in studies of possible etiological emotion disturbances, though this is currently undergoing a significant shift with the RDoC. Although space constraints preclude us from considering many possible transdiagnostic emotion disturbances, we briefly consider four promising candidates: core affect, emotion awareness, emotion regulation, and emotion disconnections. These four constructs were developed in basic affective science research and have been meaningfully translated to the study of psychopathology. These constructs were also developed prior to the RDoC initiative, and some are embedded within the RDoC. For example, emotion awareness is embedded within the RDoC social processes construct (perception and understanding of the self). In our view, these four areas will retain promise and utility in psychopathology research even as the RDoC continues to develop and evolve.

Core Affect

Although the terms "affect" and "emotion" are often used interchangeably in the psychopathology literature, there are important conceptual and empirical distinctions between the terms. Generally speaking, affect is most often used in reference to feeling states, whereas emotion is used to reference instances that may include behavior (e.g., facial expression or shouting), feeling states and language (e.g., anger), and changes in the body (e.g., heightened skin conductance). Barrett and colleagues have distinguished "core affect" from the more generic term "affect." Core affect reflects neurophysiological states that are an omnipresent indicator of a person's relationship to his or her environment at any given time (Barrett, 2006a; Barrett, Mesquita, Ochsner, & Gross, 2007; Russell, 2003). Core affect is experienced as feelings of pleasure or displeasure, and to a lesser extent arousal or activation (Barrett, 2006a; Barrett et al., 2007). Although core affect is observed across cultures, there are nevertheless important individual and cultural differences (Barrett, 2006b; Mesquita & Karasawa, 2002) that may be important for understanding disturbances in core affect in psychopathology.

Findings from several studies that have measured reports of feeling states have indicated that the experience of excessive unpleasant affect (although it is not necessarily conceived of as core affect) is common across many different disorders, including depression (Bylsma, Morris, & Rottenberg, 2008), the anxiety disorders (Watson, 2005), eating disorders (e.g., Stice, 2001), schizophrenia (Kring & Moran, 2008), substance-related disorders (e.g., Kassel, Stroud, & Paronis, 2003), and a number of personality disorders (e.g., Berenbaum et al., 2006; Huperich, 2005; Putnam & Silk, 2005). Integrating findings across behavioral and brain imaging studies, Barrett et al. (2007) have suggested that disturbances in core affect may reflect an important emotion-related transdiagnostic process in psychopathology. Indeed, the RDoC domains of negative valence states and positive valence states would seem to encompass core affect, and the conceptual, theoretical, and empirical advances regarding core affect among healthy individuals are ripe for translation into the realm of psychopathology.

Emotion Awareness: Clarity and Differentiation

Barrett and Gross (2001) have argued that knowledge and awareness of one's emotions are necessary prerequisites to effective emotion regulation. However, simply having knowledge about emotion is not sufficient; rather, greater accessibility of that emotion knowledge is believed to promote effective emotion regulation (e.g., Sauer & Baer, 2009).

For example, people who describe their feelings in a more differentiated manner (e.g., "sad," "confused," "elated") rather than more globally (e.g., "good," "bad") have greater accessibility to and awareness of emotion knowledge, and use this knowledge when trying to regulate their feelings (Barrett, Gross, Christensen, & Benvenuto, 2001; Sauer & Baer, 2009).

Recent evidence suggests that emotion awareness can be meaningfully distinguished into two constructs: emotion clarity or the awareness of one's feelings, and emotion differentiation (granularity), or the ability to distinguish among different feeling states (Boden, Thompson, Dizén, Berenbaum, & Baker, 2013). Emotion differentiation has yet to be fully studied across diagnostic categories, but there is some evidence suggesting that people with schizophrenia do not differ from people without schizophrenia in their emotion knowledge, though people with schizophrenia differentiate less among emotional states, and thus may be less effective at emotion regulation (Kring, Barrett, & Gard, 2003). Clinical conceptualizations of borderline personality disorder include the notion that people with this disorder have difficulty distinguishing among different emotional states (e.g., Westen, 1991), but the empirical confirmation of this notion is needed.

By contrast, emotion clarity has been assessed across different diagnostic categories. Emotion clarity is partially captured by the concept of "alexithymia," as assessed by the Toronto Alexithymia Scale (Bagby, Parker, & Taylor, 1994) subscales of "difficulty in identifying feelings" and "difficulty in describing feelings." This measure has been widely used in correlational studies of anxiety disorders (e.g., Frewin, Pain, Dozois, & Lanius, 2006; Parker, Taylor, Bagby, & Acklin, 1993; Turk, Heimberg, Luterek, Mennin, & Fresco, 2005), eating disorders (e.g., Cochrane, Brewerton, Wilson, & Hodges, 1993), personality disorders (e.g., Berenbaum, 1996), substance use disorders (e.g., Speranza et al., 2004), and insomnia (e.g., Lundh & Broman, 2006). However, the linkages between alexithymia and the various disorders are not always replicated across studies, and the extent to which this captures a transdiagnostic construct has not been explicitly assessed.

Emotion clarity has also been measured using the Differential Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). Correlational studies using the DERS have found emotion clarity to be correlated with anxiety disorders (e.g., Mennin, Holaway, Fresco, Moore, & Heimberg, 2007), depression (e.g., Flynn & Rudolph, 2010), borderline personality disorder (e.g., Gratz, Rosenthal, Tull, Lejuez, & Gunderson, 2006), and eating disorder symptoms (e.g., Gilboa-Schechtman, Avnon, Zubery, & Jeczmien, 2006). Furthermore, emotion clarity is independently related to symptoms including depression, anxiety, borderline personality, alcohol use, and disordered eating even when controlling for the widespread overlap in these symptoms (Vine & Aldao, 2014), suggesting that emotion clarity is indeed transdiagnostic.

Emotion Regulation

Emotion regulation problems have been at the forefront of discussions about emotion disturbances in psychopathology for more than a decade (e.g., Aldao, Nolen-Hoeksema, & Schweizer, 2010; Carl, Soskin, Kerns, & Barlow, 2013; Garland et al., 2010; Gross & Muñoz, 1995; Kring & Sloan, 2009; Linehan, 1993). Broadly, emotion regulation refers to processes that serve to modify what we feel, when we feel it, and how we use that feeling to guide behavior (e.g., Gross, 1998). Many current diagnostic criteria explicitly refer to emotion regulation difficulties (Fairholme et al., 2013). For example, the criteria "difficulty controlling anger" in borderline personality disorder, "efforts to avoid distressing feelings" in posttraumatic stress disorder (PTSD), and "rapidly shifting expressions of emotion" in histrionic personality disorder all point to difficulties in regulating emotions.

Despite the perceived importance of emotion regulation deficits in psychopathology, it is difficult to integrate the literatures across disorders, because of the myriad approaches to constraining the concept of emotion regulation across studies. For example, some researchers do not distinguish emotional responding from regulation, following from theory that suggests the processes are indistinguishable (e.g., Campos, Frankel, & Camras, 2004; Davidson, 2000). Other studies examine emotion regulation within the person, whereas still other studies examine emotion regulation from the outside (e.g., having others provide soothing to down-regulate negative emotion). Disentangling emotion from emotion regulation remains a critical challenge for the field (Rottenberg & Gross, 2003). To date, the vast majority of emotion regulation and psychopathology studies have been conducted within rather than across disorders (Aldao, 2013), but momentum toward greater transdiagnostic work is growing (Kring & Sloan, 2009). Importantly, recent theoretical and clinical conceptualizations have questioned whether emotion regulation is always adaptive in psychopathology, and instead distinguish change-based strategies such as emotion regulation from acceptance-based strategies (e.g., Sauer & Baer, 2009).

A close cousin to emotion regulation is the time course, or chronometry, of emotional responses (e.g., Davidson, 1998). Emotional responses are not wholly temporally constrained by the presence of an eliciting stimulus, but instead vary in their peak and duration in ways that may hold important information about the nature of emotion disturbances in psychopathology (Aldao, 2013; Kring & Elis, 2013). Two elements of the time course of an emotional response that have been studied in healthy populations are (1) the time from the onset to the peak intensity of the response; and (2) the recovery time, or the time it takes for the emotional response to resolve. This latter process, recovery time, is a probable transdiagnostic emotion disturbance that has been studied in individual disorders, such as schizophrenia (Kring, Germans Gard, & Gard, 2011; Ursu et al., 2011) and depression (e.g., Moran, Mehta, & Kring, 2012; Rottenberg, Kasch, Gross, & Gotlib, 2002), but remains a topic for future transdiagnostic research. For example, the prolonged experience of negative affect (NA) associated with depression, generalized anxiety disorder, and eating disorders, or the prolonged experience of positive affect (PA) associated with bipolar disorder, may reflect a difficulty in the recovery time of emotional responding (e.g., Tomarken & Keener, 1998).

Emotion Disconnections

Disconnection among emotion response components has not yet been studied across diagnostic categories. A good deal of evidence indicates that people with schizophrenia report experiencing strong emotions in response to a variety of emotionally evocative stimuli (films, pictures, social interactions), yet they do not often display these feelings outwardly (see Kring & Elis, 2013; Kring & Moran, 2008, for reviews). In other words, their outward displays of emotion are not often accurate reflections of their experienced emotion, indicating a disconnection between emotion response components. There is some evidence to suggest that this disconnection may be present prior to the onset of the illness. Walker, Grimes, Davis, and Smith (1993) analyzed home movies of adults with schizophrenia that were made before the adults developed schizophrenia. They found that girls displayed fewer joy expressions, and that both boys and girls displayed more negative facial expressions, compared with their healthy siblings.

Studies using the emotion-modulated startle paradigm (Lang et al., 1990) have observed a different disconnection among people with psychopathy. Compared with healthy controls, these people showed comparable startle inhibition during exposure to pleasant stimuli, but they did not show startle potentiation during exposure to aversive stimuli (e.g., Patrick, 1994; Patrick, Bradley, & Lang, 1993). However, the people with psychopathy did not differ from controls in their reported emotional experience to the aversive stimuli. Additional evidence for this disconnection has been found in imagery studies (Patrick, Cuthbert, & Lang, 1994) and incidental memory paradigms (Christianson et al., 1996). In both of these examples, the reports of emotional experience of people with psychopathy were indistinguishable from healthy controls, but their behavioral or psychophysiological responses differed. It may well be that such emotion disturbances are better construed as reflecting a relatively intact core affect system with corresponding behavioral system disturbances.

More broadly, situating these and other observations of emotion disconnections within recent conceptualizations of emotion that point to variability in connection (coherence) as the norm, not the exception (Barrett, 2006a; Barrett et al., 2015), remains to be done. In other words, understanding when emotion disconnections are instances of typical variability versus an indicator of an emotion disturbance remains an important direction for future research.

Treatment Development and Evaluation

Although medication is a common form of treatment for many different disorders, very few investigations have explicitly adopted a transdiagnostic approach to evaluating pharmacological treatment. Nevertheless, the evidence that particular medications may be effective for multiple disorders is hiding in plain sight. For example, studies have found that antidepressant medications are effective at reducing the symptoms of several other disorders, including specific and social phobias (e.g., Stein et al., 1998; Van Ameringen et al., 2001), panic disorder (White & Barlow, 2002), generalized anxiety disorder (Lydiard & Monnier, 2004), obsessive–compulsive disorder (OCD; Steketee & Barlow, 2002), PTSD (Brady et al., 2000), some of the personality disorders (e.g., Rinne, van den Brink, Wouters, & van Dyck, 2002), and eating disorders (e.g., Walsh et al., 2000). Following from such evidence, medications that were originally approved by the U.S. Food and Drug Administration (FDA) for the treatment of depression have since received approval (or an "indication," in FDA terminology) for the treatment of other disorders. For example, paroxetine (Paxil) was later approved for the treatment of OCD, panic disorder, generalized anxiety disorder, and social anxiety; fluoxetine (Prozac) was later approved for the treatment of OCD and bulimia nervosa; sertraline (Zoloft) was later approved for the treatment of OCD, panic disorder, social anxiety, and PTSD.

Although it may be the case that antidepressant medications are rather blunt instruments for targeting the general distress that is common across disorders, little research has directly examined the emotion-related mechanisms by which the medications might exert their transdiagnostic effects. However, we know that the selective serotonin reuptake inhibitors work on the neurotransmitter serotonin (as well as others, including dopamine; e.g., Svenningsson et al., 2002), functionally leaving more serotonin in the synapse, and that disruptions in serotonin have been implicated in depression (e.g., Thase, Jindal, & Howland, 2002), anxiety disorders (e.g., Stein et al., 1998), and eating disorders (e.g., Carrasco, Dyaz-Marsa, Hollander, Cesar, & Saiz-Ruiz, 2000; Kaye et al., 1998). We also know a good deal about how serotonin works throughout the brain, and perhaps not surprisingly, this neurotransmitter is heavily concentrated in areas of the brain linked with emotion (e.g., Barrett et al., 2007; Wrase, Reimold, Puls, Kienast, & Heinz, 2006). Finally, research has indicated that serotonin levels are associated with positive affect among healthy people (e.g., Duffy et al., 2006; Zald & Depue, 2001). The building blocks are thus available for constructing a transdiagnostic approach to medication treatment that explicitly links pharmacology, neuroscience, and emotion. Much of this integrative work remains to be done, but it is certainly a fruitful avenue for future research.

Historically, different forms of psychotherapy were conceived of as treatments that could be applied across disorders or clinical problems (e.g., psychoanalysis). Furthermore, despite the distinctly different theoretical traditions underpinning various types of psychotherapy (e.g., psychodynamic, interpersonal, gestalt, client centered, behavioral), each of these traditions has included some consideration of emotion (see Greenberg, 2002b; Greenberg & Safran, 1987, for reviews). One form of psychotherapy that is relevant to the focus of this chapter is emotion-focused therapy (EFT), which was developed by Leslie Greenberg (e.g., 2002a). Boiled down to its essence, EFT is based on the idea that some emotions are adaptive, whereas others are maladaptive. Maladaptive emotions are based on an underlying loneliness, abandonment, worthlessness, anger, or inadequacy, and they can interfere with a person's relationships and overall functioning. The primary therapeutic goal is for a client to become more aware of these maladaptive emotions, to understand the source of these feelings, and to learn emotion regulation skills. According to Greenberg (2002a), EFT is better suited to particular types of clinical conditions (including depression and generalized anxiety disorder) and less well suited to others (such as panic disorder). Unfortunately, data regarding the efficacy of this treatment are limited. No randomized controlled clinical trials have been conducted, although smaller studies examining the process of change within EFT indicate that the treatment is effective for some clinical problems (Greenberg, 2002a). The theoretical foundations of this treatment continue to be enhanced by research in emotion, emotion and psychopathology, and affective neuroscience (e.g., Greenberg, 2002b, 2004); a worthwhile endeavor for future research would be to examine whether this treatment is effective in targeting transdiagnostic emotion-related disturbances.

The shift to more disorder-specific psychotherapeutic approaches perhaps began in the late 1950s, with the pioneering work of Joseph Wolpe (1958), who developed systematic desensitization for the treatment of specific phobias. Additional disorder-specific psychotherapies were developed in the 1960s, as cognitive-behavioral therapies became more prominent. A number of other influences in the field since the 1970s have converged to solidify a disorder-specific approach to treatment development. These have included the greater demand to show that psychotherapy is effective; the development of the DSM-III, which was heavily influenced by the medical model (Wilson, 1993); the sophistication of research methods to evaluate treatment outcomes for specific disorders (e.g., Barlow, 2004; Westen, Novotny, & Thompson-Brenner, 2004); the emphasis on evidence-based practice (e.g., Barlow, 1996; Chambless & Hollon, 1998;

Kendall, 1998); the efforts to position psychology as a health care profession and thus in the larger health care context (e.g., Johnson, 2001); and the observation that psychological treatments tailored to specific disorders are as effective as, or more effective than, other types of interventions. Indeed, as Barlow (2004) has noted, "Few would argue that diversity in procedures to address specific aspects of pathology is not necessary" (p. 873).

The disorder-specific approach to treatment development, particularly in the context of empirically supported treatments (Chambless & Hollon, 1998), spawned a large number of individual treatment protocols and manuals. This proliferation of different treatment protocols has undoubtedly benefited countless people who have received these treatments, as they have been shown to be effective (Nathan & Gorman, 2002). However, the sheer magnitude of treatment protocols has become a bit overwhelming to treatment professionals, with respect to both learning the varied protocols and disseminating them to a broader range of treatment providers (e.g., Barlow, Allen, & Choate, 2004; Clark, 2009; Persons, 2005). Furthermore, the reality in clinical practice is that providers often select bits and pieces from a number of different protocols, in order to provide the best possible treatment for a given person (Persons, 2005).

Partly in reaction to this overwhelming number of treatment protocols, there has recently been a call for more unified treatments across treatment types (McEvoy, Nathan, & Norton, 2009; Mennin, Ellard, Fresco, & Gross, 2013) and, germane to this chapter, disorders. Most transdiagnostic treatments have been, to date, developed for anxiety disorders and depression, and some of these have been informed by research on emotion-related disturbances that are common across these disorders. A recent review of seven uncontrolled trials and three randomized controlled trials (RCTs) of unified treatments for anxiety and depression found that these treatments were effective in reducing both anxiety and mood symptoms (McEvoy et al., 2009), though given that the majority of these were uncontrolled trials, it remains to be determined how these treatments compare with other empirically supported treatments.

To illustrate a transdiagnostic treatment that was developed from affective science research on emotion regulation, we describe in a bit of detail the intervention of Barlow and colleagues who developed a unified protocol for anxiety and mood disorders (Barlow, Ellard, et al., 2011; Barlow, Farchione, et al., 2011). The focus of this intervention is on putative emotion-related mechanisms, particularly emotion regulation, that are common across mood and anxiety disorders. The treatment has five core skills modules derived from affective science that teach: (1) emotion awareness, (2) cognitive flexibility, (3) identification and prevention of emotion avoidance and maladaptive regulation strategies, (4) awareness of emotion-related interoceptive sensations, and (5) interceptive-based exposure. The treatment also includes education about emotions and their adaptive nature as well as relapse prevention skills. Two small open (i.e., uncontrolled; Ellard, Fairholme, Boisseau, Farchione, & Barlow, 2010) trials and one small RCT comparing the unified protocol with a wait-list control (Farchione et al., 2012) suggest that it is effective in reducing anxiety and depression symptoms as well as negative affect (and in the RCT, increasing positive affect) for people with different anxiety disorder diagnoses (social anxiety, generalized anxiety), OCD, PTSD, and depression. The unified protocol has been modified for adolescents (Ehrenreich, Goldstein, Wright, & Barlow, 2009) and children (Ehrenreich-May & Bliek, 2012) but these have not yet been tested. Though promising, additional study is needed with larger, more clinically diverse samples to determine whether this intervention is effective transdiagnostically. In addition, studies are only beginning to examine mechanisms of change for the unified protocol (Sauer-Zavala et al., 2012). Indeed, there has been a call for more treatments to target mechanisms rather than disorders per se. For example, Rosen and Davison (2003) have argued that we should be defining empirically supported principles of change rather than empirically supported treatments.

Other treatments have been designed to target emotional disturbances, such as Mennin and colleagues' emotion regulation treatment for generalized anxiety disorder (e.g., Mennin, 2004). Though this intervention was designed around the emotion regulation problems associated with generalized anxiety disorder, it seems probable that it would be useful for a number of disorders with similar difficulties in emotion regulation, such as an inability to down-regulate intense negative emotions and a lack of awareness of negative emotions (Mennin & Fresco, 2009). Furthermore, treatment development researchers have recently turned their attention toward developing interventions that focus on positive emotion (Carl et al., 2013; Garland et al., 2010), and these may also be effective across diagnostic categories, though this remains a topic for future research.

Summary and Conclusions

Advances in affective science have greatly contributed to our understanding of emotion disturbances in psychopathology. Indeed, methods, theories, and measures developed in these domains have allowed us to achieve greater clarity regarding the reach of emotion disturbances across many different disorders. With this clarity has come the realization that many of the observed emotion disturbances are common across disorders. Progress in understanding the reach of transdiagnostic emotion disturbances has begun to be achieved at the levels of descriptive phenomenology, etiology, and treatment. We have argued for the promise of four transdiagnostic emotion disturbances—core affect, emotion awareness, emotion regulation, and emotion disconnections—that are grounded in affective science research and meaningfully translated to the study of psychopathology. We also highlighted the potential of the NIMH RDoC initiative, which is by definition a transdiagnostic approach to classifying psychopathology and where emotion disturbances figure prominently. Future research will likely reveal important transdiagnostic casual and maintaining processes as well as meaningful treatment targets. Even with the promise of and current momentum toward transdiagnostic approaches to emotion disturbances in psychopathology, we also suggested that the manifestation of transdiagnostic disturbances may differ from disorder to disorder in consequential ways, thus supporting the clinical utility of (some) current diagnostic categories.

Note

1. The five current RDoC domains are not considered to be the only domains by the NIMH. Instead, they are viewed by the NIMH as a sample of possibly many such constructs or domains that will be useful for propelling research on psychopathology closer to effective treatment development.

References

Aldao, A. (2013). The future of emotion regulation research: Capturing context. *Perspectives on Psychological Science, 8*, 155–172.

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review, 30*, 217–237.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Bagby, R. M., Parker, J. D. A., & Taylor, G. J. (1994). The twenty-item Toronto Alexithymia Scale: I. Item selection and cross validation of the factor structure. *Journal of Psychosomatic Research, 38*, 23–32.

Barlow, D. H. (1996). The effectiveness of psychotherapy: Science and policy. *Clinical Psychology: Science and Practice, 1*, 109–122.

Barlow, D. H. (2004). Psychological treatments. *American Psychologist, 59*, 869–878.

Barlow, D. H., Allen, L. B., & Choate, M. L. (2004). Toward a unified treatment for emotional disorders. *Behavior Therapy, 35*, 205–230.

Barlow, D. H., Ellard, K. K., Fairholme, C. P., Farchione, T. J., Boisseau, C. L., Allen, L. B., et al. (2011). *The unified protocol for transdiagnostic treatment of emotional disorders: Client workbook*. New York: Oxford University Press.

Barlow, D. H., Farchione, T. J., Fairholme, C. P., Ellard, K. K., Boisseau, C. L., Allen, L. B., et al. (2011). *The unified protocol for transdiagnostic treatment of emotional disorders: Therapist guide*. New York: Oxford University Press.

Barnett, P. A., & Gotlib, I. H. (1988). Psychosocial functioning and depression: Distinguishing among antecedents, concomitants, and consequences. *Psychological Bulletin, 104*, 97–126.

Barrett, L. F. (2006a). Solving the emotion paradox: Categorization and the experience of emotion. *Personality and Social Psychology Review, 10*, 20–46.

Barrett, L. F. (2006b). Valence is a basic building block of emotional life. *Journal of Research in Personality, 40*, 35–55.

Barrett, L. F. (2012). Emotions are real. *Emotion, 12*, 413–429.

Barrett, L. F. (2014). The conceptual act theory: A précis. *Emotion Review, 6*, 292–297.

Barrett, L. F., & Gross, J. J. (2001). Emotional intelligence: A process model of emotion representation and regulation. In T. J. Mayne & G. A. Bonanno (Eds.), *Emotions: Current issues and future directions* (pp. 286–310). New York: Guilford Press.

Barrett, L. F., Gross, J. J., Christensen, T. C., & Benvenuto, M. (2001). Knowing what you're feeling and knowing what to do about it: Mapping the relation between emotion differentiation and emotion regulation. *Cognition and Emotion, 15*, 713–724.

Barrett, L. F., Mesquita, B., Ochsner, K., & Gross, J. J. (2007). The experience of emotion. *Annual Review of Psychology, 58*, 373–403.

Barrett, L. F., & Satpute, A. (2013). Large-scale brain networks in affective and social neuroscience: Towards an integrative architecture of the human brain. *Current Opinion in Neurobiology, 23*, 361–372.

Barrett, L. F., Wilson-Mendenhall, C. D., & Barsalou, L. W. (2013). A psychological construction account of emotion regulation and dysregulation: The role of situated conceptualizations. In J. J. Gross (Ed.), *The handbook of emotion regulation* (2nd ed.). New York: Guilford Press.

Barrett, L. F., Wilson-Mendenhall, C. D., & Barsalou, L. W. (2015). The conceptual act theory: A road map. In L. F. Barrett & J. A. Russell (Eds.), *The psychological construction of emotion* (pp. 83–110). New York: Guilford Press.

Berenbaum, H. (1996). Childhood abuse, alexithymia, and personality disorder. *Journal of Psychosomatic Research, 41*, 585–595.

Berenbaum, H., Boden, M. T., Baker, J. P., Dizén, M., Thompson, R. J., & Abramowitz, A. (2006). Emotional correlates of the different dimensions of schizotypal personality disorder. *Journal of Abnormal Psychology, 115*, 359–368.

Berenbaum, H., Raghavan, G., Le, H.-N., Vernon, L. L., & Gomez, J. J. (2003). A taxonomy of emotional disturbances. *Clinical Psychology: Science and Practice, 10*, 206–226.

Berridge, K. C., Robinson, T. E., & Aldridge, J. W. (2009). Dissecting components of reward: "Liking," "wanting," and learning. *Current Opinion in Pharmacology, 9*, 65–73.

Boden, M. T., Thompson, R. J., Dizén, M., Berenbaum, H., & Baker, J. P. (2013). Are emotional clarity and emotion differentiation related? *Cognition and Emotion, 27*, 961–978.

Bogdan, R., Nikolova, Y. S., & Pizzagalli, D. A. (2013). Neurogenetics of depression: A focus on reward processing and stress sensitivity. *Neurobiology of Disease, 52*, 12–23.

Brady, K., Pearlstein, T., Asnis, G. M., Baker, D., Rothbaum, B., Sikes, R., et al. (2000). Efficacy and safety of sertraline treatment of posttraumatic stress disorder. *Journal of the American Medical Association, 283*, 1837–1844.

Brown, T. A., & Barlow, D. H. (1992). Comorbidity among anxiety disorders: Implications for treatment and DSM-IV. *Journal of Consulting and Clinical Psychology, 60*, 835–844.

Buckner, R. L., & Carroll, J. C. (2007). Self-projection and the brain. *Trends in Cognitive Sciences, 11*, 49–57.

Bylsma, L. M., Morris, B. H., & Rottenberg, J. (2008). A meta-analysis of emotional reactivity in major depressive disorder. *Clinical Psychology Review, 28*, 676–691.

Campos, J. J., Frankel, C. B., & Camras, L. (2004). On the nature of emotion regulation. *Child Development, 75*, 377–394.

Carl, J. R., Soskin, D. P., Kerns, C., & Barlow, D. H. (2013). Positive emotion regulation in emotional disorders: A theoretical review. *Clinical Psychology Review, 33*, 343–360.

Carrasco, J. L., Dyaz-Marsa, M., Hollander, E., Cesar, J., & Saiz-Ruiz, J. (2000). Decreased monoamine oxidase activity in female bulimia. *European Neuropsychopharmacology, 10*, 113–117.

Caseras, X., Lawrence, N. S., Murphy, K., Wise, R. G., & Phillips, M. L. (2013). Ventral striatum activity in response to reward: Differences between bipolar I and II disorders. *American Journal of Psychiatry, 170*, 533–541.

Chambless, D., & Hollon, S. (1998). Defining empirically supported therapies. *Journal of Consulting and Clinical Psychology, 66*, 7–18.

Christianson, S. A., Forth, A. E., Hare, R. D., Strachan, C., Lidberg, L., & Thorell, L. H. (1996). Remembering details of emotional events: A comparison between psychopathic and nonpsychopathic offenders. *Personality and Individual Differences, 20*, 437–443.

Clark, D. A. (2009). Cognitive and behavioral therapy for anxiety and depression: Possibilities and limitations of a transdiagnostic perspective. *Cognitive Behaviour Therapy, 38*(S1), 29–34.

Cochrane, C. E., Brewerton, T. D., Wilson, D. B., & Hodges, E. L. (1993). Alexithymia in the eating disorders. *International Journal of Eating Disorders, 14*, 219–228.

Davidson, R. J. (1998). Affective style and affective disorders: Perspectives from affective neuroscience. *Cognition and Emotion, 12*, 307–330.

Davidson, R. J. (2000). The functional neuroanatomy of affective style. In R. D. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 371–388). New York: Oxford University Press.

Derosiers, A., Vine, V., Klemanski, D. H., & Nolen-Hoeksema, S. (2013). Mindfulness and emotion regulation in depression and anxiety: Common and distinct mechanisms of action. *Depression and Anxiety, 30*, 654–661.

Dillon, D. G., Rosso, I. M., Pechtel, P., Killgore, W. D. S., Rauch, S. L., & Pizzagalli, D. A. (2014). Peril and pleasure: An RDoC-inspired examination of threat responses and reward processing anxiety and depression. *Depression and Anxiety, 3*, 233–249.

Duffy, M. E., Stewart-Knox, B. J., McConville, C., Bradbury, I., O'Connor, J., Helander, A., et al. (2006). The relationship between whole blood serotonin and subjective mood in apparently healthy postmenopausal women. *Biological Psychiatry, 73*(2), 165–168.

Ehrenreich, J. T., Goldstein, C. M., Wright, L. R., & Barlow, D. H. (2009). Development of a unified protocol for the treatment of emotional disorders in youth. *Child and Family Behavior Therapy, 31*(1), 20–37.

Ehrenreich-May, J. T. & Bilek, E. L. (2012). The development of a transdiagnostic, cognitive behavioral group intervention for childhood anxiety disorders and co-occuring depression symptoms. *Cognitive and Behavioral Practice, 19*, 41–55.

Ellard, K. K., Fairholme, C. P., Boisseau, C. L., Farchione, T. J., & Barlow, D. H. (2010). Unified protocol for the transdiagnostic treatment of emotional disorders: Protocol development and initial outcome data. *Cognitive and Behavioral Practice, 17*, 88–101.

Fairburn, C. G., Cooper, Z., & Shafran, R. (2003). Cognitive behavioural treatment for eating disorders: A transdiagnostic theory and treatment. *Behaviour Research and Therapy, 41*, 509–528.

Fairholme, C. P., Nosen, E. L., Nillni, Y. I., Schumacher, J. A., Tull, M. T., & Coffey, S. F. (2013). Sleep disturbance and emotion dysregulation as transdiagnostic processes in a comorbid sample. *Behaviour Research and Therapy, 51*, 540–546.

Farchione, T. J., Fairholme, C. P., Ellard, K. K., Boisseau, C. L., Thompson-Hollands, J., Carl, J. R., et al. (2012). Unified protocol for transdiagnostic treatment of emotional disorders: A randomized controlled trial. *Behavior Therapy, 43*, 666–678.

Flynn, M., & Rudolph, K. D. (2010). The contribution of deficits in emotional clarity to stress responses and depression. *Journal of Applied Developmental Psychology, 31*(4), 291–297.

Frewin, P. A., Pain, C., Dozois, D. J. A., & Lanius, R. A. (2006). Alexithymia in PTSD: fMRI and psychometric studies. *Annals of the New York Academy of Sciences, 1071*, 397–400.

Frijda, N. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.

Garland, E., Fredrickson, B., Kring, A. M., Johnson, D. P., Meyer, P. S., & Penn, D. L. (2010). Upward spirals of positive emotions counter downward spirals of negativity: Insights from the broaden-and-build theory and affective neuroscience on the treatment of emotion dysfunction and deficits in psychopathology. *Clinical Psychology Review, 30*, 849–864.

Gilboa-Schechtman, E., Avnon, L., Zubery, E., & Jeczmien, P. (2006). Emotional processing in eating disorders: Specific impairment or general distress related deficiency? *Depression and Anxiety, 23*(6), 331–339.

Gratz, K. L., & Roemer, L. (2004). Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the difficulties in emotion regulation scale. *Journal of Psychopathology and Behavioral Assessment, 26*, 41–54.

Gratz, K. L., Rosenthal, M. Z., Tull, M. T., Lejuez, C. W., & Gunderson, J. G. (2006). An experimental investigation of emotion dysregulation in borderline personality disorder. *Journal of Abnormal Psychology, 115*, 850–855.

Greenberg, L. S. (2002a). *Emotion-focused therapy: Coaching clients to work through their feelings*. Washington, DC: American Psychological Association.

Greenberg, L. S. (2002b). Integrating and emotion-focused approach to treatment into psychotherapy integration. *Journal of Psychotherapy Integration, 12*, 154–189.

Greenberg, L. S. (2004). Emotion-focused therapy. *Clinical Psychology and Psychotherapy, 11*, 3–16.

Greenberg, L. S., & Safran, J. D. (1987). *Emotion in psychotherapy*. New York: Guilford Press.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*, 271–299.

Gross, J. J., & Muñoz, R. F. (1995). Emotion regulation and mental health. *Clinical Psychology: Science and Practice, 2*, 151–164.

Gruber, J. (2011). Can feeling too good be bad?: Positive emotion persistence (PEP) in bipolar disorder. *Current Directions in Psychological Science, 20*, 217–221.

Harvey, A., Watkins, E., Mansell, W., & Shafran, R. (2004). *Cognitive behavioural processes across psychological disorders: A transdiagnostic approach to research and treatment*. New York: Oxford University Press.

Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (1999). *Acceptance and commitment therapy: An experiential approach to behavior change*. New York: Guilford Press.

Hooley, J. M., Richters, J. E., Weintraub, S., & Neale, J. M. (1987). Psychopathology and marital distress: The positive side of positive symptoms. *Journal of Abnormal Psychology, 96*, 27–33.

Huperich, S. K. (2005). Differentiating avoidant and depressive personality disorders. *Journal of Personality Disorders, 19*, 659–673.

Insel, T. (2009). Translating scientific opportunity into public health impact: A strategic plan on mental illness. *Archives of General Psychiatry, 66*, 128–133.

Insel, T., Cuthbert, G., Garvey, M., Heinssen, R., Pine, D. S., Quinn, K., et al. (2010). Research domain criteria (RDoc): Toward a new classification framework for research on mental disorders. *American Journal of Psychiatry, 167*, 748–751.

Johnson, N. G. (2001, April). President's column: Psychology's mission includes health: An opportunity. *Monitor on Psychology, 32*(4), 5.

Johnson, S. L., Edge, M. D., Holmes, M. K., & Carver, C. S. (2012). The behavioral activation system and mania. *Annual Review of Clinical Psychology, 8*, 243–267.

Kassel, J. D., Stroud, L. R., & Paronis, C. A. (2003). Smoking, stress, and negative affect: Correlation, causation, and context across stages of smoking. *Psychological Bulletin, 129*, 270–304.

Kaye, W. H., Greeno, C. G., Moss, H., Fernstrom, J., Lilenfeld, L. R., Wahlund, B., et al. (1998). Alterations in serotonin activity and platelet monoamine oxidase and psychiatric symptoms after recovery from bulimia nervosa. *Archives of General Psychiatry, 55*, 927–935.

Keltner, D., & Kring, A. M. (1998). Emotion, social function, and psychopathology. *Review of General Psychology, 2*, 320–342.

Kendall, P. C. (1998). Empirically supported psychological therapies. *Journal of Consulting and Clinical Psychology, 66*, 3–6.

Kessler, R. C., Chiu, W. T., Demler, O., & Walters, E. (2005). Prevalence, severity, and comorbidity of 12 month DSM-IV disorders in the National Comorbidity Survey replication. *Archives of General Psychiatry, 62*, 617–627.

Kessler, R. C., McGonagle, K. A., Zhao, S., Nelson, C. B., Hughes, M., Eshleman, S., et al. (1994). Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: Results from the National Comorbidity Survey. *Archives of General Psychiatry, 51*, 8–19.

Krause, R., Steimer-Krause, E., & Hufnagel, H. (1992). Expression and experience of affects in paranoid schizophrenia. *Revue Européenne de Psychologie Appliquée, 42*, 131–138.

Kring, A. M. (2001). Emotion and psychopathology. In T. J. Mayne & G. Bonanno (Eds.), *Emotion: Current issues and future directions* (pp. 337–360). New York: Guilford Press.

Kring, A. M., & Bachorowski, J.-A. (1999). Emotion and psychopathology. *Cognition and Emotion, 13*, 575–599.

Kring, A. M., & Barch, D. M. (2014). The motivation and pleasure dimension of negative symptoms: Neural substrates and behavioral outputs. *European Neuropsychopharmacology, 24*, 725–736.

Kring, A. M., Barrett, L. F., & Gard, D. E. (2003). On the broad applicability of the circumplex: Representations of affective knowledge in schizophrenia. *Psychological Science, 14*, 207–214.

Kring, A. M., & Elis, O. (2013). Emotion deficits in people with schizophrenia. *Annual Review of Clinical Psychology, 9*, 409–433.

Kring, A. M., Germans Gard, M., & Gard, D. E. (2011). Emotion deficits in schizophrenia: Timing matters. *Journal of Abnormal Psychology, 120*, 79–87.

Kring, A. M., & Moran, E. K. (2008). Emotional response deficits in schizophrenia: Insights from affective science. *Schizophrenia Bulletin, 34*, 819–834.

Kring, A. M., Persons, J. B., & Thomas, C. (2007). Changes in affect during treatment for depression and anxiety. *Behaviour Research and Therapy, 45*, 1753–1764.

Kring, A. M., & Sloan, D. S. (Eds.). (2009). *Emotion regulation and psychopathology: A transdiagnostic approach to etiology and treatment*. New York: Guilford Press.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1990). Emotion, attention, and the startle reflex. *Psychological Review, 97*, 377–395.

Levenson, R. W. (1994). Human emotion: A functional view. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion* (pp. 123–126). New York: Oxford University Press.

Lindquist, K. A., & Barrett, L. F. (2012). A functional architecture of the human brain: Insights from emotion. *Trends in Cognitive Sciences, 16*, 533–540.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*, 121–143.

Linehan, M. M. (1993). *Cognitive-behavioral treatment of borderline personality disorder.* New York: Guilford Press.

Lundh, L.-G., & Broman, E.-L. (2006). Alexithymia and insomnia. *Personality and Individual Differences, 40*, 1615–1624.

Lydiard, R. B., & Monnier, J. (2004). Pharmacological treatment. In R. G. Heimberg, C. L. Turk, & D. S. Mennin (Eds.), *Generalized anxiety disorder* (pp. 351–381). New York: Guilford Press.

Mauss, I., Levenson, R. W., McCarter, L., Wilhelm, F., & Gross, J. J. (2005). The tie that binds?: Coherence among emotion experience, behavior, and physiology. *Emotion, 5*, 175–190.

McEvoy, P. M., Nathan, P., & Norton, P. J. (2009). Efficacy of transdiagnostic treatments: A review of published outcome studies and future research directions. *Journal of Cognitive Psychotherapy: An International Quarterly, 23*, 20–33.

Mennin, D. (2004). Emotion regulation therapy for generalized anxiety disorder. *Clinical Psychology and Psychotherapy, 11*, 17–29.

Mennin, D. S., Ellard, K. K., Fresco, D. M., & Gross, J. J. (2013). United we stand: Emphasizing commonalities across cognitive-behavioral therapies. *Behavior Therapy, 44*, 324–348.

Mennin, D. S., & Fresco, D. M. (2009). Emotion regulation as an integrative framework for understanding and treating psychopathology. In A. M. Kring & D. M. Sloan (Eds.), *Emotion regulation in psychopathology: A transdiagnostic approach to etiology and treatment* (pp. 356–379). New York: Guilford Press.

Mennin, D. S., Holaway, R. M., Fresco, D. M., Moore, M. T., & Heimberg, R. G. (2007). Delineating components of emotion and its dysregulation in anxiety and mood psychopathology. *Behavior Therapy, 38*(3), 284–302.

Mesquita, B., & Karasawa, M. (2002). Different emotional lives. *Cognition and Emotion, 16*, 127–141.

Moran, E. K., Mehta, N., & Kring, A. M. (2012). Emotional responding in depression: Distinctions in the time course of emotion. *Cognition and Emotion, 26*, 1153–1175.

Nathan, P. E., & Gorman, J. M. (Eds.). (2002). *A guide to treatments that work*. London: Oxford University Press.

Nigg, J. T. (2013). Attention deficits and hyperactivity-impulsivity: What have we learned, what next? *Development and Psychopathology, 25*, 1489–1503.

Norton, P. J., Hayes, S. A., & Hope, D. A. (2004). Effects of a transdiagnostic group treatment for anxiety disorders on secondary depression. *Depression and Anxiety, 20*, 198–202.

Parker, J. D. A., Taylor, G. J., Bagby, R. M., & Acklin, M. W. (1993). Alexithymia in panic disorder and simple phobia: A comparative study. *American Journal of Psychiatry, 150*, 1105–1107.

Patrick, C. J. (1994). Emotion and psychopathy: Startling new insights. *Psychophysiology, 31*, 319–330.

Patrick, C. J., Bradley, M. M., & Lang, P. J. (1993). Emotion in the criminal psychopath: Startle reflex modulation. *Journal of Abnormal Psychology, 102*, 82–92.

Patrick, C. J., Cuthbert, B. N., & Lang, P. J. (1994). Emotion in the criminal psychopath: Fear image processing. *Journal of Abnormal Psychology, 103*, 523–534.

Persons, J. B. (2005). Empiricism, mechanism, and the practice of cognitive-behavior therapy. *Behavior Therapy, 36*, 107–118.

Persons, J. B., Roberts, N. A., & Zalecki, C. (2003). Anxiety and depression change together during treatment. *Behavior Therapy, 34*, 149–163.

Putnam, K. M., & Silk, K. R. (2005). Emotion dysregulation and the development of borderline personality disorder. *Development and Psychopathology, 17*, 899–925.

Rinne, T., van den Brink, W., Wouters, L., & van Dyck, R. (2002). SSRI treatment of borderline personality disorder: A randomized, placebo-controlled clinical trial for female patients with borderline personality disorder. *American Journal of Psychiatry, 159*, 2048–2054.

Robinson, T. E., & Berridge, K. C. (2008). The incentive sensitization theory of addiction: Some current issues. *Philosophical Transactions of the Royal Society of London B: Biological Sciences, 363*, 3137–3146.

Rosen, G. M., & Davison, G. C. (2003). Psychology should list empirically supported principles of change (ESPs) and not credential trademarked therapies or other treatment packages. *Behavior Modification, 27*, 300–312.

Rottenberg, J., & Gross, J. J. (2003). When emotion goes wrong: Realizing the promise of affective science. *Clinical Psychology: Science and Practice, 10*, 227–232.

Rottenberg, J., & Johnson, S. L. (Eds.). (2007). *Emotion and psychopathology: Bridging affective and clinical science*. Washington, DC: American Psychological Association.

Rottenberg, J., Kasch, K. L., Gross, J. J., & Gotlib, I. H. (2002). Sadness and amusement reactivity differentially predict concurrent and prospective functioning in major depressive disorder. *Emotion, 2*, 135–146.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*, 145–172.

Sanislow, C., Pine, D. S., Quinn, K. J., Kozak, M. J., Garvey, M. A., Heinssen, R. K., et al. (2010). Developing constructs for psychopathology research: Research domain criteria. *Journal of Abnormal Psychology, 119*, 631–639.

Sauer, S., & Baer, R. A. (2009). Responding to negative internal experience: Relationships between acceptance and change-based approaches and psychological adjustment. *Journal of Psychopathology and Behavior Assessment, 31*(4), 378–386.

Sauer-Zavala, S., Boswell, J. F., Gallagher, M. W., Bentley, K. H., Ametaj, A., & Barlow, D. H. (2012). The role of negative affectivity and negative reactivity to emotions in predicting outcomes in the unified protocol for the transdiagnostic treatment of emotional disorders. *Behaviour Research and Therapy, 50*, 551–557.

Shankman, S. A., Nelson, B. D., Sarapas, C., Robison-Andrew, E. J., Campbell, M. L., Altman, S. E., et al. (2013). A psychophysiological investigation of threat and reward sensitivity in individuals with panic disorder and/or major depressive disorder. *Journal of Abnormal Psychology, 122*(2), 322–328.

Speranza, M., Corcos, M., Stéphan, P., Loas, G., Pérez-Diaz, F., Lang, F., et al. (2004). Alexithymia, depressive experiences, and dependency in addictive disorders. *Substance Use and Misuse, 39*, 567–595.

Stein, M. B., Liebowitz, M. R., Lydiard, R. B., Pitts, C. D., Bushnell, W., & Gergel, I. (1998). Paroxetine treatment of generalized social phobia (social anxiety disorder): A randomized clinical trial. *Journal of the American Medical Association, 280*, 708–713.

Steketee, G., & Barlow, D. H. (2002). Obsessive–compulsive disorder. In D. H. Barlow (Ed.), *Anxiety and its disorders: The nature and treatment of anxiety and panic* (pp. 516–550). New York: Guilford Press.

Stice, E. (2001). A prospective test of the dual-pathway model of bulimic pathology: Mediating effects of dieting and negative affect. *Journal of Abnormal Psychology, 110*, 124–135.

Svenningsson, P., Tzavara, E. T., Witkin, J. M., Fienberg, A. A., Nomikos, G. G., & Greengard, P. (2002). Involvement of striatal and extrastriatal DARPP-32 in biochemical and behavioral effects of fluoxetine (Prozac). *Proceedings of the National Academy of Sciences of the USA, 99*, 3182–3187.

Thase, M. E., Jindal, R., & Howland, R. H. (2002). Biological aspects of depression. In C. L. Hammen & I. H. Gotlib (Eds.), *Handbook of depression* (pp. 192–218). New York: Guilford Press.

Tomarken, A. J., & Keener, A. D. (1998). Frontal brain asymmetry and depression: A self-regulatory perspective. *Cognition and Emotion, 12*, 387–420.

Tsao, J. C. I., Mystkowski, J. L., Zucker, B. G., & Craske, M. G. (2002). Effects of cognitive behavioral therapy for panic disorder on comorbid conditions: Replication and extension. *Behaviour Therapy, 33*, 493–509.

Turk, C. L., Heimberg, R. G., Luterek, J. A., Mennin, D. S., & Fresco, D. M. (2005). Emotion dysregulation in generalized anxiety disorder: A comparison with social anxiety disorder. *Cognitive Therapy and Research, 29*, 89–106.

Ursu, S., Kring, A. M., Germans Gard, M., Minzenberg, M., Yoon, J., Ragland, D., et al. (2011). Prefrontal cortical deficits and impaired cognition-emotion interactions in schizophrenia. *American Journal of Psychiatry, 168*, 276–285.

Van Ameringen, M. A., Lane, R. M., Walker, J. R., Bowen, R. C., Chokka, P. R., Goldner, E. M., et al. (2001). Sertraline treatment of generalized social phobia: A 20-week, double-blind, placebo-controlled study. *American Journal of Psychiatry, 158*, 275–281.

Vine, V., & Aldao, A. (2014). Impaired emotional clarity and psychopathology: A transdiagnostic deficit with symptom-specific pathways through emotion regulation. *Journal of Social and Clinical Psychology, 33*, 319–342.

Walker, E. F., Grimes, K. E., Davis, D. M., & Smith, A. J. (1993). Childhood precursors of schizophrenia: Facial expressions of emotion. *American Journal of Psychiatry, 150*, 1654–1660.

Walsh, B. T., Agras, S. W., Devlin, M. J., Fairburn, C. G., Wilson, G. T., Kahn, C., et al. (2000). Fluoxetine for bulimia nervosa following poor response to psychotherapy. *American Journal of Psychiatry, 157*, 1332–1334.

Watson, D. (2005). Rethinking the mood and anxiety disorders: A quantitative hierarchical model for DSM-V. *Journal of Abnormal Psychology, 114*, 522–536.

Westen, D. (1991). Cognitive-behavioral interventions in the psychoanalytic psychotherapy of borderline personality disorders. *Clinical Psychology Review, 11*, 211–230.

Westen, D., Novotny, C. M., & Thompson-Brenner, H. (2004). The empirical status of empirically supported psychotherapies: Assumptions, findings, and reporting in controlled clinical trials. *Psychological Bulletin, 130*, 631–663.

White, K. S., & Barlow, D. H. (2002). Panic disorder and agoraphobia. In D. H. Barlow (Ed.), *Anxiety and its disorders: The nature and treatment of anxiety and panic* (pp. 328–379). New York: Guilford Press.

Wilson, M. (1993). DSM-III and the transformation of American psychiatry: A history. *American Journal of Psychiatry, 150*, 399–410.

Wolpe, J. (1958). *Psychotherapy by reciprocal inhibition*. Stanford, CA: Stanford University Press.

Wrase, J., Reimold, M., Puls, I., Kienast, T., & Heinz, A. (2006). Serotonergic dysfunction: Brain imaging and behavioral correlates. *Cognitive, Affective, and Behavioral Neuroscience, 6*, 53–61.

Zald, D. H., & Depue, R. A. (2001). Serotonergic functioning correlates with positive and negative affect in psychiatrically healthy males. *Personality and Individual Differences, 30*, 71–86.

CHAPTER 39

The Clinical Application of Emotion in Psychotherapy

Leslie S. Greenberg

This chapter addresses the emerging focus on emotion in psychotherapy. Given that emotion is now seen as information (i.e., as signaling the significance of a situation to a person's well-being), and that affect regulation is seen as a key human motivation, it has become clear that emotion needs to be focused on, validated, and worked with directly in therapy to promote emotional change (Greenberg, 2002; Samoilov & Goldfried, 2000; Fosha, 2000). The idea that accessing and exploring painful emotions, within the context of a secure therapeutic relationship, makes one feel better is currently widely held by several schools of psychotherapy but during the past it had been difficult to prove.

In the prior decades, influenced by the cognitive revolution in psychology, emotion in therapy was seen by cognitive therapy as postcognitive and often a function of error (Beck, 1976; Ellis, 1994) and by the behavioral therapies as needing to be modified or regulated to prevent being overwhelmed (Linehan, 1993). This often led to interventions involving reasoning to correct error and psychoeducation to teach ways of managing emotion. However, exposure to fear—which involved activating the emotion—was also used and was viewed as resulting in decreasing intensity or eliminating the emotion by desensitization, habituation, or extinction rather than by actually changing the emotion. Psychoanalytic theories initially viewed emotion as discharge and saw catharsis of blocked emotion as curative (Freud, 1915/1957). Psychoanalysts later saw reflection on and understanding the source of emotions and more recently mentalization of emotion (the ability to reflect on that one has emotion) as curative (Maroda, 2009; Bateman & Fonagy, 2004). However, another more interpersonal view sees emotions as needing to be evoked with the therapist to provide a corrective emotional experience that changes the emotion (Mitchell, 1988; Castonguay & Hill, 2012). Humanistic views saw emotions as basically healthy expressions of the self that needed to be brought to awareness, experienced, and reowned (Rogers, 1951; Perls, 1969). Very few tests of the different proposed mechanisms were done except for depth of experiencing, which was shown to relate to outcome in many studies (Elliott, Greenberg, & Lietaer, 2004). Thus, although cognitive-behavior therapy (CBT) has shown treatment outcome effects, no convincing evidence has shown that cognitive change is the actual mechanism of change. However, over the last decades, newer therapeutic approaches that treat emotion as a primary target of intervention and work on changing emotion within the context of an empathic relationship have been developed and tested.

This chapter begins with a brief review of the results of evidence-based studies of the efficacy of emotion-focused treatment of mood disorders, personality disorders, and trauma. Principles of emotion assessment and emotional change processes are discussed, and evidence on the change processes are reviewed. These principles provide a map for differential intervention with emotion by showing that different classes of emotions in therapy benefit from different types of interventions—ranging from awareness of adaptive emotions through regulation of dysregulated emotions to transformation of maladaptive emotions. The chapter concludes with a discussion of different methods of activating new emotional responses to change habitual problematic emotional responses.

Evidence-Based Treatment

A number of treatment approaches that focus on painful emotions have been demonstrated to be effective in randomized clinical trials (Elliott et al., 2004; Greenberg & Pascual-Leone, 2006; Whelton, 2004). Emotion-focused therapy (EFT) for depression (Greenberg & Watson, 2006) has been found to be highly effective in treating depression in three separate studies (Greenberg & Watson, 1998; Goldman, Greenberg, & Angus, 2006; Watson, Gordon, Stermac, Kalogerakos, & Steckley, 2003). In these studies, EFT was found to be as effective as, or more effective on some indices, than either a purely relational empathic treatment or CBT. Both the treatments with which EFT was compared were themselves also found to be highly effective in reducing depression, but EFT was found to be more effective in both reducing interpersonal problems and promoting change in symptoms than the purely relational treatment and more effective in preventing relapse (Greenberg & Watson, 1998; Goldman et al., 2006; Ellison, Greenberg, Goldman, & Angus, 2009). EFT was also found to be equally effective to CBT in symptom reduction and more effective in reducing interpersonal problems (Watson et al., 2003), which could have implications for relapse given the strong role of interpersonal factors in depression.

The objective of EFT is to access and restructure the habitual maladaptive emotional states that are seen as the source of dysfunctions such as the depression. This involves accessing feelings of shame-based worthlessness, anxious dependence, powerlessness, abandonment, and invalidation, and transforming these through accessing adaptive emotions (such as healthy grief and empowering anger), as well as reflecting on emotional experience to create new meaning and develop new narratives. This process of emotional change is aided by the use of specific therapeutic techniques that help stimulate both the arousal and processing of emotion. Various experiential interventions are used to engage patients in emotion processing in session. For example, in two-chair dialogue, two parts of the self—one the internal self-critical voice and the other the responding, experiencing self—are put into contact with each other in response to in-session statements of self-critical conflicts. In empty-chair dialogue, in response to in-session statements of unresolved feelings toward a significant other, the self expresses previously unexpressed feeling to the imagined other, and focuses attention on bodily felt meaning in response to an unclear felt sense

Short-term dynamic therapy, which works on overcoming defenses and treats affect phobia by exposure to dreaded emotion, has been found to be effective in treating personality disorders in two studies (Winston et al., 1994; Svartberg, Stiles, & Seltzer, 2004). EFT for adult survivors of childhood abuse, which uses empathy plus empty-chair work and involves the arousal and processing of painful emotions, has been found effective in treating abuse (Paivio & Nieuwenhuis, 2001). Emotionally focused couple therapy (Greenberg & Johnson, 1988; Johnson, 1996), which involves partners' revealing their underlying attachment- and identity-related vulnerable feelings to each other, has been found to be effective in treating couples' distress (Johnson, Hunsley, Greenberg, & Schindler, 1999). In addition, versions of CBT based on exposure to imaginal stimuli have been shown to be effective for posttraumatic stress disorder (PTSD) and other anxiety disorders (Borkovec, Alcaine, & Behar, 2004; Shapiro, 1999). Finally, therapy based on an avoidance theory in which worry is understood as a cognitive response that orients individuals to a threat, while insulating them from the immediacy of their emotional experience, has recently gained support (Borkovec et al., 2004).

A recent study examining the therapists' stance in interpersonal therapy (IPT) and CBT for depression showed the importance of focusing on emotion, regardless of orientation. This study (Coombs, Coleman, & Jones, 2002) found that collaborative emotional exploration (which occurred significantly more frequently in IPT) was found to relate positively to outcome in both forms of therapy, whereas educative/directive process (which was more frequent in CBT) had no relationship to outcome. Helping people overcome their avoidance of emotions, focusing collaboratively on emotions, and exploring them in therapy thus appears to be important in therapeutic change, whichever therapeutic orientation is employed. What is needed now is a more differentiated understanding of how to work with emotion. A differential approach to assessment and intervention has recently emerged.

Differential Emotion Assessment and Intervention

In assessing and working with emotion in therapy, it is helpful to make certain distinctions between different types of emotional experiences and expressions, which require different types of in-session interventions. This involves differentiating between "primary" emotions and "secondary" or "reactive" emotions, and between "adaptive" and "maladaptive" emotional experiences (Greenberg, 2002). Primary emotions are people's first, gut-level emotional responses to situations. These responses need to be accessed and assessed for whether they provide adaptive information and the capacity to organize action, or whether they are maladaptive. Maladaptive emotions are learned responses that are not appropriate to current situations and thus are no longer adaptive; these emotions need to be regulated and transformed. Secondary emotions are those responses that are secondary to other, more primary internal processes and may be defenses against these, such as feeling ashamed of one's sadness or hopeless when angry. Secondary maladaptive emotions need to be explored to access their more primary cognitive or emotional generators. These distinctions between different types of emotions thus provide clinicians with a map for differential intervention with emotions.

The Dualities of Emotion

Clinicians have had to recognize that to work with emotion therapeutically, they need to treat emotion processing not as singular phenomenon but to adopt, at least, dual views of emotional processing. The first duality is that emotions serve both *informational* and *hedonic* functions. Emotions are both carriers of knowledge and givers of pleasure/pain. A second duality lies in the difference between automatically activated amygdala-based, "low"-road emotions and "high"-road emotions that involve more deliberate prefrontal cortex processing (Le Doux, 1996).

Feelings in their informational aspect act as a form of knowing that provide us with immediate, intimate, personally meaningful information about ourselves and others in an unmediated and personally specific manner. They need *articulation*, as this sharpens and clarifies what is felt and promotes self-understanding. There comes a point, however, when feelings change their function. Given the powerful dimension of feelings as pleasure/pain, they can lose their meaning giving function and become overwhelming or destructive experiences. These are more like the passions the Stoics wanted to rid us of, although they seemed more concerned with freeing us from the appetitive functions of the passions than the pain itself. The hedonic aspects of feelings carry suffering and pain at intensities that cannot be tolerated (or feelings of pleasure beyond description), can produce intolerable experiences, be a danger to psychological existence, and can become a source of threat and trauma. In these cases, they need to be regulated to preserve a sense of self-coherence.

The second duality important in working with emotion stems from the different ways in which emotion is produced. Low-road emotional processing is automatic and holistic, and occurs out of our control like the passions of which we are the passive recipients. When functioning well, however, these emotions are a source of adaptive intelligence. They can be brought to awareness and help us orient to the environment. When dysfunctional, these emotions need to be accessed to change them. Low-road emotions, when dysfunctional, need to be worked by using principles of *emotional change* designed to deal with the automatic, prereflective, bodily felt nature of emotion (Greenberg, 2012).

On the other hand, emotion produced by high-road processing is far more cognitively derived and culturally influenced. Reason is involved in both its generation and change, and dysfunction in this system is based on cognitive error; change involves *cognitive change* principles designed to deal with errors in reasoning or learning. Those problems based on deliberate processes such as faulty thinking, or skill deficits, are more likely to benefit from efficient psychoeducational and rational methods. These forms of intervention are aimed at changing things under more deliberate control such as clients' thinking and learned behavior, and promoting the practice of new coping skills.

However, where reason cannot penetrate, cognitive and psychoeducative methods that appeal to reason and deliberate processing will not work, and emotional change processes will be needed. Change in the domain of amygdala-based emotion (Whalen & Phelps, 2009) involves both awareness of emotion and its transformation. Awareness is facilitated by approaching and attending to the emotion, tolerating it, symbolizing it—most often with words—and becoming aware of the "cues" that trigger it. Transformation occurs by activating problematic maladaptive emotions and both exposing them to new opposing emotions, and constructing new narrative meanings to create coherence and consolidate the felt change into a new account.

With the advent of the view of emotion as an adaptive resource and a meaning system—rather than as something that needs to be got rid of cathartically, modified, or corrected by reason—the understanding of emotion's role in human relationships and psychotherapy has changed. This "new look" has begun to set a new agenda for psychological research: to determine under what conditions emotions play a determining role in the human experience and how this occurs. The question especially relevant to psychotherapy is how can therapists best facilitate change in emotions themselves, treating emotion as independent variables that exist as such, rather than being secondary to cognition.

Principles of Working with Emotion

Outcome and process research findings point toward emotional processing as centrally important to good therapy, but what good processing is actually remains to be elucidated. Emotional insight, catharsis, awareness, and exposure have all been put forward as explanations of the role of emotion in change, but there is still not a comprehensive, empirically based understanding of how emotion and its processing lead to change. The following five principles provide an empirically based understanding of emotional change processes in clinical change: (1) increasing awareness of emotion, (2) expressing emotion, (3) enhancing emotion regulation, (4) reflecting on emotion, and (5) transforming emotion (Greenberg, 2002; Greenberg & Watson, 2006).

Emotion Awareness

The first and most general goal of emotional change is for clients to become aware of their emotions in general and their primary adaptive emotions in particular. Increased emotion awareness is therapeutic in a variety of ways. Becoming aware of core emotional experience and symbolizing it in words provides access to both the adaptive information and action tendency in the emotion. Labeling emotions is often a first step in problem definition. It is important to note that emotion awareness is not thinking about feeling; it involves feeling the feeling in awareness. Only once an emotion is felt does its articulation in language become an important component of its awareness.

The therapist thus needs to help clients approach, tolerate, and accept their emotions. Acceptance of emotional experience as opposed to its avoidance is the first step in awareness work. Once clients have accepted their emotions rather than avoided them, the therapist then helps the clients in the utilization of emotion to improve coping—that is, clients are helped to make sense of what each emotion is telling them and to identify the goal/need/concern that it is organizing them to attain. Emotion is thus used both to inform and to move.

A measure of levels of emotion awareness has been developed by Lane and Schwartz (1992). Five such levels can be measured. In ascending order, these are physical sensations, action tendencies, single emotions, blends of emotions, and blends of blends of emotional experience (the capacity to appreciate complexity in the experiences of self and other). The dynamic interactions among phenomenal experience, establishing a representation of it, elaborating that representation (e.g., identifying the source of the emotional response), and integrating it with other cognitive processes are the fundamental processes involved in the cognitive elaboration of emotion and addressed by the levels of this measure. Scores on the measure have been found to correlate significantly with self-reported self-restraint and impulse control. Individual differences in emotion awareness have also been found to predict recovery of positive mood and decrements in ruminative thoughts following a distressing stimulus (Salovey, Mayer, Golman, Turvey, & Palfai, 1995).

Awareness of emotion also involves overcoming the avoidance of emotional experience. There is a strong human tendency to avoid or interrupt painful emotions. Normal cognitive processes often deny, distort, or interrupt emotion and transform adaptive but unpleasant emotions into dysfunctional behaviors designed to avoid feeling. Leahy (2002) has defined "emotional schemas" as cognitive structures that frame the interpretation of emotional experience and guide the strategies used in coping with emotion. He has noted that there are two fundamental coping pathways for dealing with emotion. One involves attending to and labeling emotions in a manner that accepts and normalizes them; the other pathway pathologizes some emotional experiences, and this leads to attempts to distort or avoid them (initiating guilt, frantic efforts at control, obsessive rumination, etc.). To overcome emotion avoidance, clients must first be helped to approach emotions by attending to their emotional experience. This often involves changing the cognitions governing their avoidance. Then clients must allow and tolerate being in live contact with their emotions. These two steps are consistent with notions of exposure.

Emotional Arousal and Expression

Emotional expression has recently been shown to be a unique aspect of emotional processing that predicts adjustment to breast cancer (Stanton et al., 2000). Women who coped with cancer through expressing emotion had fewer medical appointments, enhanced physical health and vigor, and less distress than those low in emotional expression. Expressive coping was also related to increased quality of life for those who perceived their social environment to be highly receptive. Analyses further suggested that expressive coping enhanced the pursuit of goals, perhaps by helping clients attend to and clarify central concerns, but that this relationship was mediated by hope. Emotional arousal and its expression in therapeutic contexts thus appears to constitute a therapeutic aspect of emotional processing. Expressing emotion in therapy does not involve simply venting emotion, but rather overcoming avoidance of, strongly experiencing, and expressing previously constricted emotions.

There is a long line of evidence on the effectiveness of arousal of and exposure to previously avoided feelings as a mechanism of change. Results from a variety of studies indicate that emotional engagement (fear expression) with trauma memories during exposure in early sessions, and habituation (reduced distress) during exposure over the course of therapy, predict better outcome (Foa & Jaycox, 1999; Jaycox, Foa, & Morral, 1998). Emotional engagement with trauma memories early in therapy appears to be important in overcoming trauma. However, only a subgroup of individuals are able to engage in the exposure technique and therefore maximally benefit from therapy (Jaycox et al., 1998). Pretreatment severity of PTSD symptoms is also associated with engagement difficulties and poorer outcome. Foa, Zoellner, Feeny, Hembree, and Alvarez-Conrad (2002) have shown that although imaginal exposure, which arouses strong emotion, can exacerbate symptoms in some clients, it does this in relatively few cases, and even then this does not impede a long-term positive outcome. Overall, a chain of factors beginning with trauma symptom severity through initial engagement in imaginal exposure, activation of the fear structure, and repeated exposure while providing new information, appears to predict outcome (Jaycox et al., 1998).

However, studies on exposure and arousal do not take into account the importance to the client of the change in the therapeutic relationship. In a process–outcome study evaluating EFT for adult survivors of childhood abuse (Paivio, Hall, Holowaty, Jellis, & Tran, 2001), the therapeutic alliance, initial engagement in the primary imaginal confrontation intervention, the overall dosage of this intervention (quality × frequency), and client predisposing variables all contributed to reduced global and trauma-specific symptomatology and interpersonal problems. The effect of emotional arousal in therapy also depends on the quality of the working alliance. Beutler, Clarkin, and Bongar (2000) studied several therapies in an attempt to match patient variables with treatments. Across modalities, emotional intensity of sessions was a strong predictor of outcome, but this effect was mediated by the working alliance. Likewise, Iwakabe, Rogan, and Stalikas (2000) documented that high arousal predicted good session outcome only when there was a strong alliance.

Learning to contain and regulate strong emotions is central to adaptive emotional arousal and expression, and these skills are often lacking in people seeking therapy. The ability to regulate emotion is believed to emerge from early attachment experiences of validation, soothing, and safety, and involves attending to emotions and dampening or expressing them as appropriate. The emotional validation and empathy of the therapist seem to be particularly important in allowing clients with dysregulated emotions to learn to self-soothe and restore emotional equilibrium (Greenberg, 2002).

It is clear that emotional arousal and expression are not always helpful or appropriate in therapy or in life, and that for some clients, training in the capacity for emotion regulation (see the section "Emotion Regulation") must precede or accompany it (Greenberg, 2002). Any benefits believed to accrue from the intense expression of emotion are generally predicated on the client's overregulation (overcontrol) or suppression of emotion

(Gross, 1999), but it is apparent that for some individuals with certain psychological disorders or in particular situations, emotions are under- or dysregulated (Linehan, 1993; Gross, 1999). Some support has been found for the cathartic expression of feeling in therapy, but only with certain people under specified circumstantial conditions (Pierce, Nichols, & DuBrin, 1983). Catharsis is not helpful all the time for all people. Process–outcome research on EFT for depression, however, has shown that higher expressed emotional arousal at midtreatment predicted positive treatment outcomes (Warwar, 2003). This supports the importance of expressed arousal as a key change process in these treatments. It is important to also note that this study measured *expressed* as opposed to *experienced* emotion. A follow-up study examining in-session client reports of experienced emotional intensity (Warwar, Greenberg, & Perepeluk, 2003) found that client reports of in-session experienced emotion were not related to positive therapeutic change. A discrepancy was observed between clients' reports of in-session experienced emotions and the emotions that were actually expressed, based on arousal ratings of videotaped therapy segments. For example, one client reported that she had experienced intense emotional pain and anger in a session. Her level of expressed emotional arousal, however, was judged to be very low by observers who rated emotional arousal from videotaped therapy segments. The therapeutic outcome here validated the difference between expressed and reported experiences in that it was only expressed emotion that predicted outcome.

Exposure methods have established a basis for understanding the emotional processing required for therapeutic change in the treatment of fear and anxiety. Hunt (1998), however, looked at emotional processing of depressive events and found that although greater short-term attention to negative feelings induced short-term emotional pain, those who went through this pain felt better in the long run than individuals who engaged in problem solving or avoided processing their feelings after the depressive event. This benefit was mediated by degree of emotional arousal, suggesting again that emotions must be "up and running" and must be experienced for beneficial emotional processing to occur. Evidence has also been found supporting the specific effectiveness of arousing and expressing *anger* in the treatment of depression and traumatic sexual abuse (Beutler et al., 1991; Van Velsor & Cox, 2001). Anger can be a means for survivors of sexual abuse to develop self-efficacy, heal memories, and correctly attribute blame. In these studies, arousal and expression of anger was related to the development of agency, self-efficacy, and self-assertion. In a review of research literature related to the benefits and dangers of reexperiencing painful emotion in therapy, Littrell (1998) concluded that when therapy is designed to allow for the planned restructuring of painful memories, the reexperience of pain in therapy has been demonstrated to be beneficial and therapeutic.

Pierce et al. (1983) found that catharsis was therapeutically useful only under very specific circumstances and only for certain people. There can be no universal rule about the effectiveness of arousing emotion or evoking emotional expression. The role of arousal and the degree to which it may be useful in therapy depend on what emotion is expressed and about what issue; how it is expressed, by whom, to whom, when, and under what conditions; and in what way the emotional expression is followed by other experiences of affect and meaning (Whelton, 2004). Nonetheless, the evidence suggests that emotional processing is mediated by arousal, so that for emotion processing to occur, the distressing affective experience must be activated and viscerally experienced by the client. Arousal is necessary but not sufficient for therapeutic progress. Recently we (Greenberg, Auszra, & Herrmann, 2007; Auszra, Greenberg, & Herrmann, 2013) found that the productivity of processing of aroused emotions, rather than arousal alone, distinguished good from poor outcomes.

Emotion Regulation

The third principle of emotional processing involves the regulation of emotion. Important issues in any treatment are what emotions are to be regulated and how. Undercontrolled secondary emotions and maladaptive emotions are what need to be regulated. Clients with these types of underregulated affect have been shown to benefit both from validation and from the learning of specific emotion regulation and distress tolerance skills (Linehan, 1993).

The provision of a safe, validating, supportive, and empathic environment is the first level of intervention for automatically generated underregulated distress (Bohart & Greenberg, 1997). Linehan et al. (2002) found evidence for the effectiveness of emotional validation and soothing as part of the treatment for borderline personality disorder. Empathy from another person seems to be particularly important in learning to self-soothe, restore emotional equilibrium, and strengthen the self.

Emotion regulation skills—including such things as identifying and labeling emotions, allowing and tolerating emotions, establishing a working distance, increasing positive emotions, reducing vulnerability to negative emotions, self-soothing, breathing, and distraction—have also been found to help with high distress (Linehan, 1993). Particularly important among these skills are getting some distance from overwhelming shame, despair, hopelessness, and/or shaky vulnerability, and developing self-soothing capacities to calm and comfort core anxieties and humiliation. Forms of meditative practice and self-acceptance are often most helpful in achieving a working distance from overwhelming core emotions. The ability to regulate breathing, and to observe one's emotions and let them come and go, are important processes to help regulate emotional distress. Mindfulness treatments have been shown to be effective in treating generalized anxiety disorder and panic (Kabat-Zinn et al., 1992), treating chronic pain (Kabat-Zinn, Lipworth, Burney, & Sellers, 1986), and preventing relapse in depression (Teasdale et al., 2000).

Another important aspect of regulation, however, is developing clients' abilities to tolerate emotion and to self-soothe *automatically*. Such abilities can be developed at various levels of processing. Physiological soothing involves teaching clients to activate the parasympathetic nervous system to regulate heart rate, breathing, and other sympathetic functions that speed up under stress. At the more deliberate behavioral and cognitive levels, promoting clients' abilities to receive and be compassionate to their emerging painful emotional experience is the first step toward helping them develop automatic emotion tolerance and self-soothing. This form of self-soothing involves, among other things, diaphragmatic breathing, relaxation, and the development of self-empathy and self-compassion.

Soothing also comes interpersonally in the form of another's empathic attunement to one's affect and through acceptance and validation by another person. Internal security develops from feeling that one exists in the mind and heart of another, and the security of being able to soothe the self develops through internalizing the soothing functions of the protective other (Sroufe, 1996). It is also important to make a distinction in emotion work between intensity of emotion per se and the depth of processing of the emotion. It is the latter that is the aim in EFT, not the former, and the regulation of overwhelming emotional intensity is vital in promoting the required depth of processing of emotion.

Reflecting on Emotion

The fourth principle of emotional change is related to the first principle, emotion awareness, in that it involves making meaning of emotion. Reflection on emotion helps people make sense of their experience and promotes its assimilation into their ongoing self-narratives. What we make of our emotional experience makes us all who we are. In addition to the informational value of emotion awareness, symbolizing emotion in awareness promotes reflection on experience to create new meaning, and this helps people develop new narratives to explain their experience (Pennebaker, 1995; Greenberg & Angus, 2004). Understanding an emotional experience always involves putting it into narrative form. In therapy as well as in literature, all emotions occur in the context of significant stories, and all stories involve significant emotions (Greenberg & Angus, 2004). Therapy thus involves both change in emotional experiences and change in the narratives in which they are embedded.

In particular, symbolizing traumatic emotion memories in words helps promote their assimilation into people's ongoing self-narratives (van der Kolk, 1995). This process of verbalization allows *previously unsymbolized* experience in emotion memory to be assimilated into people's conscious, conceptual understandings of self and world, where it can be organized into a coherent story. Once such emotions are in words, they allow people to reflect on what they are feeling, create new meanings, and evaluate their own emotional experience. For example, reflecting on interpersonal difficulties and understanding that one is prone to get angry at one's partner because one is feeling abandoned, and that this relates to one's own history of abandonment rather than to the withholding nature of the partner, can be most therapeutic.

Pennebaker (1995) and colleagues have shown the positive effects of writing about emotional experience on autonomic nervous system activity, immune functioning, and physical and emotional health. Pennebaker (1995) concludes that through language, individuals are able to organize, structure, and ultimately assimilate both their emotional experiences and the events that may have provoked the emotions. Both insight and reframing of emotional experience have long been viewed as ways to change emotion. The role in psychotherapy of humans' capacity for conscious awareness of the processes and contents of their own minds, and for reason and insight to shed light on unconscious motivations, has been substantial—from the beginnings of psychoanalysis right up to the present day. In addition, many therapists have written on the importance of changing people's assumptive frameworks in therapy (see, e.g., Frank, 1961).

In a study of events in which problematic issues were resolved in session, Watson (1996) found that vivid descriptions, emotional arousal, and cognitive meaning making interacted in complex yet orderly stages to produce therapeutic change. Theses stages allowed for clients to reflect on the emotions they were experiencing. Similarly, Stalikas and Fitzpatrick (1995) did an intensive analysis of "good client moments" and showed that in-session change was related to the combination of strength of feeling and higher-order levels of reflection. In addition, computer-assisted studies of verbal patterns in psychodynamic and other therapies have shown that in the key moments in therapy in which substantial shifts happened, there was a frequent co-occurrence of high emotion tone (emotional arousal) and high abstraction (a reflection on this emotional process)—a beneficial co-occurrence that was called "making a connection" (Mergenthaler, 1996). It seems to be the timely conjunction of emotional arousal and a thoughtful exploration of the emotion's meaning that generates change.

Thus, as well as having emotions, we also live in a constant process of making sense of our emotions. A dialectical–constructivist view of human functioning has been offered to explain this process (Greenberg & Pascual-Leone, 1995, 2001; Neimeyer & Mahoney, 1995). In this view, personal meaning emerges from the self-organization and explication of one's own emotional experience, and optimal adaptation involves an integration of reason and emotion. This integration is achieved by an ongoing circular process of making sense of experience by symbolizing bodily felt sensations in awareness and articulating them in language, thereby constructing new ones.

In this dialectical–constructivist view, symbol and bodily felt referents are viewed as interacting to carry meaning forward, and newly symbolized experience is organized in different ways to construct new views. Attending to and discovering preconceptual elements of emotional experience influence the process of meaning construction. New experiential elements from many sources from within, and sometimes from without, can be integrated into this process. People are then viewed as constantly striving toward making sense of their preconceptual emotional experience by symbolizing it, explaining it, and putting it into narrative form. Preconceptual tacit meaning carries implications and acts to constrain, but does not fully determine, meaning. Rather, it is synthesized with conceptual, explicit meaning to form explanations constrained by experiencing (Greenberg & Pascual-Leone, 1995, 2001). This provides the ongoing narrative of a person's life.

Thus, although the recipe for emotional processing from the perspective of behavioral therapies and CBT is that arousal plus habituation to the distressing stimulus produces change, approach, arousal, acceptance, and tolerance of emotional experience are necessary but not sufficient from an EFT perspective. Optimum emotional processing involves in addition the integration of cognition and affect and the creation of new meaning (Greenberg, 2002; Greenberg & Pascual-Leone, 1995; Pos, Greenberg, Goldman, & Korman, 2003). Once contact with emotional experience is achieved, clients must also cognitively orient to that experience as information, and explore, reflect on, and make sense of it.

EFT appears to work by enhancing emotional processing, and this involves helping people both accept their emotions and make sense of them (Pos et al., 2003; Goldman, Greenberg, & Pos, 2005). Deepening of experience over therapy as measured by the Experiencing Scales (Klein, Mathieu-Coughlan, & Kiesler, 1986), which measure clients' ability to focus on feelings and use them to solve problems and create new meaning, has been shown to be a specific change process that predicts outcome over and above the change predicted by the therapeutic alliance. Past studies also show a strong relationship between in-session emotional experiencing and therapeutic gain in dynamic, cognitive, and experiential therapies (Castonguay, Goldfried, Wiser, Raue, & Hayes, 1996; Silberschatz, Fretter, & Curtis, 1986). This suggests that this variable may be a common factor that helps explain change across approaches.

In addition, it has been shown that therapists' depth of experiential focus influenced clients' depth of experiencing in the next moment, and that this predicted outcome. Moreover, the effect of early emotional processing on outcome was found to be mediated by late emotional processing, where "emotional processing" was defined as depth of experiencing emotion episodes (Pos et al., 2003). Early capacity for emotional processing alone thus did not guarantee good outcome; nor did entering therapy without this capacity guarantee poor outcome. Therefore, although early emotional processing skill was probably an advantage, it appeared not as critical as the ability to acquire and/or increase depth of experiencing throughout therapy. In this study, late emotional processing independently added 21% to the explained variance in reduction in symptoms over and above early alliance and early emotional processing level.

In another study (Warwar, 2003), not only did midtherapy-expressed emotional arousal predict outcome, a client's ability to use internal experience to make meaning and solve problems as measured by the Experiencing Scales, particularly in the late phase of treatment, added to the outcome variance over and above middle-phase emotional arousal. This study thus showed that a combination of emotional arousal and reflection was a better predictor of outcome than either index alone. Reflection on aroused emotion thus appears to be an important change process (Missirlian, Toukmanian, Warwar, & Greenberg, 2005).

Emotion Transformation

The final and probably most fundamental principle of emotional change is the transformation of one emotion into another. This applies most specifically to transforming primary maladaptive emotions—those old familiar bad feelings that occur repeatedly but do not change by contact with more adaptive emotions. Although the more traditional ways of transforming emotions (either exposure through experience, expression, and completion, or reflection on them) can occur with primary maladaptive emotions, another process appears to be more important. This is a process of *changing emotion with emotion* (Greenberg, 2002). In other words, a maladaptive emotional state can be transformed best by undoing it with another, more adaptive emotion. In time, the activation of the more adaptive emotion along with or in response to the maladaptive emotion helps transform the maladaptive emotion. While thinking usually changes thoughts, only feeling can change emotions.

Spinoza (1677/1967) was the first to note that emotion is needed to change emotion; he proposed that "An emotion cannot be restrained nor removed unless by an opposed and stronger emotion" (p. 195). Reason clearly is seldom sufficient to change automatic emergency-based emotional responses. Darwin (1872/1998), on jumping back from the strike of a glassed-in snake, noted that despite his having approached it with the determination not to start back, his will and reason were powerless against the imagination of a danger that he had never even experienced. Rather than reasoning with an emotion, one needs to transform the emotion by accessing another emotion.

In an interesting line of investigation, positive emotions have been found to undo lingering negative emotions (Frederickson, 2001). The basic observation is that key components of positive emotions are incompatible with negative emotions. Frederickson (2001) suggests that by broadening a person's momentary thought–action repertoire, a positive emotion may loosen the hold that a negative emotion has on the person's mind. The experiences of joy and contentment were found to produce faster cardiovascular recovery from negative emotions than a neutral experience. Frederickson, Mancuso, Branigan, and Tugade (2000) also found that resilient individuals coped by recruiting positive emotions to regulate negative emotional experiences. They found that these individuals manifested a physiological "bounce back" that helped them to return to cardiovascular baseline more quickly.

It thus seems possible to replace bad feelings with happy feelings, not in a simple manner, by trying to look on the bright side, but by evoking meaningfully embodied alternative experiences to undo the negative feelings. For example, in grief, laughter has been found to be a predictor of recovery; thus being able to remember the happy times, to experience joy, serves as an antidote to sadness (Bonanno & Keltner, 1997). Similarly, warmth and affection are often antidotes to anxiety. In depression, a protest-filled, submissive sense of worthlessness can be transformed therapeutically by guiding people to the desire that drives their protest—a desire to be free of their cages and to access their feelings of joy and excitement for life. Isen (1999) notes that at least some of the positive effects of happy feelings have been hypothesized to depend on the effects of the neurotransmitters involved in the emotion of joy on specific parts of the brain that influence purposive thinking. Mild positive affect has been found to facilitate problem solving.

In a study of self-criticism, Whelton and Greenberg (2005) found that people who were more vulnerable to depression showed more contempt but also less resilience in response to self-criticism than people less vulnerable to depression. The less vulnerable people were able to recruit positive emotional resources, such as self-assertive pride and anger, to combat the depressogenic contempt and negative cognitions. In other words, after a distressing experience, resilient people appear to generate a positive feeling (often through imagery or memory) in order to soothe themselves, and they can combat negative feelings and views of self in this more resilient state. Accessing a positive emotional state therefore helps them counteract the effect of a negative emotional state. These studies together indicate that positive affect can be used to regulate negative feelings.

Davidson (2000) suggests that the right-hemispheric, withdrawal-related negative affect system can be transformed by activation of the approach-related system in the left prefrontal cortex. He defines "resilience" as the maintenance of high levels of positive affect and well-being in the face of adversity; he highlights that it is not that resilient people do net feel negative affect, but that their negative affect does not persist. Levenson (1992) has reviewed research indicating that specific emotions are associated with specific patterns of autonomic nervous system activity, providing evidence that different emotions change one's physiology differentially. Emotion has also been shown to be differentially transformed by people's differing capacity to self-generate imagery to replace unwanted, automatically generated emotions with more desirable imagery scripts (Derryberry & Reed, 1996); this finding suggests the importance of individual differences in this domain.

It is important to note that the process of changing emotion with emotion goes beyond ideas of catharsis, completion, exposure, extinction, or habituation, in that the maladaptive feeling is not purged, nor is it simply attenuated by the person feeling it. Rather, another feeling is used to transform or undo it. Although exposure to emotion at times may be helpful to overcome affect phobia in many situations in therapy, change also occurs because one emotion is transformed by another emotion rather than simply attenuated. In these instances, emotional change occurs by the activation of an incompatible, more adaptive experience that undoes or reverses the old response.

Clinical observation and research suggest that emotional transformation occurs through a process of dialectical synthesis of opposing schemes. When opposing schemes are coactivated, they synthesize compatible elements from the coactivated schemes to form new higher-level schemes, just as in development when schemes for standing and falling, in a toddler, are dynamically synthesized into a higher-level scheme for walking (Greenberg & Pascual-Leone, 1995; Pascual-Leone, 1991). Schemes of different emotional states are similarly synthesized to form new higher-level states. Thus, in therapy, maladaptive fear, once aroused, can be transformed into security by evoking the more boundary-establishing emotions of adaptive anger or disgust, or the softer feelings of compassion or forgiveness. Similarly, maladaptive anger can be undone by adaptive sadness. Maladaptive shame can be transformed by accessing anger at violation, self-comforting feelings, and pride and self-worth. For example, the tendency to shrink into the ground in shame is transformed by the thrusting-forward tendency in newly accessed anger at violation. Withdrawal emotions from one side of the brain are replaced with approach emotions from another part of the brain, or vice versa (Davidson, 2000). Once the alternative emotion has been accessed, it transforms or undoes the original state, and a new state is forged.

Given the importance of accessing new, more adaptive emotions to transform old maladaptive emotions, this question arises: "How then are new emotions accessed?" How does a therapist help people in the midst of maladaptive experiences access emotions that will help them transform their maladaptive feelings and beliefs? Some different ways are listed below (Greenberg, 2002, 2010; Greenberg & Watson, 2006):

1. *The therapeutic relationship.* A good therapeutic relationship provides an ongoing source of new emotions by providing a secure empathic environment that soothes and calms.

2. *Shifting attention.* Shifting people's focus of attention so that they pay attention to a background feeling is a key method of helping them change their emotional states. On the edge of awareness or in the background, behind their current dominant emotion, often lies a subdominant emotion that can be found if attended to or searched for. Another feeling is there, but not yet in focal awareness. Behind anger is sadness, love, or forgiveness; at the edge of sadness is anger; within hurt or fear is anger; behind shame are pride and self-esteem. The subdominant emotion is often present in the room nonverbally, in tone of voice or manner of expression.

3. *Accessing needs/goals.* A more process-directive way in which a therapist can help clients access their healthy healing emotions and internal resources is by asking them when they are in a maladaptive state, such as shame, what they

need to resolve their pain. People usually know what they need when they are suffering their pain. Once they know what they need in a situation, they often begin to feel as if they have some control over it. Raising a need or a goal to a self-organizing system has a number of effects. At the conscious, intentional level, it opens a problem space to search for a solution. At an affective level, it conjures up a feeling of what it is like to reach the goal, and opens up neural pathways to both the feeling and the goal. Most important, raising a need that is unmet helps a new feeling such as anger or sadness to emerge.

4. *Positive imagery.* Another way to activate alternative feelings is to use imagery. Imagination is a means of bringing about an emotional response. This involves helping clients use their conscious capacities to generate new experience. People can use their imaginations to create scenes that they know will help them feel an emotion, and can use this emotion as an antidote to a maladaptive feeling they want to change. They can change what they feel, not by changing feelings with reason, but by using imagination to evoke new emotions. With practice, people can learn how to generate opposing emotions through imagery and use these as antidotes to negative emotions.

5. *Expressive enactment of the emotion.* Yet another way to access alternate emotions is to have people enact a feeling that is not currently being experienced. This goes back to William James's (1890) idea that we feel afraid because we run. The therapist asks clients to adopt certain emotional stances, and helps them to deliberately assume the expressive posture of that feeling and then to intensify it. Thus, a therapist might use a psychodramatic enactment and instruct a client, "Try telling him, 'I'm angry.' Say it again—yes, louder. Can you put your feet on the floor and sit up straight? Yes, do it some more." Here the therapist coaches the person in expressing an emotion until the emotion actually begins to be experienced. This is not encouraging phony expression, but trying to facilitate access to a suppressed, disallowed experience. Instructions to take on expressive postures are always balanced by asking people what they experience after doing this.

6. *Remembering another emotion.* Remembering a situation in which an emotion occurred can bring the emotion memory alive in the present. This technique is related to the imaging process described above. Remembering past emotional scenes clearly produces emotion. To help people change what they feel, a therapist has to help them access and restructure their emotion memories. One important way of changing emotion memories involves accessing the emotion memory to be changed and then transforming it with another emotion memory. Once another emotion memory is evoked, either the new memory dominates and the old one recedes into the background and becomes less accessible, or the new one eventually transforms the old memory.

7. *Cognitive change.* A therapist can also help people access a new emotion by talking with them about the more desirable emotion. This is using cognitive meaning to generate new feelings. Talking about an emotional episode helps people reexperience the feelings they had in that episode.

8. *Expressing the emotion for the client.* A therapist might express outrage or sadness for a client that the client is not yet able to express. This gives the client permission to begin experiencing this emotion. We all often see ourselves in the reflections of ourselves that we get back from others. Seeing that our stories have an impact on others and that they are moved can also move us.

9. *Using the therapy relationship to generate a new emotion.* A new emotion can be evoked in response to a new interaction with a therapist. The therapist can evoke a particular emotion in a client by taking a particular position in the interaction. For example, a therapist who is comforting will evoke soft feelings; one who is confrontive will evoke anger.

Emotion Coaching

A view of the therapist as an "emotion coach"—a view that encompasses the importance of both the therapeutic relationship and emotional processing—has been proposed as a model of the therapist's role and function in working with emotion. Emotion coaching (Gottman, 1997; Greenberg, 2002) is essentially aimed at helping people become aware of and make sense of their emotional experience. The effects of a good therapeutic relationship on outcome is widely recognized (Norcross, 2002), and there is good reason to believe that a good alliance is also a prerequisite to productive emotional processing, as noted throughout this chapter. An accepting, empathic relational environment provides people with the experience of emotional soothing and support they need to pay attention to their bodily felt experience. This type of relational environment helps people to sort out their feelings, develop self-empathy, and find alternative inner resources from which new responses can be constructed. Within this relational context, emotion coaching aims to help clients be informed by their emotions, regulate them, transform them, and use them intelligently to solve problems in living.

In addition to following where the client is moment by moment, the therapist acting as an emotion coach guides the client in new ways of processing experiential information. Emotion coaching thus involves a style that combines leading and following, and embodies the idea that it is possible to influence the construction of people's subjective experience. Change and novelty can be introduced in the emotional domain by training people to become aware of their emotional processes, and by guiding their attention and meaning construction processes.

Based on a major principle that one cannot leave an emotional place until one has arrived, two phases of emotion coaching—the "arriving" phase and the "leaving" phase—have been proposed. Each phase includes four steps designed to help people experience their emotions more skillfully. The first phase, focused on awareness of emotion, is designed to help people arrive at what they feel and involves the following steps:

1. The coach helps people attend to their emotions.
2. The coach encourages people to welcome their emotional experience and allow it (this does not necessarily mean they must express everything they feel to other people; rather, they must acknowledge it themselves). People also need to be coached in skills of emotion regulation if these are needed.
3. The coach helps people to describe their feelings in words, in order to aid them in solving problems.
4. The coach guides people to become aware of whether their emotional reactions are their primary feelings in this situation. If not, they need help in discovering what their primary feelings are.

The second phase focuses on emotion utilization or transformation and is designed to help clients leave the place where they have arrived. This stage involves moving on and transforming core feelings when necessary. It is here that the coaching aspect is more central.

5. When a person has been helped to experience a primary emotion, the coach and person together need to evaluate whether the emotion is a healthy, adaptive emotion or an unhealthy, maladaptive response to the current situation. If it is healthy, it should be used as a guide to action. If it is unhealthy, it needs to be changed.
6. If the accessed primary emotion is unhealthy, the person has to be helped to identify the negative cognition associated with this emotion.
7. Alternative, adaptive emotional responses and needs are now processed and developed.
8. People are coached to challenge the destructive thoughts in their maladaptive emotions from their new inner voice, based on their adaptive primary emotions and needs, and to regulate maladaptive emotions when necessary.

Coaching in the emotional domain thus involves helping clients verbally label each emotion they are feeling, accept the emotion, talk about what it is like to experience the emotion, develop new ways of processing the emotion, and learn ways of soothing or regulating the emotion. It is important to note that people often cannot simply be explicitly taught new strategies for dealing with difficult emotions; they have to be assisted to engage in the new process experientially, and only later explicitly taught what to do. For example, accessing a need or goal may be very helpful in overcoming a sense of passivity or defeat or to help a painful feeling. However, explicitly teaching people that this is what they should do is not nearly as helpful as interpersonally facilitating this by asking them at the right time what it is they need. For example, it is through experiencing a process of shifting from negative to more positive emotional states that the experiential links between states are best forged. This then is consolidated only later by explicit knowledge of the process.

Conclusion

EFT emphasizes becoming aware of and reflecting on primary emotions, as well as regulating and transforming maladaptive emotions. Both the utilization and the transformation of emotion are seen as therapeutic. A two-step therapeutic process is recommended when the core emotion accessed is adaptive. First, the symptomatic secondary emotion (such as feeling upset, despairing, or hopeless) is evoked in therapy; then the core primary adaptive emotion that is being interrupted (such as sadness, grief, or empowering anger) is accessed, validated, and utilized to promote adaptive action. A three-step sequence is required to transform a core maladaptive emotion. In this sequence, the secondary emotion is first evoked; then the core maladaptive emotion being avoided (such as shame, fear, or anger) is accessed. This latter emotion is then transformed by accessing a more adaptive emotion (such as anger, sadness, or compassion). When adaptive emotions finally are evoked, they are incorporated into new views of self and used to transform personal narratives.

References

Auszra, L., Greenberg, L. S., & Hermann, I. (2013). Client emotional productivity-optimal client in-session emotional processing in experiential therapy. *Psychotherapy Research, 23*(6), 732–746.

Bateman, A., & Fonagy, P. (2004). *Psychotherapy for borderline personality disorder: Mentalisation-based treatment*. New York: Oxford University Press.

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders*. Oxford, UK: International Universities Press.

Beutler, L., Engle, D., Mohr, D., Daldrup, R., Bergan, M., & Merry, W. (1991). Predictors of differential response to cognitive, experiential, and self-directed psychotherapeutic procedures. *Journal of Consulting and Clinical Psychology, 59*, 333–340.

Beutler, L. E., Clarkin, J. F., & Bongar, B. (2000). *Guidelines for the systematic treatment of the depressed patient*. New York: Oxford University Press.

Bohart, A. C., & Greenberg, L. S. (Eds.). (1997). *Empathy reconsidered: New directions in psychotherapy*. Washington, DC: American Psychological Association.

Bonanno, G. A., & Keltner, D. (1997). Facial expressions of emotion and the course of conjugal bereavement. *Journal of Abnormal Psychology, 106*, 126–137.

Borkovec, T. D., Alcaine, O., & Behar, E. (2004). Avoidance theory of worry and generalized anxiety disorder. In R. G. Heimberg, C. L. Turk, & D. S. Mennin (Eds.), *Generalized anxiety disorder: Advances in research and practice* (pp. 77–108). New York: Guilford Press.

Castonguay, L., & Hill, C. (2012). *Transformation in psychotherapy: Corrective experiences across cognitive behavioral, humanistic, and psychodynamic approaches*. Washington, DC: American Psychological Association.

Castonguay, L. G., Goldfried, M. R., Wiser, S., Raue, P. J., & Hayes, A. M. (1996). Predicting the effect of cognitive therapy for depression: A study of unique and common factors. *Journal of Consulting and Clinical Psychology, 64*, 497–504.

Coombs, M. M., Coleman, D., & Jones, E. E. (2002). Working with feelings: The importance of emotion in both cognitive-behavioral and interpersonal therapy in the NIMH Treatment of Depression Collaborative Research Program. *Psychotherapy: Theory, Research, Practice, Training, 39*, 233–244.

Darwin, C. (1998). *Expression of the emotions in man and animals* (3rd ed.). London: HarperCollins. (Original work published 1872)

Davidson, R. J. (2000). Affective style, psychopathology, and resilience: Brain mechanisms and plasticity. *American Psychologist, 5*(11), 1193–1196.

Derryberry, D., & Reed, M. A. (1996). Regulatory processes and the development of cognitive representations. *Development and Psychopathology, 8*, 215–234.

Elliott, R., Greenberg, L., & Lietaer, G. (2004). Research on experiential psychotherapy. In M. Lambert (Ed.), *Bergin and Garfield's handbook of psychotherapy and behavior change* (pp. 493–539). New York: Wiley.

Ellis, A. (1994). *Reason and emotion in psychotherapy: Comprehensive method of treating human disturbances*. New York: Citadel Press.

Ellison, J. A., Greenberg, L. S., Goldman, R. N., & Angus, L. (2009). Maintenance of gains following experiential therapies for depression. *Journal of Consulting and Clinical Psychology, 77*(1), 103–112.

Foa, E. B., & Jaycox, L. H. (1999). Cognitive-behavioral theory and treatment of posttraumatic stress disorder. In D. Spiegel (Ed.), *Efficacy and cost-effectiveness of psychotherapy* (pp. 23–61). Washington, DC: American Psychiatric Press.

Foa, E. B., Zoellner, L. A., Feeny, N. C., Hembree, E. A., & Alvarez-Conrad, J. (2002). Does imaginal exposure exacerbate PTSD symptoms? *Journal of Consulting and Clinical Psychology, 70*, 1022–1028.

Fosha, D. (2000). *The transforming power of affect: A model of accelerated change*. New York: Basic Books.

Frank, J. (1961). *Persuasion and healing*. Baltimore: Johns Hopkins University Press.

Fredrickson, B. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist, 56*(3), 218–226.

Fredrickson, B., Mancuso, R., Branigan, C., & Tugade, M. (2000). The undoing effects of positive emotion. *Motivation and Emotion, 24*, 237–258.

Freud, S. (1957). Instincts and their vicissitudes. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 14, pp. 109–140). London: Hogarth Press. (Original work published 1915)

Goldman, R., Greenberg, L., & Pos, A. (2005). Depth of emotional experience and outcome. *Psychotherapy Research, 15*, 248–260.

Goldman, R., Greenberg, L. S., & Angus, L. (2006). The effects of adding emotion-focused interventions to the therapeutic relationship in the treatment of depression. *Psychotherapy Research, 16*, 537–549.

Gottman, J. (1997). *The heart of parenting: How to raise an emotionally intelligent child*. New York: Simon & Schuster.

Greenberg, L. (2010). *Emotion-focused therapy: Theory and practice*. Washington, DC: American Psychological Association.

Greenberg, L. (2012). Emotions, the great captains of our lives: Their role in the process of change in psychotherapy. *American Psychologist, 67*, 697–707.

Greenberg, L. S. (2002). *Emotion-focused therapy: Coaching clients to work through their feelings*. Washington, DC: American Psychological Association.

Greenberg, L. S., & Angus, L. (2004). The contributions of emotion processes to narrative change in psychotherapy: A dialectical constructivist approach. In L. Angus & J. McLeod (Eds.), *Handbook of narrative psychotherapy* (pp. 331–352). Thousand Oaks, CA: Sage.

Greenberg, L. S., Auszra, L., & Herrmann, I. (2007). The relationship between emotional productivity, emotional arousal and outcome in experiential therapy of depression. *Psychotherapy Research, 2*, 57–66.

Greenberg, L. S., & Johnson, S. M. (1988). *Emotionally focused therapy for couples*. New York: Guilford Press.

Greenberg, L. S., & Pascual-Leone, A. (2006). Emotion in psychotherapy: A practice-friendly research review. *In Session: Psychotherapy in Practice, 62*, 611–630.

Greenberg, L. S., & Pascual-Leone, J. (1995). A dialectical constructivist approach to experiential change. In R. A. Neimeyer & M. Mahoney (Eds.), *Constructivism in psychotherapy* (pp. 169–191). Washington, DC: American Psychological Association.

Greenberg, L. S., & Pascual-Leone, J. (2001). A dialectical constructivist view of the creation of personal meaning. *Journal of Constructivist Psychology, 14*(3), 165–186.

Greenberg, L. S., & Watson, J. (1998). Experiential therapy of depression: Differential effects of client-centered relationship conditions and process experiential interventions. *Psychotherapy Research, 8*, 210–224.

Greenberg, L. S., & Watson, J. C. (2006). *Emotion-focused therapy for depression*. Washington, DC: American Psychological Association.

Gross, J. J. (1999). Emotion and emotion regulation. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 525–552). New York: Guilford Press.

Hunt, M. G. (1998). The only way out is through: Emotional processing and recovery after a depressing life event. *Behaviour Research and Therapy, 36*, 361–384.

Isen, A. (1999). Positive affect. In T. Dalgleish & M. Power (Eds.), *Handbook of cognition and emotion*. Chichester, UK: Wiley.

Iwakabe, S., Rogan, K., & Stalikas, A. (2000). The relationship between client emotional expressions, therapist interventions, and the working alliance: An exploration of eight emotional expression events. *Journal of Psychotherapy Integration, 10*, 375–402.

James, W. (1890). *The principles of psychology*. Oxford, UK: Holt.

Jaycox, L. H., Foa, E. B., & Morral, A. R. (1998). Influence of emotional engagement and habituation on exposure therapy for PTSD. *Journal of Consulting and Clinical Psychology, 66*, 185–192.

Johnson, S. (1996). *The practice of emotionally focused couples therapy: Creating connections*. New York: Brunner-Routledge.

Johnson, S., Hunsley, J., Greenberg, L., & Schlindler, D. (1999). Emotionally focused couples therapy: Status and challenges. *Clinical Psychology: Science and Practice, 6*, 67–79.

Kabat-Zinn, J., Lipworth, L., Burney, R., & Sellers, W. (1986). Four year follow-up of a meditation-based program for the self-regulation of chronic pain: Treatment outcomes and compliance. *Clinical Journal of Pain, 2*, 159–173.

Kabat-Zinn, J., Massion, A. O., Kristeller, J., Peterson, L. G., Fletcher, K. E., Pbert, L., et al. (1992). Effectiveness of a meditation-based stress reduction program in the treatment of anxiety disorders. *American Journal of Psychiatry, 149*, 936–943.

Klein, M. H., Mathieu-Coughlan, P., & Kiesler, D. J. (1986). The Experiencing Scales. In L. S. Greenberg & W. M. Pinsof (Eds.), *The psychotherapeutic process: A research handbook* (pp. 21–71). New York: Guilford Press.

Lane, R. D., & Schwartz, G. E. (1992). Levels of emotional awareness: Implications for psychotherapeutic integration. *Journal of Psychotherapy Integration, 2*, 1–18.

Leahy, R. L. (2002). A model of emotional schemas. *Cognitive and Behavioral Practice, 9*, 177–191.

Le Doux, J. (1996). *The emotional brain: The mysterious underpinnings of emotional life*. New York: Simon and Schuster.

Levenson, R. W. (1992). Autonomic nervous system differences among emotions. *Psychological Science, 3*, 23–27.

Linehan, M. M. (1993). *Cognitive-behavioral treatment of borderline personality disorder*. New York: Guilford Press.

Linehan, M. M., Dimeff, L. A., Reynolds, S. K., Comtois, K. A., Shaw Welch, S., Heagerty, P., et al. (2002). Dialectical behavior therapy versus comprehensive validation plus 12 step for the treatment of opioid dependent women meeting criteria for borderline personality disorder. *Drug and Alcohol Dependence, 67*, 13–26.

Littrell, J. (1998). Is the reexperience of painful emotion therapeutic? *Clinical Psychology Review, 18*, 71–102.

Maroda, K. (2009). *Psychodynamic techniques: Working with emotion in the therapeutic relationship*. New York: Guilford Press.

Mergenthaler, E. (1996). Emotion–abstraction patterns in verbatim protocols: A new way of describing psychotherapeutic processes. *Journal of Consulting and Clinical Psychology, 64*, 1306–1315.

Missirlian, T., Toukmanian, S., Warwar, S., & Greenberg, L. (2005). Emotional arousal, client perpetual processing, and the working alliance in experiential psychotherapy for depression. *Journal of Consulting and Clinical Psychology, 73*(5), 861–871.

Mitchell, S. (1988). *Relational concepts in psychoanalysis: An integration*. Cambridge, MA: Harvard University Press.

Neimeyer, R. A., & Mahoney, M. (1995).*Constructivism in psychotherapy*. Washington, DC: American Psychological Association.

Norcross, J. C. (2002). Empirically supported therapy relationships. In J. C. Norcross (Ed.), *Psychotherapy relation-*

ships that work: Therapist contributions and responsiveness to patients (pp. 3–16). London: Oxford University Press.

Paivio, S. C., Hall, I. E., Holowaty, K. A. M., Jellis, J. B., & Tran, N. (2001). Imaginal confrontation for resolving child abuse issues. *Psychotherapy Research, 11*, 56–68.

Paivio, S. C., & Nieuwenhuis, J. A. (2001). Efficacy of emotionally focused therapy for adult survivors of child abuse: A preliminary study. *Journal of Traumatic Stress, 14*, 115–134.

Pascual-Leone, J. (1991). Emotions, development and psychotherapy: A dialectical constructivist perspective. In J. Safran & L. S. Greenberg (Eds.), *Emotion, psychotherapy, and change* (pp. 302–335). New York: Guilford Press.

Pennebaker, J. W. (Ed.). (1995). *Emotion, disclosure, and health.* Washington, DC: American Psychological Association.

Perls, F. S. (1969). *Gestalt therapy verbatim.* Lafayette, CA: Real People Press.

Pierce, R. A., Nichols, M. P., & DuBrin, J. R. (1983). *Emotional expression in psychotherapy.* New York: Gardner Press.

Pos, A. E., Greenberg, L. S., Goldman, R. N., & Korman, L. M. (2003). Emotional processing during experiential treatment of depression. *Journal of Consulting and Clinical Psychology, 71*, 1007–1016.

Rogers, C. R. (1951). *Client-centered therapy.* Boston: Houghton Mifflin.

Salovey, P., Mayer, J. D., Golman, S. L., Turvey, C., & Palfai, T. P. (1995). Emotional attention, clarity, and repair: Exploring emotional intelligence using the Trait Meta-Mood Scale. In J. W. Pennebaker (Ed.), *Emotion, disclosure, and health* (pp. 125–154). Washington, DC: American Psychological Association.

Samoilov, A., & Goldfried, M. (2000). Role of emotion in cognitive behavior therapy. *Clinical Psychology: Science and Practice, 7*, 373–385.

Shapiro, F. (1999). Eye-movement desensitization and reprocessing (EMDR) and the anxiety disorders: Clinical and research implications of an integrated psychotherapy treatment. *Journal of Anxiety Disorders, 13*, 35–67.

Silberschatz, G., Fretter, P. B., & Curtis, J. T. (1986). How do interpretations influence the process of psychotherapy? *Journal of Consulting and Clinical Psychology, 54*, 646–652.

Spinoza, B. (1967). *Ethics (Part IV)*. New York: Hafner. (Original work published 1677)

Sroufe, L. A. (1996). *Emotional development: The organization of emotional life in the early years.* New York: Cambridge University Press.

Stalikas, A., & Fitzpatrick, M. (1995). Client good moments: An intensive analysis of a single session. *Canadian Journal of Counselling, 29*, 160–175.

Stanton, A., Danoff-Burg, S., Cameron, C., Bishop, M., Collins, C., Kirk, S. B., et al. (2000). Emotionally expressive coping predicts psychological and physical adjustment to breast cancer. *Journal of Consulting and Clinical Psychology, 68*, 875–882.

Svartberg, M., Stiles, T. C., & Seltzer, M. H. (2004). Randomized, controlled trial of the effectiveness of short-term dynamic psychotherapy and cognitive therapy for Cluster C personality disorders. *American Journal of Psychiatry, 161*, 810–817.

Teasdale, J. D., Segal, Z. V., Williams, J. M. G., Ridgeway, V. A., Soulsby, J. M., & Lau, M. A. (2000). Prevention of relapse/recurrence in major depression by mindfulness-based cognitive therapy. *Journal of Consulting and Clinical Psychology, 68*, 615–623.

van der Kolk, B. A. (1995). The body, memory, and the psychobiology of trauma. In J. L. Alpert (Ed.). *Sexual abuse recalled: Treating trauma in the era of the recovered memory debate* (pp. 29–60). Northvale, NJ: Aronson.

Van Velsor, P., & Cox, D. L. (2001). Anger as a vehicle in the treatment of women who are sexual abuse survivors: Reattributing responsibility and accessing personal power. *Professional Psychology: Research and Practice, 32*, 618–625.

Warwar, N. (2003). *Relating emotional processes to outcome in experiential psychotherapy of depression.* Unpublished doctoral dissertation, York University, Toronto.

Warwar, N., Greenberg, L. S., & Perepeluk, D. (2003, June). *Reported in-session emotional experience in therapy.* Paper presented at the annual meeting of the International Society for Psychotherapy Research, Weimar, Germany.

Watson, J. C. (1996). The relationship between vivid description, emotional arousal, and in-session resolution of problematic reactions. *Journal of Consulting and Clinical Psychology, 64*, 459–464.

Watson, J. C., Gordon, L. B., Stermac, L., Kalogerakos, F., & Steckley, P. (2003). Comparing the effectiveness of process-experiential with cognitive-behavioral psychotherapy in the treatment of depression. *Journal of Consulting and Clinical Psychology, 71*, 773–781.

Whalen, P., & Phelps, E. (Eds.). (2009). *The human amygdala.* New York: Guilford Press.

Whelton, W., & Greenberg, L. (2005). Emotion in self-criticism. *Personality and Individual Differences, 38*, 1583–1595.

Whelton, W. J. (2004). Emotional processing in psychotherapy: Evidence across therapeutic modalities. *Clinical Psychology and Psychotherapy, 11*, 58–71.

Winston, A., Laikin, M., Pollack, J., Samstag, L., McCullough, L., & Muran, C. (1994). Short-term psychotherapy of personality disorders: 2 year follow-up. *American Journal of Psychiatry, 151*, 190–194.

CHAPTER 40

Eat, Drink, and Be Sedentary

A Review of Health Behaviors' Effects on Emotions and Affective States, and Implications for Interventions

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There is a large body of work showing that emotions and emotion regulation shape health behaviors (DeSteno, Gross, & Kubzansky, 2013; see Chapter 36, "Emotions and Health," this volume). In turn, many health behaviors have potent effects on how we feel. When feeling emotional, many people often turn to unhealthy behaviors to modulate or dampen their emotions. It is not surprising then that health behaviors are often conceptualized as a way to cope with stress. Standard coping scales include, in addition to emotional and problem-focused coping responses, the common behavioral responses to stress such as eating, drug use, drinking, watching television, or sleeping more than usual. Behavioral responses such as these are a form of passive coping or mental disengagement, reflected in our cultural idioms "drown your sorrows," "numbing out," using "food as therapy," or "sleeping it off." While the more common behavioral responses to "negative" emotions, like sadness and anxiety, tend to be "negative" health behaviors, some people lean toward exercise to feel better. Positive health behaviors such as exercising and sufficient sleep may also impact affective states, both dampening negative but also increasing positive affect and related specific emotions. Clearly, then, this relationship is bidirectional, although much less attention is on the path from health behaviors to affect.

Why should one care about the transient emotional responses to a bout of exercise, for example? It may be that within such phenomena lie the critical levers to promoting positive habits. The link between how health behaviors shape emotional responses is sorely underexamined. Emotional responses that are induced by health behaviors predict a wide range of outcomes that can then feed back to further shape decision making and other health behaviors. New initiatives to understand behavior change, such as the National Institutes of Health Science of Behavior Change (SOBC) initiative's attempt to find commonalities in mechanisms of behavioral change across types of behaviors, in order to promote more effective in-

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terventions (National Institutes of Health, 2015). Promoting adherence to health behaviors is one of the toughest issues in public health, and the role of emotional responses may provide one window into understanding individuals' choices to engage or terminate health behaviors.

Here we review the primary health behaviors that are relevant to most people as they age, regardless of health status, including positive behaviors—*exercise* and *good sleep*—and consummatory behaviors—*overeating* and *drinking alcohol*—and what is known about their effects on emotion and affective states, and stress-related processes, including physiological responses to stress. We touch upon emotion regulation when there is research directly assessing regulation (see the section "Eating"). Health behaviors can affect default or basal emotional states, anticipation of stressors, and then appraisal and evaluation. They also impact neurobiological processes that maintain or modulate affective states and discrete emotional experiences *after* a stressor has occurred. Further, the affective and emotional responses during and immediately after engaging in a health behavior may affect a person's decision to continue to engage in or maintain the behavior, although this is less studied.

This chapter lays initial groundwork for a better understanding of the behavior–affect link. In addition, we pose the question of whether health behaviors at the right dose and intensity can promote more positive emotional responses, which may predict better adherence to the healthy behavior (Figure 40.1). This is a nascent area of research, applied mainly to exercise so far.

Acute versus Chronic Effects

One obstacle to understanding health behavior's effects on emotions is that there is not a programmatic literature with a common language and conceptual paradigm. How can we best learn from the studies that have been done thus far? Here we organize studies based on the exposure (chronic/regular or acute health behavior). If an individual is regularly engaging in a health behavior, we can consider *chronic effects* of the health behavior on emotion and emotion regulation processes. We review how emotional experiences differ in people who vary on physical activity, sleeping habits, eating patterns, and alcohol consumption. To varied extents, each behavior has been studied in its chronic form and how it impacts discrete emotions and affective states, in psychiatric conditions, general emotional experiences of everyday life, and in the laboratory in response to stress induction. We also review the small but important experimental literature on the impact of acute health behaviors on emotions. *Acute effects* of a health behavior can be studied through one-time or short-term repeated manipulations of the health behavior, by using either standardized conditions, such as in the lab, or by using more naturalistic examination in daily life, with repeated ecologically valid measurements, such as those afforded by ecological momentary

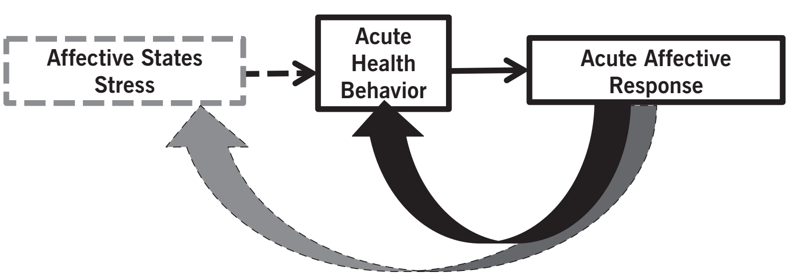

FIGURE 40.1. Health behaviors can acutely alter affective experience—emotions (valence, arousal), emotion regulation, and stress appraisal. This can affect both longer-term affective states, and we propose may affect frequency of the health behavior. Using the example of exercise, a positive emotional response to a bout of exercise can predict better adherence (Williams et al., 2008). This may extend to other health behaviors where changes in negative and positive emotional balance could be critical determinants of future adherence or abstinence from that behavior, and predict treatment success.

assessment (EMA). And while each behavior has been studied in a vacuum, we present suggestions for a more programmatic focus on health behaviors and their impact on emotions that envelops common strategies and language to uncover common, underlying neurobiological mechanisms situated within a broader conceptual model.

Physical Activity

First, it is important to be specific about definitions of activity, since they may work differently. Physical activity, exercise, and sedentary behavior are typically used interchangeably, yet incorrectly (Caspersen, Powell, & Christenson, 1985). *"Physical activity" is defined as any skeletal muscle movement that results in energy expenditure.* Physical activity can occur at home during household activities, at work, during leisure time, and sports, for example. Exercise, on the other hand, is structured, deliberate, and repetitive physical activity that has the planned outcome of improving physical fitness. Researchers also differentiate between type, duration, and intensity (light, moderate, and vigorous) of physical activity. Activity in the moderate and vigorous intensity zones is typically considered an "exercise bout" since these levels of intensity are typically only reached during structured and deliberate exercise. Recent research also differentiates between physical activity and sedentary behaviors (television watching, sitting at work, spending time at a computer), as there is growing evidence that they independently predict health and disease (Chomistek et al., 2013; Katzmarzyk, 2010).

It is apparent from the literature that depression and physical activity are intimately connected. Depressed and anxious individuals are less likely to be physically active (Camacho, Roberts, Lazarus, Kaplan, & Cohen, 1991; Goodwin, 2003; Stroehle, 2009) and remain more sedentary (Teychenne, Ball, & Salmon, 2010). Prospectively, physical inactivity appears to increase the risk of developing depression (Farmer et al., 1988; Lampinen, Heikkinen, & Ruoppila, 2000; Motl, Birnbaum, Kubik, & Dishman, 2004). Several meta-analyses and reviews suggest that exercise interventions promote reductions in depressive and anxious symptoms in healthy and clinical populations (Blumenthal et al., 2007; Brosse, Sheets, Lett, & Blumenthal, 2002; Conn, 2010a, 2010b; Rethorst, Wipfli, & Landers, 2009; Wipfli, Rethorst, & Landers, 2008). Randomized trials demonstrate that exercise interventions considerably benefit depressed individuals, with similar effects to pharmacotherapy (Barbour, Edenfield, & Blumenthal, 2007; Blumenthal et al., 2007; Brosse et al., 2002), and that depressed individuals who start an intervention and maintain regular exercise over the long term also maintain the therapeutic affective effects of exercise up to 1 year later (Babyak et al., 2000; Hoffman et al., 2011). Physical activity, thus, appears to have antidepressant effects.

Here we examine research that assesses the emotion- and affect-altering effects of physical activity by examining how physical activity and exercise can help people "feel less worse" and "feel better." Much of the work to date rests in the area of affective states, general states of positive affect or negative affect, or pleasure and displeasure. We highlight evidence from observational and experimental studies that examines differences in affective states that occur naturally and in the laboratory between physically active people and those who are less active. We also highlight the work on affective states from naturalistic and experimental studies that occur after a bout of exercise in everyday life and in response to a standard exercise bout in the laboratory. We complete the section with a focus on the potential neurobiological mediators of these effects.

Regular Physical Activity

Regular Physical Activity, Emotions, and Affect

From a broad emotions perspective, it has been of considerable interest to examine whether becoming physically active makes people feel better (i.e., boost positive affect) or makes people feel less worse (i.e., reduce negative affect). Reviews and meta-analyses abound addressing these studies. A review of the literature indicates that physical activity is more likely to be related to changes in positive affect than to negative affect. For example, the long-term benefit of an exercise intervention on older adults' quality of life is mediated by positive affect alone, not negative affect (Elavsky et al., 2005). In fact, a meta-analysis (Reed & Buck, 2009) suggests that participants who are randomized to an exercise program increase in positive affect, with a Cohen's d effect size of 0.57. Importantly, those who start preintervention with lower positive affect scores or who exercise more than three times a week are especially more likely to increase in their positive affect ratings. However, it is unclear which discrete emotions are altered or whether the impact of exercise is more general.

Regular Physical Activity and Emotional and Stress Reactivity

Studies in the laboratory have, however, examined the response of discrete emotions to novel stressors in active individuals compared with those less active. Physical activity buffers individuals' emotional responses to acute and novel stressors. Active individuals are less likely to experience psychological stress or increased negative emotions after a laboratory-induced stressor than inactive individuals. For example, Rimmele and colleagues (2007, 2009) demonstrated that while all individuals experience heightened state anxiety and decreased calmness in response to stress induction in the laboratory, athletes are seemingly less emotionally responsive to stressors than sedentary, untrained individuals. Similarly, individuals with high levels of regular physical activity have smaller neuroendocrine and autonomic responses to a stressor compared with those who are sedentary (Puterman et al., 2011; Rimmele et al., 2007, 2009; Traustadóttir, Bosch, Cantu, & Matt, 2004).

Acute Physical Activity

Acute Physical Activity, Emotions, and Affect

While regular physical activity is psychologically beneficial, perhaps via alterations in positive affect, less is known about how an acute bout of exercise impacts trajectories of positive and negative affect or discrete emotions. Diary studies, including EMAs, have opened the door to understanding the relationships between acute episodes of physical activity and positive and negative affective states on a daily basis. Giacobbi, Hausenblas, and Frye (2005) examined the relationships between self-reported physical activity and affect on a daily basis in 106 college students utilizing end-of-day 24-hour recall self-reports. They demonstrated that on days that students were physically active, reported positive affect was higher whereas negative affect was lower, compared with the days these students were inactive. However, to eliminate the effects of random events that occurred, Giacobbi and colleagues (2005) covaried actual positive and negative events that the participants' experienced on each day and found only positive affect was related to reporting being active, whereas negative affect was no longer related. These findings corroborate previous research on daily activity and positive affect (Steptoe, Kimbell, & Basford, 1998), although there are also null findings with similar methods (Ready, Marquez, & Akerstedt, 2009).

To better assess acute effects of activity naturalistically, it is necessary to examine repeated assessments of mood in order to get at changes before and after activity. Using such an exemplary study method as EMAs, Wichers and colleagues (2012) examined the lagged relationships between physical activity and affect in over 500 female twins by measuring self-reported physical activity and negative and positive affect at 10 time points throughout the day for 5 consecutive days. Fluctuations in negative affect within individuals were not related to engaging in physical activity on a daily basis nor did physical activity decrease negative affect after an increase in activity. On the other hand, positive affect increased immediately after a bout of activity for as long as 180 minutes in women with no history of depression, and for 90 minutes in women with a history of depression.

The question of whether a bout of exercise makes people "feel better" (i.e., increase in positive affect) or "feel less worse" (i.e., decrease in negative affect) has received wide attention beyond daily experiences, and has a longer history in laboratory experiments. Wichers and colleagues' (2012) study suggests that activity makes people feel better, but experimental studies suggest that this might be the case because people in their daily lives self-select types of activities at intensity and duration levels that *make* them feel better. In a series of studies that span the past decade, Ekkekakis, Hall, and Petruzzello (2008), as well as others, have demonstrated that while most people feel better *after* exercising (typically when affect is measured in EMA studies), not everyone feels better *during* exercise—in fact, many people feel worse.

One might wonder why exercise seems pleasant for some people and torturous for others. One's fitness level and the intensity of a bout of activity seem to play crucial roles in this equation (Reed & Ones, 2006). One's physiological fitness states, including ventilatory and lactate thresholds, are key to understanding when physical activity switches from a positively to negatively valenced effect on emotional state. The ventilatory threshold is the point at which breathing becomes disproportionately high in comparison to how much oxygen is actually being consumed. The lactate threshold is the point at which lactic acid starts to accumulate in the blood, forcing the organism to switch to anaerobic respiration (Caiozzo et al., 1982). While these thresholds are reached at slightly different intensities, based on nutrition and overall fitness of the individual, a wide range of studies suggest that below these thresholds, physical activity is widely experienced as pleasurable, with some interindividual variability. Above these thresholds, exercising switches from an experience of positive affect to negative affect (Ekkekakis et al., 2008; Ekkekakis & Petruzzello, 1999; Hall, Ekkekakis, & Petruzzello, 2002; Welch, Hulley, & Beauchamp, 2010). Furthermore, in those who remain subthreshold, positive affect seems to peak at 30 minutes and starts declining soon after (Woo, Kim, Kim, Petruzzello, & Hatfield, 2009). Last, during recovery from exercise, there is another burst of positive affect (Woo et al., 2009).

This trajectory—positive affect subthreshold, negative affect above threshold, and positive affect after a bout of exercise—may differ for individuals based on factors such as how active individuals are in their daily lives. For example, some evidence suggests that *inactive* women tip toward negative affect even before the ventilatory threshold is reached, and bounce back toward a positively valenced experience after around 10 minutes after a bout of exercise (Welch, Hulley, Ferguson, & Beauchamp, 2007). In contrast, active women typically bounce back immediately after a bout of exercise that surpasses the ventilator threshold.

Temperament also seems to influence the experience of affect during exercise. Individuals who tend toward reward seeking or high arousal states experience greater positive affect during exercise than those who are more driven toward low arousal states or avoiding pain (Legrand, Bertucci, & Thatcher, 2009; Schneider & Graham, 2009). Additionally, those who feel higher levels of mastery during activity (Hu, Motl, McAuley, & Konopack, 2007; Jerome et al., 2002) and autonomy over the choice of intensity (Lind, Ekkekakis, & Vazou, 2008; Parfitt, Blisset, Rose, & Eston, 2012; Parfitt & Hughes, 2009) seem to receive greater boosts in positive affect during a bout of exercise. For example, overweight and obese women *forced* to exercise 10% greater than their preferred or self-selected intensity level are more likely to experience negative affect during a 20-minute bout of exercise than normal-weight women (Ekkekakis & Lind, 2006).

These studies may be of critical importance in understanding adherence to—versus dropping out—from exercise programs. In one study, greater positive affective response to one acute bout of moderate intensity exercise predicted maintenance of a fitness regimen up to 1 year after assessment (Williams et al., 2008). As a result of these findings, clinical researchers are increasingly recommending that individuals without current fitness routines base their new activities on what feels good to them, and less on their maximum heart rate target zones. Target zones might surpass the thresholds in unfit individuals, in turn promoting negative affect sooner into a bout of exercise (Welch et al., 2010) and thus, an increased likelihood to drop out of an exercise routine (Ekkekakis, 2009b). A recent study increased expectations of a positive mood after exercise in one group of volunteers. Both groups exercised for 10 minutes, and the group with the positive expectation induction indeed had significantly higher positive affect and greater behavioral intentions to exercise again (Helfer, Elhai, & Geers, 2015). Manipulating positive expectations, in order to promote more positive affect, may be yet one more important lever that can be used in promoting better adherence.

Acute Physical Activity and Affective and Stress Reactivity

The affect-moderating effects of activity in response to stressors are not limited to only those who are active versus inactive but extend to a single bout of exercise as well (Anshel, 1996; Mata, Hogan, Joormann, Waugh, & Gotlib, 2013; Smith, 2013). In a study of nondepressed and previously depressed individuals, Mata and colleagues (2013) induced a sad mood twice in a 20-minute period and monitored mood states continuously. Prior to the sad mood induction, however, half of the participants exercised for 15 minutes at self-selected intensities while the other half rested comfortably. All increased in negative affect after the first mood induction; however, only those with histories of depression who did not exercise for 15 minutes prior to the mood-induction task continued to increase in their negative affect after the second induction, whereas all the other participants did not. Thus, those with tendencies toward depression may be sensitive to the positive effect of exercise on negative emotional processing.

Neural Mechanisms of Physical Activity and Affective Experience

Research from animal and human studies has identified neurobiological underpinnings that may partially mediate the affective responses experienced during a bout of exercise. One of a rodent's favorite pastimes is to run on a wheel. Fortunately for the rodent, wheel running appears to be mood enhancing and stress buffering. Rodents provided a running wheel have amplified expression of several neurotransmitters (e.g., serotonin, brain-derived neurotrophic factor [BDNF], galanin) that increase cognitive flexibility and learning and reduce arousal of the endocrine and autonomic nervous activity, systems that play a role in the experience of affect and stress (Dishman et al., 2006; Matta Mello Portugal et al., 2013; Sciolino, Dishman, & Holmes, 2012; Sciolino & Holmes, 2012). In a recent mouse study, immersing mice in a cold-water swim stress task—much more of a stressor than an exercise opportunity—provoked a large stress response and neurogenesis in the region of the hippocampus that plays a role in heightened emotion processing (ventral hippocampus). However, mice that were provided free access to running wheels for several weeks prior to immersion in the cold-water swim stress task calmed much sooner. These exercise related effects on reducing behavioral signs of anxiety were accounted for by increased gamma-aminobutyric acid (GABA)-releasing neurons in the ventral hippocampus that inhibited the excitatory neurons (Schoenfeld, Rada, Pieruzzini, Hsueh, & Gould, 2013).

In humans, such detailed examinations of the neurobiological effects of chronically exercising are either not explored as of yet or currently impossible to test. However, physical activity in humans changes brain activity in ways that may affect stress appraisal and emotion regulation processes, and possibly underlie antidepressant responses. Recent advances in cerebral hemodynamics support previous studies of electroencephalogram (EEG) research demonstrating differential activation of the frontal and prefrontal areas of the brain at increasing levels of exercise intensity. Many of these changes correlate with the experience of pleasure or displeasure during exercise, and the transition from the former to the latter at the ventilatory threshold (Ekkekakis, 2009a; Fumoto et al., 2010; Hall, Ekkekakis, & Petruzzello, 2010; Kop et al., 2011; S. Schneider et al., 2009; Tempest, Eston, & Parfitt, 2014; Woo, Kim, Kim, Petruzzello, & Hatfield, 2010). In individuals not pushed to their ventilatory threshold, however, it is believed that the required neural activity for movement and balance during exercise, coupled with the finite metabolic resources of the brain that limit neural activity in nonmovement essential areas, allows for the decreased stimulation of the prefrontal and limbic regions. These regions are typically overly active in anxiety and depressive disorders, and, in part, these alterations in the brain that occur during exercise may partly underlie some of the benefits of physical activity to those suffering mood disorders (Dietrich & Audiffren, 2011).

Summary and Future Directions

Regular physical activity is associated with less major depression, anxiety disorders, and greater positive affect in general. Acute exercise is associated with a trajectory of affective responses—more positive emotional response in the low and moderate intensity zones—and if it reaches the ventilator threshold and an anaerobic state, a short-lived negative affective tone until the exercise bout ends.

In recovery from exercise, EMA studies suggest that a positive affective state is induced that can last for up to 3 hours. If this type of quantification of standard affective effects was performed reliably across studies and types of health behaviors, we could better examine how affective responses predict future health behaviors and modifiers of these effects. As shown in Figure 40.1, the dynamics of the affective response may be critical for understanding individual differences in new exercisers—or any new health behavior for that matter—who take to their new lifestyle and those who drop out quickly. There are hints that a positive affective response to a bout of exercise predicts long-term adherence to a program. Thus, making exercise pleasurable by, in part, keeping people in a subthreshold zone is key to long-term maintenance in new exercisers. Past depression, temperament, and fitness level are important moderators of affective response.

It is clear from previous research that being physically active has affect-altering effects, and that perhaps, the immediate effects of a single bout of exercise build over time to secure a general better mood for individuals. Much less is known about discrete emotional experiences, whether experienced naturalistically, in the laboratory after a bout of exercise, or in response to a laboratory stressor. Whether the affect-altering effects are universal remains unknown. For example, the physical activity-depressive symptomatology association was apparent only in adolescent girls with the met-allele BDNF polymorphism (not val/val polymorphism) in a prior study (Mata, Thompson, & Gotlib, 2010). Future research directed toward the genetic, social, or life history underpinnings of who benefits affectively from interventions is thus of particular interest. To date, few exercise-based intervention studies combine daily process methods and laboratory evaluations of affect and emotion pre- and postintervention, so it is unclear exactly how affect experience is altered in naturalistic and experimental conditions.

Sleep

The link between sleep and emotion is intuitive. One only needs to pull an all-nighter, either in the service of extending fun or by necessity, and then reflect on how one's mood was disrupted the next day to appreciate that sleep loss can dramatically affect the emotional system, including one's expression and regulation of emotions. Taken to its extreme, chronic sleep disturbances, such as prolonged difficulties in falling or staying asleep, can constitute psychiatric conditions in their own right (e.g., primary insomnia) and co-occur with many other psychiatric conditions (e.g., mood and anxiety disorders; Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010). This co-occurrence is so common that sleep disturbance has been proposed as a potential transdiagnostic factor in psychiatric illness (Harvey, Murray, Chandler, & Soehner, 2011). The relation between sleep and emotion is complex and bidirectional, and accruing evidence suggests that sleep and emotion are in "obligate symbiosis" (Walker & Harvey, 2010). Here we focus primarily on one direction of this dynamic system, namely, on how the quantity and quality of sleep serves to modulate emotional health, by studying affect in people with chronic sleep conditions, and by examining how acute sleep deprivation influences affective experience.

Chronic Sleep Disturbances

Chronic sleep disturbance is a significant predictor of onset and recurrence of several psychiatric conditions, especially major depressive disorder (MDD; Baglioni et al., 2010, 2011; Tsuno, Besset, & Ritchie, 2005). Further, sleep complaints often remain after the MDD remits (Iovieno, van Nieuwenhuizen, Clain, Baer, & Nierenberg, 2011). Accordingly, sleep interventions have emerged as promising treatment strategies in mitigating affective disorders. Chronic sleep problems also negatively affect emotional functioning in nonclinical samples. For instance, rotating shift workers, who by the nature of their jobs have disrupted sleep, show elevated rates of emotional exhaustion as well as mood disorders compared with nonrotating night-shift workers and day-shift workers (Drake, Roehrs, Richardson, Walsh, & Roth, 2004; Jamal, 2004). Similarly, police officers who screened positive for a sleep disorder, including obstructive sleep apnea and insomnia, were at significantly greater risk of making cognitive errors on the job, falling asleep while driving, and missing work. However, what was particularly alarming was that these officers were also significantly more likely than non-sleep-disordered officers to display uncontrolled anger toward a citizen or suspect and receive citizen complaints (Rajaratnam et al., 2011). The impact of sleep on emotion generation and regulation is complex. To get a better handle on the link between sleep and emotion, researchers have turned to more experimental paradigms.

Acute Sleep Disturbances

Acute Sleep Disturbance, Emotions, and Affect

The effects of sleep disturbance on emotions can be large, and in some cases more robust than sleep-induced decrements in cognition (Pilcher & Huffcutt, 1996). Experimental paradigms employing sleep deprivation serve as useful tools for elucidating these effects (Hall, Levenson, & Hasler, 2012; Kahn, Sheppes, & Sadeh, 2013; Vandekerckhove & Cluydts, 2010). In general, findings from this literature demonstrate that experimental acute sleep deprivation is associated with increases in a bevy of negative emotions. For instance, participants subjected to 1 week of partial sleep deprivation (5 hours of sleep per night) reported increases in daily emotional difficulties and negative mood states (Dinges et al., 1997). Elevations in reports of anxiety and depression have been observed in several other studies employing sleep deprivation in otherwise healthy adults (Babson, Trainor, Feldner, & Blumenthal, 2010; Franzen, Siegle, & Buysse, 2008; Sagaspe et al., 2006). These sleep-related impairments in emotion are thought to be particularly salient to adolescents, who as a group are experiencing developmental brain changes that affect sleep and emotional processes (Dahl, 2004). For example, 1 week of partial sleep restriction (6.5 hours in bed per night for five nights) produced greater reports of anxiety, anger/hostility, fatigue, and confusion in adolescents, and increased parental reports of oppositional behavior by their adolescent child as compared with the same young adults (ages 14 to 17) under a week of "healthy sleep duration" (10 hours in bed per night for five nights; Baum et al., 2014).

There is also growing evidence that positive affect is tied to sleep (Ong et al., 2013; Steptoe, O'Donnell, Marmot, & Wardle, 2008), a relationship that is often independent of negative affect. In a recent naturalistic study of 100 midlife adults who underwent eight consecutive end-of-day telephone interviews and 7 consecutive days of actigraphy to measure sleep, greater trait levels of positive affect were associated with feeling more rested and overall better-quality sleep. However, greater positive affect reactivity in response to daily events was related to overall poorer self-reported sleep efficiency (Ong et al., 2013). While this study cannot determine the directionality of the relationship between positive emotions and sleep, a recent report found that acute sleep loss modulates the neural processing of positive stimuli. In this regard, Gujar, Yoo, Hu, and Walker (2011) demonstrated that acute sleep deprivation led to interpreting emotional stimuli as more positive, which in turn was correlated with exaggerated activity in the mesolimbic circuitry.

Positive affective responses may be partly dependent on the stimulus. For instance, in a longitudinal study of medical residents, researchers employing EMA found that sleep loss intensified negative affect from a disruptive daily event, while sleep loss attenuated positive affective responses to goal-enhancing events (Zohar, Tzischinsky, Epstein, & Lavie, 2005). This study stresses the importance of context when considering the effects of sleep on affect. In another recent study, adolescents undergoing a 2-night partial sleep-deprivation protocol showed a decrease in the ratio of positive to negative affect—but this was solely due to a decrease in positive affect alone, and no significant change in negative affect following sleep deprivation (Dagys et al., 2012). Endogenous diurnal sleep rhythms may also matter—those who had an evening chronotype (went to bed much later) had a lower positive to negative ratio even when rested.

Chronotype also appears to modulate diurnal patterns of positive affect, and has been implicated in the onset of mood disorders such as depression (Hasler, Allen, Sbarra, Bootzin, & Bernert, 2010). In a recent analysis, participants with an evening chronotype displayed lower amplitude and delayed peak in daily levels of positive affect as compared with other chronotypes (Miller et al., 2014). This underscores the importance of accounting for circadian factors when investigating links between sleep and affect.

Acute Sleep Loss and Affective Reactivity to Stress

Sleep disturbance may lower one's threshold for emotional reactivity, enhancing one's emotional sensitivity to stressors. In this regard, Minkel and colleagues (2012) showed that following a night of total sleep deprivation participants reported greater subjective distress, anxiety, and anger in response to a low-stress cognitive task compared with normal sleepers; however, no differences in affect were observed between groups following a high-stress task (Minkel et al., 2012). This suggests that sleep-deprived individuals may have a lower threshold for what they perceive as stressful. Concordant with the line of thinking, participants under a night of sleep deprivation showed enhanced systolic blood pressure reactivity following an acute laboratory stressor (Franzen et al., 2011). In terms of chronic effects, poorer global subjective sleep quality enhanced the effects of acute stress exposure on proinflammatory cytokines (Heffner et al., 2012; Prather, Puterman, Epel, & Dhabhar, 2013).

Neural Mechanisms of Sleep and Affective Experience

Studies of sleep restriction have also demonstrated changes in several objective markers of emotional functioning, which further strengthens the argument that sleep is intimately related to the processing and production of affective experience. Franzen, Buysse, Dahl, Thompson, and Siegle (2009) employed pupillography as an indicator of affective processing and found that sleep-deprived participants showed greater pupil dilation to negative emotional stimuli compared with normal sleepers. Advances in neuroimaging have further illuminated the effects of sleep on the emotional brain. In a seminal study, Yoo, Hu, Gujar, Jolesz, and Walker (2007) showed that 1 night of sleep deprivation resulted in a 60% increase in reactivity of the amygdala to negative emotional stimuli compared with a rested control group. Moreover, sleep-deprived participants showed less functional connectivity between the amygdala and medial prefrontal cortex, a brain region important in exerting top-down regulatory control of the amygdala. This is consistent with a recent study that found similar decrements in functional connectivity between these brain regions and that the declines were associated with higher reports of state anxiety (Motomura et al., 2013). Habitual sleep quality has been significantly related to stronger links between amygdala reactivity and negative affect (Prather, Bogdan, & Hariri, 2013), while longer durations were associated with stronger resting state connectivity between the medial prefrontal cortex and the amygdala (Killgore, 2013). Taken together, these data suggest that sleep loss results in greater threat reactivity, possibly due to impaired emotion regulation. Consistent with this, a recent study found that poorer overall sleep quality was related to greater difficulty utilizing cognitive reappraisal strategies in response to a sadness-inducing film clip (Mauss, Troy, & LeBourgeois, 2013).

There is also mechanistic understanding of why sufficient sleep enhances emotional functioning (Goldstein & Walker, 2014), focused on the role of rapid eye movement (REM) sleep. In this regard, REM sleep has been shown to be central to emotional memory consolidation (see Walker & van der Helm, 2009, for a review). Additionally, REM sleep is proposed to aid in resolving the strong emotions associated with challenging memories, serving as a sort of "overnight therapy" (Walker & van der Helm, 2009). REM sleep has also been implicated in recalibrating the emotional brain before the next-day emotional events, thus restoring appropriate emotional reactivity (Goldstein & Walker, 2014). The centrality of REM sleep in emotional functioning is consistent with the observed REM abnormalities associated with daily affect (Vandekerckhove & Cluydts, 2010) and REM alterations commonly observed in psychiatric samples, particularly MDD and posttraumatic stress disorder (PTSD; Baglioni et al., 2010).

Summary and Future Directions

There continues to be disagreement over the purpose of sleep and why it is conserved across species despite drastically varied predatory environments. However, it is clear that one function may be to maintain adaptive emotional functioning—by resetting the limbic machinery each night for greater connectivity between aspects critical to emotion regulation, such as the medial prefrontal cortex and amygdala. Chronically disrupted sleep leads to greater negative mood, less positive mood, and in the extreme, affective disorders. In some cases, acute and chronically disturbed sleep predicts greater reactivity to an acute lab stressor, such as in terms of blood pressure and proinflammatory responsiveness. Acute sleep deprivation appears to shape affective experience as well, although few studies have actually assessed the dynamics of emotional experience across the day. Therefore, it remains unclear whether acute sleep loss affects the diurnal rhythmicity of positive and negative mood, which tends to change significantly from waking to bedtime. There is some evidence to suggest that circadian rhythms play a role, particularly with regard to positive affect. Research methods using both standardized lab stimuli, employing state-of-the-art emotional probes, and EMA to examine the architecture of affective experience of a day would shed light on the complex dynamics between sleep and affect. Sleep can vary across several distinct dimensions, including type (REM, non-REM), ability (initiation, maintenance), form (amount, structure), and occurrence (timing, variability; Walker & Harvey, 2010). The extent to which each dimension contributes to the generation and regulation of emotion remains to be discovered.

Another open question in sleep research is whether improvements in sleep can promote long-term changes in emotion. Indeed, behavioral sleep interventions are remarkably effective in improving sleep quality among individuals with clinical sleep disorders (e.g., insomnia; Edinger & Means, 2005), and while affective processes are not primary outcomes in trials testing the efficacy of sleep interventions, there is accruing evidence that improvements in symptoms of depression, anxiety, and overall quality of life often co-occur with resolving sleep (e.g., Thorndike et al., 2013). Unfortunately, a sophisticated exploration of the affective processes that may underlie some of these findings, as well as identification of individual differences that may contribute to success of the sleep treatment for some but not others, has been lacking. Accordingly, there is unique space for affective and sleep scientists to work together to explore these processes and improve health and well-being.

Eating

Culturally speaking, the power of food to comfort us has been assumed across many centuries, as early as 1615 in the first modern novel *Don Quixote*, in which Cervantes penned the line "All sorrows are less with bread" (p. 537). The rigorous study of how eating behavior affects emotions is, however, sparse. The effects of emotions—in particular, negative emotional states or stress—on eating are summarized in several reviews (Adam & Epel, 2007; Greeno & Wing, 1994; Sinha & Jastreboff, 2013; Wardle, Chida, Gibson, Whitaker, & Steptoe, 2011), and several of the most commonly used scales to measure eating behavior contain emotional eating subscales (Stunkard & Waterland, 1997; Van Strien, Frijters, Bergers, & Defares, 1986). Emotion is clearly important in triggering eating behavior, but does this eating behavior have consistent effects on changing emotional experience? If so, for who, and for how long? What are the long-term consequences?

Chronic Eating Behaviors

Chronically Disordered Eating, Emotions, and Affect

Individuals with eating disorders (anorexia nervosa and bulimia nervosa) report higher emotion regulation difficulties and have attentional biases toward negative emotional stimuli (Harrison, Sullivan, Tchanturia, & Treasure, 2010). Emotion regulation is particularly relevant to binge-eating disorder, with negative affect being the most commonly reported triggers for binge episodes (Polivy & Herman, 1993). In a clinical sample of treatment-seeking patients with binge-eating disorder, for example, emotional eating was related to fewer emotion regulation strategies, lack of emotional clarity, and difficulty accepting emotions (Gianini, White, & Masheb, 2013). Although studies of emotion regulation in eating-disordered populations are often framed as emotion regulation failure causing the disordered eating, many of these studies are cross-sectional, and therefore the converse—that eating disorders yield negative emotion regulation strategies—should also be considered.

Chronic Dietary Restraint and Dieting

Dieting is a common health behavior that can affect emotional states as well. Here we review studies on (1) diet interventions, which lower caloric intake; (2) self-reported dieting status (e.g., "Are you currently on a diet?"); and (3) chronic *dietary restraint*, which is not necessarily associated with lower caloric intake.

The negative emotional sequelae of severe caloric deprivation itself have been documented since the 1950s, beginning with Ansel Keys's seminal Minnesota Starvation Experiment using conscientious war objectors (Keys, Brozek, Henschel, Mickelson, & Taylor, 1950). In that study and others, negative emotional symptoms following dieting interventions included depressive symptomatology, anxiety, nervousness, weakness, and irritability (Stunkard & Rush, 1974; Stunkard, 1957). In experimental studies, dieting can cause depressive symptomatology in both animals (Chandler-Laney et al., 2007; Jahng et al., 2007) and humans (Wadden et al., 2004). Other human experimental data has indicated that dieting causes negative emotion after eating (Hetherington & MacDiarmid, 1993), as well as self-blame and negative views of one's character (Jeffery, French, & Schmid, 1990). In one of the few studies designed to examine the stress of dieting, in a randomized, controlled experiment, participants assigned to a 1,200-kilocalorie diet for just 3 weeks increased in both perceived stress and diurnal salivary cortisol levels, thereby providing causal evidence of dieting as an elicitor of the stress response (Tomiyama et al., 2010).

However, many intervention studies also find positive emotion effects of dieting. A paper that reviewed 10 studies of the mood effects of behavioral weight loss therapies found six out of 10 studies (separate from those above) showed an improvement in mood posttreatment while the other four showed no significant change in mood (Wing, Epstein, Marcus, & Kupfer, 1984). One short-term experimental study also observed improvements in depressive symptomatology (Bryan & Tiggemann, 2001).

In terms of self-reported dieting, depressive symptomatology appears to be one of the most common correlates of dieting in cross-sectional human studies (Ackard, Croll, & Kearney-Cooke, 2002; Cachelin & Regan, 2006; Crow, Eisenberg, Story, & Neumark-Sztainer, 2006; Gillen, Markey, & Markey, 2012; Isomaa, Isomaa, Marttunen, Kaltiala-Heino, & Bjorkqvist, 2010; Wadden, Stunkard, & Smoller, 1986). Other correlates of self-reported dieting status include anxiety symptoms (Isomaa et al., 2010). Similarly, higher dietary restraint is associated with greater depression (Cachelin & Regan, 2006), higher perceived psychological stress (McLean & Barr, 2003), and higher urinary levels of the stress hormone cortisol (McLean, Barr, & Prior, 2001).

Acute Eating Behavior

In terms of acute/experimental effects of eating on emotion and emotion regulation, several studies have examined effects of acute stress reactivity and negative mood on eating during recovery from stress. While some studies have shown that acute high cortisol reactivity predicts greater snacking after stress (Epel, Lapidus, McEwen, & Brownell, 2001; Newman, O'Connor, & Conner, 2007), other studies have found important moderators that suggest people with more stress eating may have underlying profiles of cortisol hyporeactivity. One study found that emotional eating moderated the relationship between cortisol responses to a standardized laboratory stressor (Trier Social Stress Test) and subsequent food intake, such that high-emotional eaters with a blunted cortisol response to the stressor ate more food (van Strien, Roelofs, & de Weerth, 2013). Tryon, DeCant, and Laugero (2013) found that chronically high-stress women with low cortisol reactivity ate more food in response to the stressor and had higher total fat percentage. It is unclear whether blunted stress response is a marker for vulnerability to emotional eating, or if emotional overeating dampens stress reactivity chronically, or both. In rodent research, chronic access to palatable food leads rats to develop abdominal fat, which then functions to dampen physiological stress responses at every level of the hypothalamic–pituitary–adrenal (HPA) axis (Dallman et al., 2003)—a phenomenon termed the "chronic stress response network" (Dallman, 2010; Dallman et al., 2003, 2004). Human research on this phenomenon is sparser, but one cross-sectional study found positive correlations among high chronic stress, emotional eating, and abdominal obesity, where high-stress women demonstrated dampened HPA axis activity (lower cortisol responses to a standardized stressor as well as lower daily cortisol levels; Tomiyama, Dallman, & Epel, 2011).

A small number of studies have examined food's effect on affect, rather than on stress response. Macht and Mueller (2007) found that compared with water, chocolate (but only palatable chocolate) ameliorated negative mood, although the effects were short-lived on the order of 3 minutes. In a different study by this group (Macht & Dettmer, 2006), however, both chocolate and apple consumption showed positive mood effects as long as 90 minutes after consumption. Interestingly, these positive mood effects were concurrent with guilt effects, particularly in the case of chocolate. Hetherington and MacDiarmid (1993) observed that positive mood effects of food occur only during the moment of eating, with negative emotions returning soon thereafter. Bongers, Jansen, Havermans, Roefs, and Nederkoorn (2013) found a positive correlation between calories consumed and mood improvement on a visual analog scale, regardless of whether the eating was induced by a negative, neutral, or positive mood-eliciting film clip. Finally, a study of adolescent young adult females found that the relationship between stressful life events and perceived stress was attenuated in self-reported emotional eaters (Finch & Tomiyama, 2015). However, this attenuation was not observed in those high in depressive symptoms, pointing to the complexity of the effect of eating behavior along the many different dimensions of affect.

Clearly, emotions must be measured frequently to capture acute effects of eating, and palatability of food may matter. Across three well-controlled lab studies, Wagner and colleagues (2014) sought to determine whether "comfort" food had comforting properties. Participants in these studies watched negative emotion-inducing film clips and were fed their top-ranked comfort food (including their desired brand and flavor) or a control food (a low-ranked noncomfort food), a neutral food (granola bars), or no food in respective studies. Comfort foods did indeed lead to significant improved mood, but no more so than any of the control conditions (which included no food at all), prompting the authors to determine that comfort food was a "myth." It is possible that for some people, when facing naturalistic life stressors that cause larger affective responses than the lab-based stressor, comfort eating might promote quicker recovery from negative affect through distraction or neural mechanisms of reward. It may also be that eating motives shape emotional response. Parker, Parker, and Brotchie (2006), based on their literature review, conclude that eating to feel better prolongs dysphoric mood, whereas eating to satisfy cravings provides hedonistic reward and improvements in mood.

Nutritional scientists have come at this question with a different lens by identifying chemical properties of food that might have psychoactive properties. Food contains substances such as carbohydrates, protein, fat, caffeine, tryptophan (the precursor to serotonin), and theobromine (a stimulant that is relatively high in chocolate), all of which can affect emotions (Rogers, 1995). These emotion effects are sometimes observed only when the relative ratio of one substance to another is altered. For example, food that is high in carbohydrates but low in protein can increase the ratio of tryptophan to other large neutral amino acids and therefore affects central serotonergic function (Markus et al., 1998; Wurtman, Hefti, & Melamed, 1980). Beyond chemical substances, the orosensory properties of food (i.e., sweetness as opposed to sucrose content) can also have emotion effects. Administering sugar (vs. water) to infants reduces crying (Ramenghi et al., 2002; Smith, Fillion, & Blass, 1990), and these effects can be seen with nutritionally insignificant amounts of sucrose, implicating orosensory effects. These effects are likely mediated through opioid peptides (Kirkham & Cooper, 1988). Rogers's (1995) review of the chemical properties of food highlight other notable inconsistencies in the literature, such as the fact that mood-altering chemicals in chocolate occur at much higher levels in foods not often used for mood effects (Rogers & Smit, 2000), and note the importance of culture, learned preferences, and moderators such as dietary restraint. Examining key mediators and moderators, as well as nutritional and orosensory components, may provide a fuller picture of the effects of eating on emotions.

Neural Mechanisms of Eating and Affective Experience

The neural mechanisms that govern eating are complex and deeply intertwined with affective and emotional experience, and beyond the scope of this chapter. Here we highlight a few key models that specifically address affective and emotional *responses* to eating behavior, as that is the focus of this chapter. The aforementioned chronic stress response network as put forth by Dallman and colleagues (Dallman, 2010; Dallman et al., 2003) describes decreased basal corticotropin-releasing factor (CRF) in the hypothalamus of rodents that have consumed "comfort foods" under conditions of chronic stress. In this model, comfort foods also lessen chronic stress-induced dopamine inhibition (by preventing inhibition of dopamine output and increasing dopamine transporter activity) in the nucleus accumbens seen under chronic stress. Furthermore, comfort-eating behavior promotes intra-abdominal fat stores, which go on to act as a surrogate negative feedback signal, suppressing hypothalamic CRF expression (Dallman et al., 2004). These neural mechanisms, however, have yet to be confirmed in humans. In their reward-based stress eating model, Adam and Epel (2007) describe the ability of palatable foods to stimulate endogenous opioid release in the brain, which in turn function to attenuate the HPA stress response. Stress further sensitizes the brain to the rewarding value of palatable food, leading to a chronic drive for palatable food, and chronic suppression of the stress response. In our unpublished data from a large weight loss trial, we find that women with a blunted cortisol response to a stressor have both a greater drive to eat and a significantly greater likelihood to regain weight earlier, underscoring the tight links between eating and reactivity. Causality is unknown but the rodent studies suggest that palatable food consumption can precede the blunted reactivity.

Summary and Future Directions

Eating is a complex behavior, with many factors to consider such as overeating versus dieting, nutrient content versus orosensory properties of food, and time course of emotion effects due to eating behavior—the latter particularly in the context of acute eating given the conflicting literature. Furthermore, the potential negative emotional consequences of dieting, which is typically considered "healthy," should not be overlooked. Conversely, the positive emotional effects of being on a diet should be better understood. We must understand how dieting can promote both positive and negative emotion. What type of restricted eating behavior promotes positive emotion, and for what type of person? Can we tailor interventions so that people have positive emotion as a reinforcement and less of the "stress of dieting," and are thus more likely to adhere?

Alcohol

"Drown your sorrows" is an adage that captures the emotion-dampening role of alcohol. For centuries, humans have turned to alcohol in response to emotions (Sayette, 1993). How does imbibing alcohol, in turn, affect emotion? Of the health behaviors discussed in this chapter, the theory and literature on alcohol's effect on emotions is the most long-standing. The dampening effect of alcohol on negative emotion is one of the key examples of Hull's (1943) drive reduction theory of motivation from the 1940s. An often-cited study from this decade showed, for example, that cats provided ethanol demonstrated reduced tension and cat neurosis (Masserman & Yum, 1946). Conger (1956) then formally characterized the tension reduction hypothesis of alcohol in the 1950s, which has spawned nearly 70 years of research on what the literature has termed "stress-response dampening" (SRD; Levenson, Sher, Grossman, Newman, & Newlin, 1980; Sher & Walitzer, 1986) resulting from alcohol consumption (Sayette, 1993).

Chronic Alcohol Use

The effects of chronic alcohol use and alcoholism on emotion have been studied during use and in response to withdrawal. Anxiety and depression are often comorbid with alcoholism, although in some cases a pathological absence of anxiety (externalizing psychopathology) is also observed (Heilig, Egli, Crabbe, & Becker, 2010). Increased anxiety is a hallmark of alcohol withdrawal, and poses a risk for relapse during treatment (Heilig et al., 2010). In later stages of alcohol withdrawal, heightened stress sensitivity (Lovallo, Dickensheets, Myers, Thomas, & Nixon, 2000) and upregulated HPA axis responsivity (Heilig & Koob, 2007) are observed. In recently abstinent alcohol-dependent individuals, however, hyporesponsivity of the HPA axis is observed (see Adinoff, Junghanns, Kiefer, & Krishnan-Sarin, 2005).

Acute Alcohol Use

The acute effects of alcohol use on stress reactivity have been widely studied in the SRD literature. Stress has been operationalized using a variety of measures. Rat models demonstrate a direct SRD effect, wherein ethanol administration dampens basal corticosterone levels (Brick & Pohorecky, 1985) as well as corticosterone responses to foot shock, restraint, and tail pinch stress (Brick & Pohorecky, 1982). In humans, acute alcohol consumption has been shown to dampen self-report measures of anxiety and distress, such as the State/Trait Anxiety Inventory (Spielberger, 2005) and physiological measures such as galvanic skin response and cardiovascular reactivity as measured by heart rate (Sayette, 1993). Despite these and other empirical studies, notable inconsistencies in the literature are evident (Wilson, 1988). For example, researchers have observed a "crying-in-your-beer" effect, wherein alcohol consumption can exacerbate negative emotions (Steele & Josephs, 1988). Indeed, for every paper indicating SRD effects in self-report, physiological, and behavioral stress, roughly equal numbers of studies fail to find effects in these very outcomes (Sayette, 1993). Even within studies examining physiological outcomes, alcohol effects can diverge, with significant findings for some measures and not others (Stritzke, Lang, & Patrick, 1996). A number of theoretical approaches have been advanced to reconcile these conflicting findings. Most notable are the Steele and Josephs's (1988, 1990) attention allocation model (later renamed the alcohol myopia model), Sayette's (1993) appraisal disruption model, and Hull's (1981) self-awareness model.

Noting that none of the existing models of alcohol and emotion was able to account for the many divergent findings, Stritzke and colleagues (1996) outlined several methodological issues to consider, including lack of consistent operationalization of "stress," both in terms of experimental manipulations and outcome measures, variation in time sampling, and variation in data analytic procedures. They called for multilevel, multidimensional models of emotion/affect that simultaneously take into account, for example, appetitive versus withdrawal motivations, positive and negative valence, and primary motivational systems versus higher cognitive functions. They also called for experimental designs that do not confound the physiological effects of alcohol with the outcome measures. For example, alcohol pharmacologically increases heart rate, and therefore using heart rate to index emotional arousal would be unproductive (Stritzke et al., 1996).

The phrase "drown your sorrows" suggests that dampening negative emotion is the predominant reason for alcohol use, but individuals also use alcohol to experience positive emotion. Among recovering alcoholics, the reasons cited for relapse are not only reducing negative emotions but also actively seeking euphoria (Marlatt & Gordon, 1980). Individuals also use alcohol acutely to increase positive emotions, particularly when fatigued or underaroused (Wills & Shiffman, 1985), or when drinking with social motives (Cooper, Frone, Russell, & Mudar, 1995).

Neural Mechanisms of Emotional Response to Alcohol Consumption

Alcohol, unlike food, is processed centrally by the central nervous system (CNS). The stimulant/depression hypothesis of alcohol accounts for both the positive and negative emotions that arise out of alcohol consumption (Tucker, Vuchinich, & Sobell, 1982). At low to moderate levels, alcohol is presumed to act as an emotional stimulant and euphoriant (or "elatant"), whereas at higher levels, alcohol acts as an emotional depressant (Stritzke et al., 1996). Another conceptualization that takes into account the arc of CNS metabolism of alcohol is the slope of intake; rather than simple blood alcohol levels, the "rising limb" of the blood alcohol content curve is presumed to be stimulating and elating, whereas the "falling limb" of intoxication acts as an emotional depressant (Newlin & Thomson, 1990; Stritzke et al., 1996). In support of this, euphoria ratings and EEG alpha activity were closely tied to the rising blood alcohol curve in one study, but only at moderate (not low) doses (Lukas, Mendelson, Benedikt, & Jones, 1986).

Summary and Future Directions

Taken together, substantial research supports the existence of a relationship between alcohol and changes in emotional experience. However, the literature is extremely conflicted, pointing to the existence of many dispositional and situational moderators (summarized in Sayette, 1999). Regardless of whether drinking actually elicits positive or negative emotion, it is clear that individuals *expect* changes in emotional states—and these expectations may be the most fruitful area for intervention. In the validation sample of the widely used Alcohol Expectancies Scale (Brown, Christiansen, & Goldman, 1987), "physical and social pleasure" and "relaxation and tension reduction" were among the subscales with the highest endorsement (Brown, Goldman, Inn, & Anderson, 1980). Indeed, interventions that target these expectancies have had success in the short term (Darkes & Goldman, 1993; Scott-Sheldon, Terry, Carey, Garey, & Carey, 2012).

Future research should identify individual differences that govern differential responses to alcohol, with careful calibration of blood alcohol content given the physiological actions of alcohol. Do emotional effects on a person predict vulnerability to addiction, or treatment response? For example, those who evidence subjective sensitivity to the stimulating properties of alcohol (e.g., those who feel "elated" and "excited"; Martin, Earleywine, Musty, Perrine, & Swift, 1993) relative to the sedating properties of alcohol (e.g., those who feel "down") are at greater risk of developing alcoholism (Ray, Mackillop, & Monti, 2010). Finally, as alcohol contains calories, the fields of eating behavior and alcohol consumption should intersect, and future studies should also examine the two behaviors in tandem as they relate to emotional experience.

General Conclusions and Future Research Directions

Our emotional life, starting early in life, shapes our pattern of health behaviors in ways that are difficult to change. While the transactional process between emotions and health behaviors has been a focus of some scientific inquiry, one angle that has received little attention is whether engagement in health behaviors shapes emotional processes, and if this, in turn, has consequences for future health behaviors. This review shows that health behaviors have potent effects on immediate affective and emotional responses, longer-term mood states, appraisal of stressful situations, and stress reactivity.

While our review also highlights specific areas in the brain that play a role in modulating emotional states and affective responses to stress in response to each specific behavior, it is important to move beyond the idea that there is any type of one-to-one mapping of brain region and function. While each has been studied in isolation, recent reviews highlight common underlying brain regions for many health behaviors and emotions (Barrett & Simmons, under review; Lenard & Berthoud, 2008). Barrett and Simmons (under review) and Lenard and Berthoud (2008) highlight the key role of the limbic region to gauge and modulate glucose storage and usage in the body, and to promote behavioral modifications (e.g., increased or decreased food intake, exercise, sleep) accordingly to access more or use fewer nutrients (or vice versa). Emotions are the interoceptive experiences of the incongruence between the nutrient needs and usage of the body and memories from previous experiences. Emotions can thus result from or promote/hinder behavioral engagement. Within this context, for example, the findings that exercising beyond our physiological thresholds stimulates negative affective states (Ekkekakis et al., 2008; Ekkekakis & Petruzzello, 1999; Hall et al., 2002; Welch et al., 2010) makes biological sense. The negative affective state that is reached when one surpasses his or her threshold is perhaps the interoceptive experience resulting from a physiological imbalance that attempts to provoke disengagement of the activity.

We propose that a deeper understanding of the behavior–affect trajectory, in part by adopting a transdisciplinary framework, may lead to powerful insights into how to tailor interventions for better adherence and ultimately mobilize this information for health promotion at the individual and population level (Figure 40.1). We further propose that the study of chronic health behavior effects would be best performed through long-term interventions that examine the process of change, as well as an examination of dose–response effects, and a closer examination of affect valence and arousal dynamics (Kuppens, Tuerlinckx, Russell, & Barrett, 2013).

There is tremendous potential to learn about the development and maintenance of health behaviors by applying an emotion research lens. Emotion research provides a fresh perspective on the old but important questions such as Why do some people adopt and adhere to health behaviors, both salutary (sufficient exercise and sleep) and damaging (overeating and alcohol abuse)? It also raises new questions at the heart of the emotion–health behavior processes, such as How can we capitalize on the finding that, in many cases, doing what is good for us feels good? Further, how do we reconcile that harmful appetitive behaviors, like overeating, make us feel good in the moment but often promote more negative affect than positive in the long term? Using the methodology of emotion research for a more mechanistic view of how health behaviors affect emotional and affective experiences and regulation will provide a large step forward in this field. Such information might be applied to promote more effective interventions.

We call for a new generation of research that takes on understanding the health behavior–emotion relationship with greater granularity. Specifically, we believe that it is critical that research investigate the emotional antecedents and consequences that bookend both salubrious and deleterious health behaviors, with attention to both valence and arousal, and their interrelationship (Kuppens et al., 2013; see Figure 40.1). Factors that increase postbehavior positive affect or reduce postbehavior negative affect should be identified and capitalized on. For example, manipulating positive expectations appears to have at least a short-term effect on positive affect and intentions to engage in the behavior again.

The first steps in laying a foundation in this area would be a fuller examination of emotional experience throughout the health behavior process—before onset of health behavior, during, in recovery, and long-term effects. For people who do not have the habit of a behavior (e.g., not a regular exerciser) what is the valence, arousal, and duration of positive and negative emotions arising from a bout of a new health behavior (e.g., a bout of exercise)? Do emotional effects last across a day or spill into subsequent days, and what determines duration? Does the health behavior impact the balance of positive and negative valence, evoke specific types of emotions, and/or alter appraisal processes? Such studies will require both laboratory experiments, EMA methods in naturalistic environments, and randomized behavioral interventions. **Without a within-person examination of behavior and affect dynamics, intervention data will be of limited utility in explaining individual differences in uptake and adherence of new behaviors.**

There is also a need to identify important individual differences in the behavior–emotion relationship, which may be behavior dependent. As noted above, both fitness level and dietary restraint appear to matter for exercise and for eating, respectively. Genetic propensities, personality, or emotional differences are likely important as well. It will also be important to more closely examine the mechanisms through which the health behavior modulates and improves emotional responses. For instance, the specific emotion regulation processes underlying exaggerated stress sensitivity and how they shift after behavioral interventions are key to our understanding of the emotional benefits of behavior change.

The science of emotion and behavior change hold great promise for improving individual and population health. It is clear that investigations of chronic and acute effects of specific health behaviors provide important information about emotions, affective states and regulatory processes, and their underlying neurobiology. Innovations in physiological assessment, including neuroimaging, and in sampling daily experience, provide windows into health behavior–emotion processes once hidden from view. Future research focused on teasing apart and carefully tracking the dynamic and recursive processes linking emotion and health behaviors will, without question, advance our science of both, and thus our ability to promote lifelong health at its roots.

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References

Ackard, D. M., Croll, J. K., & Kearney-Cooke, A. (2002). Dieting frequency among college females: Association with disordered eating, body image, and related psychological problems. *Journal of Psychosomatic Research, 52*(3), 129–136.

Adam, T. C., & Epel, E. S. (2007). Stress, eating and the reward system. *Physiology and Behavior, 91*(4), 449–458.

Adinoff, B., Junghanns, K., Kiefer, F., & Krishnan-Sarin, S. (2005). Suppression of the HPA axis stress-response: Implications for relapse. *Alcoholism, Clinical and Experimental Research, 29*(7), 1351–1355.

Anshel, M. H. (1996). Effect of chronic aerobic exercise and progressive relaxation on motor performance and affect following acute stress. *Behavioral Medicine, 21*(4), 186–196.

Babson, K. A., Trainor, C. D., Feldner, M. T., & Blumenthal, H. (2010). A test of the effects of acute sleep deprivation on general and specific self-reported anxiety and depressive symptoms: An experimental extension. *Journal of Behavior Therapy and Experimental Psychiatry, 41*(3), 297–303.

Babyak, M., Blumenthal, J. A., Herman, S., Khatri, P., Doraiswamy, M., Moore, K., et al. (2000). Exercise treatment for major depression: Maintenance of therapeutic benefit at 10 months. *Psychosomatic Medicine, 62*(5), 633–638.

Baglioni, C., Battagliese, G., Feige, B., Spiegelhalder, K., Nissen, C., Voderholzer, U., et al. (2011). Insomnia as a predictor of depression: A meta-analytic evaluation of longitudinal epidemiological studies. *Journal of Affective Disorders, 135*(1-3), 10–19.

Baglioni, C., Spiegelhalder, K., Lombardo, C., & Riemann, D. (2010). Sleep and emotions: A focus on insomnia. *Sleep Medicine Reviews, 14*(4), 227–238.

Barbour, K. A., Edenfield, T. M., & Blumenthal, J. A. (2007). Exercise as a treatment for depression and other psychiatric disorders. *Journal of Cardiopulmonary Rehabilitation and Prevention, 27*(6), 359–367.

Barrett, L. F., & Simmons, W. K. (under review). Limbic cortex and its role in interoceptive predictions within the brain. Manuscript submitted for publication.

Baum, K. T., Desai, A., Field, J., Miller, L. E., Rausch, J., & Beebe, D. W. (2014). Sleep restriction worsens mood and emotion regulation in adolescents. *Journal of Child Psychology and Psychiatry, 55*(2), 180–190.

Blumenthal, J. A., Babyak, M. A., Doraiswamy, P. M., Watkins, L., Hoffman, B. M., Barbour, K. A., et al. (2007). Exercise and pharmacotherapy in the treatment of major depressive disorder. *Psychosomatic Medicine, 69*(7), 587–596.

Bongers, P., Jansen, A., Havermans, R., Roefs, A., & Nederkoorn, C. (2013). Happy eating: The underestimated role of overeating in a positive mood. *Appetite, 67*, 74–80.

Brick, J., & Pohorecky, L. A. (1982). Ethanol-stress interaction: Biochemical findings. *Psychopharmacology, 77*(1), 81–84.

Brick, J., & Pohorecky, L. A. (1985). Monoamines and the effect of ethanol on corticosterone and non-esterified fatty acids. *Alcohol, 2*(2), 261–265.

Brosse, A. L., Sheets, E. S., Lett, H. S., & Blumenthal, J. A. (2002). Exercise and the treatment of clinical depression in adults: Recent findings and future directions. *Sports Medicine, 32*(12), 741–760.

Brown, S. A., Christiansen, B. A., & Goldman, M. S. (1987). The Alcohol Expectancy Questionnaire: An instrument for the assessment of adolescent and adult alcohol expectancies. *Journal of Studies on Alcohol, 48*(5), 483–491.

Brown, S. A., Goldman, M. S., Inn, A., & Anderson, L. R. (1980). Expectations of reinforcement from alcohol: Their domain and relation to drinking patterns. *Journal of Consulting and Clinical Psychology, 48*(4), 419–426.

Bryan, J., & Tiggemann, M. (2001). The effect of weight-loss dieting on cognitive performance and psychological well-being in overweight women. *Appetite, 36*(2), 147–156.

Cachelin, F. M., & Regan, P. C. (2006). Prevalence and correlates of chronic dieting in a multi-ethnic U.S. community sample. *Eating and Weight Disorders, 11*(2), 91–99.

Caiozzo, V. J., Davis, J. A., Ellis, J. F., Azus, J. L., Vandagriff, R., Prietto, C. A., et al. (1982). A comparison of gas exchange indices used to detect the anaerobic threshold. *Journal of Applied Physiology: Respiratory, Environmental and Exercise Physiology, 53*(5), 1184–1189.

Camacho, T. C., Roberts, R. E., Lazarus, N. B., Kaplan, G. A., & Cohen, R. D. (1991). Physical activity and depression: Evidence from the Alameda County Study. *American Journal of Epidemiology, 134*(2), 220–231.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Reports, 100*(2), 126–131.

Cervantes, S. M. (1615). *Don Quixote.* Spain: Francisco de Robles.

Chandler-Laney, P. C., Castaneda, E., Pritchett, C. E., Smith, M. L., Giddings, M., Artiga, A. I., et al. (2007). A history of caloric restriction induces neurochemical and behavioral changes in rats consistent with models of depression. *Pharmacology, Biochemistry, and Behavior, 87*(1), 104–114.

Chomistek, A. K., Manson, J. E., Stefanick, M. L., Lu, B., Sands-Lincoln, M., Going, S. B., et al. (2013). Relationship of sedentary behavior and physical activity to incident cardiovascular disease: Results from the Women's Health Initiative. *Journal of the American College of Cardiology, 61*(23), 2346–2354.

Conger, J. J. (1956). Alcoholism: Theory, problem and challenge: II. Reinforcement theory and the dynamics of alcoholism. *Quarterly Journal of Studies on Alcohol, 17*(2), 296–305.

Conn, V. S. (2010a). Anxiety outcomes after physical activity interventions: Meta-analysis findings. *Nursing Research, 59*(3), 224–231.

Conn, V. S. (2010b). Depressive symptom outcomes of physical activity interventions: Meta-analysis findings. *Annals of Behavioral Medicine, 39*(2), 128–138.

Cooper, M. L., Frone, M. R., Russell, M., & Mudar, P. (1995). Drinking to regulate positive and negative emotions: A motivational model of alcohol use. *Journal of Personality and Social Psychology, 69*(5), 990–1005.

Crow, S., Eisenberg, M. E., Story, M., & Neumark-Sztainer, D. (2006). Psychosocial and behavioral correlates of dieting among overweight and non-overweight adolescents. *Journal of Adolescent Health, 38*(5), 569–574.

Dagys, N., McGlinchey, E. L., Talbot, L. S., Kaplan, K. A., Dahl, R. E., & Harvey, A. G. (2012). Double trouble?: The effects of sleep deprivation and chronotype on adolescent affect. *Journal of Child Psychology and Psychiatry, 53*(6), 660–667.

Dahl, R. E. (2004). Adolescent brain development: A period of vulnerabilities and opportunities. [Keynote address.] *Annals of the New York Academy of Sciences, 1021*, 1–22.

Dallman, M. F. (2010). Stress-induced obesity and the emotional nervous system. *Trends in Endocrinology and Metabolism, 21*(3), 159–165.

Dallman, M. F., La Fleur, S. E., Pecoraro, N. C., Gomez, F., Houshyar, H., & Akana, S. F. (2004). Minireview: Glucocorticoids—food intake, abdominal obesity, and wealthy nations in 2004. *Endocrinology, 145*(6), 2633–2638.

Dallman, M. F., Pecoraro, N., Akana, S. F., La Fleur, S. E., Gomez, F., Houshyar, H., et al. (2003). Chronic stress and obesity: A new view of "comfort food." *Proceedings of the National Academy of Sciences USA, 100*(20), 11696–11701.

Darkes, J., & Goldman, M. S. (1993). Expectancy challenge and drinking reduction: Experimental evidence for a mediational process. *Journal of Consulting and Clinical Psychology, 61*(2), 344.

DeSteno, D., Gross, J. J., & Kubzansky, L. (2013). Affective science and health: The importance of emotion and emotion regulation. *Health Psychology, 32*(5), 474–486.

Dietrich, A., & Audiffren, M. (2011). The reticular-activating hypofrontality (RAH) model of acute exercise. *Neuroscience and Biobehavioral Reviews, 35*(6), 1305–1325.

Dinges, D. F., Pack, F., Williams, K., Gillen, K. A., Powell, J. W., Ott, G. E., et al. (1997). Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4–5 hours per night. *Sleep, 20*(4), 267–277.

Dishman, R. K., Berthoud, H.-R., Booth, F. W., Cotman, C. W., Edgerton, V. R., Fleshner, M. R., et al. (2006). Neurobiology of exercise. *Obesity, 14*(3), 345–356.

Drake, C. L., Roehrs, T., Richardson, G., Walsh, J. K., & Roth, T. (2004). Shift work sleep disorder: Prevalence and consequences beyond that of symptomatic day workers. *Sleep, 27*(8), 1453–1462.

Edinger, J. D., & Means, M. K. (2005). Cognitive-behavioral therapy for primary insomnia. *Clinical Psychology Review, 25*(5), 539–558.

Ekkekakis, P. (2009a). Illuminating the black box: Investigating prefrontal cortical hemodynamics during exercise with near-infrared spectroscopy. *Journal of Sport and Exercise Psychology, 31*(4), 505–553.

Ekkekakis, P. (2009b). Let them roam free?: Physiological and psychological evidence for the potential of self-selected exercise intensity in public health. *Sports Medicine, 39*(10), 857–888.

Ekkekakis, P., Hall, E. E., & Petruzzello, S. J. (2008). The relationship between exercise intensity and affective responses demystified: To crack the 40-year-old nut, replace the 40-year-old nutcracker! *Annals of Behavioral Medicine, 35*(2), 136–149.

Ekkekakis, P., & Lind, E. (2006). Exercise does not feel the same when you are overweight: The impact of self-selected and imposed intensity on affect and exertion. *International Journal of Obesity, 30*(4), 652–660.

Ekkekakis, P., & Petruzzello, S. J. (1999). Acute aerobic exercise and affect: Current status, problems and prospects regarding dose–response. *Sports Medicine, 28*(5), 337–374.

Elavsky, S., McAuley, E., Motl, R. W., Konopack, J. F., Marquez, D. X., Hu, L., et al. (2005). Physical activity enhances long-term quality of life in older adults: Efficacy, esteem, and affective influences. *Annals of Behavioral Medicine, 30*(2), 138–145.

Epel, E., Lapidus, R., McEwen, B., & Brownell, K. (2001). Stress may add bite to appetite in women: A laboratory study of stress-induced cortisol and eating behavior. *Psychoneuroendocrinology, 26*(1), 37–49.

Farmer, M. E., Locke, B. Z., Mościcki, E. K., Dannenberg, A. L., Larson, D. B., & Radloff, L. S. (1988). Physical activity and depressive symptoms: The NHANES I Epidemiologic Follow-Up Study. *American Journal of Epidemiology, 128*(6), 1340–1351.

Finch, L. E., & Tomiyama, A. J. (2015). Comfort eating, psychological stress, and depressive symptoms in young adult women. *Appetite, 95*, 239–244.

Franzen, P. L., Buysse, D. J., Dahl, R. E., Thompson, W., & Siegle, G. J. (2009). Sleep deprivation alters pupillary reactivity to emotional stimuli in healthy young adults. *Biological Psychology, 80*(3), 300–305.

Franzen, P. L., Gianaros, P. J., Marsland, A. L., Hall, M. H., Siegle, G. J., Dahl, R. E., et al. (2011). Cardiovascular reactivity to acute psychological stress following sleep deprivation. *Psychosomatic Medicine, 73*(8), 679–682.

Franzen, P. L., Siegle, G. J., & Buysse, D. J. (2008). Relationships between affect, vigilance, and sleepiness following sleep deprivation. *Journal of Sleep Research, 17*(1), 34–41.

Fumoto, M., Oshima, T., Kamiya, K., Kikuchi, H., Seki, Y., Nakatani, Y., et al. (2010). Ventral prefrontal cortex and serotonergic system activation during pedaling exercise induces negative mood improvement and increased alpha band in EEG. *Behavioural Brain Research, 213*(1), 1–9.

Giacobbi, P., Hausenblas, H., & Frye, N. (2005). A naturalistic assessment of the relationship between personality, daily life events, leisure-time exercise, and mood. *Psychology of Sport and Exercise, 6*(1), 67–81.

Gianini, L. M., White, M. A., & Masheb, R. M. (2013).

Eating pathology, emotion regulation, and emotional overeating in obese adults with binge eating disorder. *Eating Behaviors, 14*(3), 309–313.

Gillen, M. M., Markey, C. N., & Markey, P. M. (2012). An examination of dieting behaviors among adults: Links with depression. *Eating Behaviors, 13*(2), 88–93.

Goldstein, A. N., & Walker, M. P. (2014). The role of sleep in emotional brain function. *Annual Review of Clinical Psychology, 10*, 679–708.

Goodwin, R. D. (2003). Association between physical activity and mental disorders among adults in the United States. *Preventive Medicine, 36*(6), 698–703.

Greeno, C. G., & Wing, R. R. (1994). Stress-induced eating. *Psychological Bulletin, 115*(3), 444–464.

Gujar, N., Yoo, S. S., Hu, P., & Walker, M. P. (2011). Sleep deprivation amplifies reactivity of brain reward networks, biasing the appraisal of positive emotional experiences. *Journal of Neuroscience, 31*(12), 4466–4474.

Hall, E. E., Ekkekakis, P., & Petruzzello, S. J. (2002). The affective beneficence of vigorous exercise revisited. *British Journal of Health Psychology, 7*(Part 1), 47–66.

Hall, E. E., Ekkekakis, P., & Petruzzello, S. J. (2010). Predicting affective responses to exercise using resting EEG frontal asymmetry: Does intensity matter? *Biological Psychology, 83*(3), 201–206.

Hall, M., Levenson, J., & Hasler, B. (2012). Sleep and emotion. In C. M. Morin & C. A. Espie (Eds.), *The Oxford handbook of sleep and sleep disorders* (pp. 131–149). New York: Oxford University Press.

Harrison, A., Sullivan, S., Tchanturia, K., & Treasure, J. (2010). Emotional functioning in eating disorders: Attentional bias, emotion recognition and emotion regulation. *Psychological Medicine, 40*(11), 1887–1897.

Harvey, A. G., Murray, G., Chandler, R. A., & Soehner, A. (2011). Sleep disturbance as transdiagnostic: Consideration of neurobiological mechanisms. *Clinical Psychology Review, 31*(2), 225–235.

Hasler, B. P., Allen, J. J., Sbarra, D. A., Bootzin, R. R., & Bernert, R. A. (2010). Morningness–eveningness and depression: Preliminary evidence for the role of the behavioral activation system and positive affect. *Psychiatry Research, 176*(2-3), 166–173.

Heffner, K. L., Ng, H. M., Suhr, J. A., France, C. R., Marshall, G. D., Pigeon, W. R., et al. (2012). Sleep disturbance and older adults' inflammatory responses to acute stress. *American Journal of Geriatric Psychiatry, 20*(9), 744–752.

Heilig, M., Egli, M., Crabbe, J. C., & Becker, H. C. (2010). Acute withdrawal, protracted abstinence and negative affect in alcoholism: Are they linked? *Addiction Biology, 15*(2), 169–184.

Heilig, M., & Koob, G. F. (2007). A key role for corticotropin-releasing factor in alcohol dependence. *Trends in Neurosciences, 30*(8), 399–406.

Helfer, S. G., Elhai, J. D., & Geers, A. L. (2015). Affect and exercise: Positive affective expectations can increase post-exercise mood and exercise intentions. *Annals of Behavioral Medicine, 49*, 269–279.

Hetherington, M. M., & MacDiarmid, J. I. (1993). "Chocolate addiction": A preliminary study of its description and its relationship to problem eating. *Appetite, 21*(3), 233–246.

Hoffman, B. M., Babyak, M. A., Craighead, W. E., Sherwood, A., Doraiswamy, P. M., Coons, M. J., et al. (2011). Exercise and pharmacotherapy in patients with major depression: One-year follow-up of the SMILE Study. *Psychosomatic Medicine, 73*(2), 127–133.

Hu, L., Motl, R. W., McAuley, E., & Konopack, J. F. (2007). Effects of self-efficacy on physical activity enjoyment in college-aged women. *International Journal of Behavioral Medicine, 14*(2), 92–96.

Hull, C. L. (1943). *Principles of behavior.* Oxford, UK: Appleton-Century.

Hull, J. G. (1981). A self-awareness model of the causes and effects of alcohol consumption. *Journal of Abnormal Psychology, 90*(6), 586–600.

Iovieno, N., van Nieuwenhuizen, A., Clain, A., Baer, L., & Nierenberg, A. A. (2011). Residual symptoms after remission of major depressive disorder with fluoxetine and risk of relapse. *Depression and Anxiety, 28*(2), 137–144.

Isomaa, R., Isomaa, A. L., Marttunen, M., Kaltiala-Heino, R., & Bjorkqvist, K. (2010). Psychological distress and risk for eating disorders in subgroups of dieters. *European Eating Disorders Review, 18*(4), 296–303.

Jahng, J. W., Kim, J. G., Kim, H. J., Kim, B. T., Kang, D. W., & Lee, J. H. (2007). Chronic food restriction in young rats results in depression- and anxiety-like behaviors with decreased expression of serotonin reuptake transporter. *Brain Research, 1150*, 100–107.

Jamal, M. (2004). Burnout, stress and health of employees on non-standard work schedules: A study of Canadian workers. *Stress and Health, 20*(3), 113–119.

Jeffery, R. W., French, S. A., & Schmid, T. L. (1990). Attributions for dietary failures: Problems reported by participants in the Hypertension Prevention Trial. *Health Psychology, 9*(3), 315–329.

Jerome, G. J., Marquez, D. X., McAuley, E., Canaklisova, S., Snook, E., & Vickers, M. (2002). Self-efficacy effects on feeling states in women. *International Journal of Behavioral Medicine, 9*(2), 139–154.

Kahn, M., Sheppes, G., & Sadeh, A. (2013). Sleep and emotions: Bidirectional links and underlying mechanisms. *International Journal of Psychophysiology, 89*(2), 218–228.

Katzmarzyk, P. T. (2010). Physical activity, sedentary behavior, and health: Paradigm paralysis or paradigm shift? *Diabetes, 59*(11), 2717–2725.

Keys, A., Brozek, J., Henschel, A., Mickelson, O., & Taylor, H. L. (1950). *The biology of human starvation*. Oxford Township: University of Minnesota Press.

Killgore, W. D. (2013). Self-reported sleep correlates with prefrontal-amygdala functional connectivity and emotional functioning. *Sleep, 36*(11), 1597–1608.

Kirkham, T. C., & Cooper, S. J. (1988). Naloxone attenuation of sham feeding is modified by manipulation of sucrose concentration. *Physiology and Behavior, 44*(4–5), 491–494.

Kop, W. J., Synowski, S. J., Newell, M. E., Schmidt, L. A., Waldstein, S. R., & Fox, N. A. (2011). Autonomic nervous system reactivity to positive and negative mood induction: The role of acute psychological responses and frontal electrocortical activity. *Biological Psychology, 86*(3), 230–238.

Kuppens, P., Tuerlinckx, F., Russell, J. A., & Barrett, L. F. (2013). The relation between valence and arousal in subjective experience. *Psychological Bulletin, 139*, 917–940.

Lampinen, P., Heikkinen, R. L., & Ruoppila, I. (2000). Changes in intensity of physical exercise as predictors of depressive symptoms among older adults: An eight-year follow-up. *Preventive Medicine, 30*(5), 371–380.

Legrand, F. D., Bertucci, W. M., & Thatcher, J. (2009). Telic dominance influences affective response to a heavy-intensity 10-min treadmill running session. *Journal of Sports Sciences, 27*(10), 1059–1067.

Lenard, N. R., & Berthoud, H.-R. (2008). Central and peripheral regulation of food intake and physical activity: Pathways and genes. *Obesity, 16* (S3), S11–S22.

Levenson, R. W., Sher, K. J., Grossman, L. M., Newman, J., & Newlin, D. B. (1980). Alcohol and stress response dampening: Pharmacological effects, expectancy, and tension reduction. *Journal of Abnormal Psychology, 89*(4), 528–538.

Lind, E., Ekkekakis, P., & Vazou, S. (2008). The affective impact of exercise intensity that slightly exceeds the preferred level: "Pain" for no additional "gain." *Journal of Health Psychology, 13*(4), 464–468.

Lovallo, W. R., Dickensheets, S. L., Myers, D. A., Thomas, T. L., & Nixon, S. J. (2000). Blunted stress cortisol response in abstinent alcoholic and polysubstance-abusing men. *Alcoholism, Clinical and Experimental Research, 24*(5), 651–658.

Lukas, S. E., Mendelson, J. H., Benedikt, R. A., & Jones, B. (1986). EEG alpha activity increases during transient episodes of ethanol-induced euphoria. *Pharmacology, Biochemistry, and Behavior, 25*(4), 889–895.

Macht, M., & Dettmer, D. (2006). Everyday mood and emotions after eating a chocolate bar or an apple. *Appetite, 46*(3), 332–336.

Macht, M., & Mueller, J. (2007). Immediate effects of chocolate on experimentally induced mood states. *Appetite, 49*(3), 667–674.

Markus, C. R., Panhuysen, G., Tuiten, A., Koppeschaar, H., Fekkes, D., & Peters, M. L. (1998). Does carbohydrate-rich, protein-poor food prevent a deterioration of mood and cognitive performance of stress-prone subjects when subjected to a stressful task? *Appetite, 31*(1), 49–65.

Marlatt, G. A., & Gordon, J. R. (1980). Determinants of relapse: Implications for the maintenance of behavior change. In P. O. Davidson & S. M. Davidson (Eds.), *Behavioral medicine: Changing health lifestyles* (pp. 410–452). New York: Brunner/Mazel.

Martin, C. S., Earleywine, M., Musty, R. E., Perrine, M. W., & Swift, R. M. (1993). Development and validation of the Biphasic Alcohol Effects Scale. *Alcoholism, Clinical and Experimental Research, 17*(1), 140–146.

Masserman, J. H., & Yum, K. S. (1946). An analysis of the influence of alcohol on experimental neuroses in cats. *Psychosomatic Medicine, 8*, 36–52.

Mata, J., Hogan, C. L., Joormann, J., Waugh, C. E., & Gotlib, I. H. (2013). Acute exercise attenuates negative affect following repeated sad mood inductions in persons who have recovered from depression. *Journal of Abnormal Psychology, 122*(1), 45–50.

Mata, J., Thompson, R. J., & Gotlib, I. H. (2010). BDNF genotype moderates the relation between physical activity and depressive symptoms. *Health Psychology, 29*(2), 130–133.

Matta Mello Portugal, E., Cevada, T., Sobral Monteiro-Junior, R., Teixeira Guimarães, T., da Cruz Rubini, E., Lattari, E., et al. (2013). Neuroscience of exercise: From neurobiology mechanisms to mental health. *Neuropsychobiology, 68*(1), 1–14.

Mauss, I. B., Troy, A. S., & LeBourgeois, M. K. (2013). Poorer sleep quality is associated with lower emotion-regulation ability in a laboratory paradigm. *Cognition and Emotion, 27*(3), 567–576.

McLean, J. A., & Barr, S. I. (2003). Cognitive dietary restraint is associated with eating behaviors, lifestyle practices, personality characteristics and menstrual irregularity in college women. *Appetite, 40*(2), 185–192.

McLean, J. A., Barr, S. I., & Prior, J. C. (2001). Cognitive dietary restraint is associated with higher urinary cortisol excretion in healthy premenopausal women. *American Journal of Clinical Nutrition, 73*(1), 7–12.

Miller, M. A., Rothenberger, S. D., Hasler, B. P., Donofry, S. D., Wong, P. M., Manuck, S. B., et al. (2014). Chronotype predicts positive affect rhythms measured by ecological momentary assessment. *Chronobiology International, 32*(3), 1–9.

Minkel, J. D., Banks, S., Htaik, O., Moreta, M. C., Jones, C. W., McGlinchey, E. L., et al. (2012). Sleep deprivation and stressors: Evidence for elevated negative affect in response to mild stressors when sleep deprived. *Emotion, 12*(5), 1015–1020.

Motl, R. W., Birnbaum, A. S., Kubik, M. Y., & Dishman, R. K. (2004). Naturally occurring changes in physical activity are inversely related to depressive symptoms during early adolescence. *Psychosomatic Medicine, 66*(3), 336–342.

Motomura, Y., Kitamura, S., Oba, K., Terasawa, Y., Enomoto, M., Katayose, Y., et al. (2013). Sleep debt elicits negative emotional reaction through diminished amygdala-anterior cingulate functional connectivity. *PLoS One, 8*(2), e56578.

National Institutes of Health (2015). Science of behavior change. Available at *https://commonfund.nih.gov/behaviorchange/index*.

Newlin, D. B., & Thomson, J. B. (1990). Alcohol challenge with sons of alcoholics: A critical review and analysis. *Psychological Bulletin, 108*(3), 383–402.

Newman, E., O'Connor, D. B., & Conner, M. (2007). Daily hassles and eating behaviour: The role of cortisol reactivity status. *Psychoneuroendocrinology, 32*(2), 125–132.

Ong, A. D., Exner-Cortens, D., Riffin, C., Steptoe, A., Zautra, A., & Almeida, D. M. (2013). Linking stable and dynamic features of positive affect to sleep. *Annals of Behavioral Medicine, 46*(1), 52–61.

Parfitt, G., Blisset, A., Rose, E. A., & Eston, R. (2012). Physiological and perceptual responses to affect-regulated exercise in healthy young women. *Psychophysiology, 49*(1), 104–110.

Parfitt, G., & Hughes, S. (2009). The exercise intensity–affect relationship: Evidence and implications for exercise behavior. *Journal of Exercise Science and Fitness, 7*(2), S34–S41.

Parker, G., Parker, I., & Brotchie, H. (2006). Mood state effects of chocolate. *Journal of Affective Disorders, 92*(2–3), 149–159.

Pilcher, J. J., & Huffcutt, A. I. (1996). Effects of sleep deprivation on performance: A meta-analysis. *Sleep, 19*(4), 318–326.

Polivy, J., & Herman, C. P. (1993). Etiology of binge eating: Psychological mechanisms. In *Binge eating: Nature, assessment, and treatment* (pp. 173–205). New York: Guilford Press.

Prather, A. A., Bogdan, R., & Hariri, A. R. (2013). Impact of sleep quality on amygdala reactivity, negative affect, and perceived stress. *Psychosomatic Medicine, 75*(4), 350–358.

Prather, A. A., Puterman, E., Epel, E. S., & Dhabhar, F. S. (2013). Poor sleep quality potentiates stress-induced cytokine reactivity in postmenopausal women with high visceral abdominal adiposity. *Brain, Behavior, and Immunity, 35*, 155–162.

Puterman, E., O'Donovan, A., Adler, N. E., Tomiyama, A. J., Kemeny, M., Wolkowitz, O. M., et al. (2011). Physical activity moderates effects of stressor-induced rumination on cortisol reactivity. *Psychosomatic Medicine, 73*(7), 604–611.

Rajaratnam, S. M., Barger, L. K., Lockley, S. W., Shea, S. A., Wang, W., Landrigan, C. P., et al. (2011). Sleep disorders, health, and safety in police officers. *JAMA, 306*(23), 2567–2578.

Ramenghi, L. A., Webb, A. V., Shevlin, P. M., Green, M., Evans, D. J., & Levene, M. I. (2002). Intra-oral administration of sweet-tasting substances and infants' crying response to immunization: A randomized, placebo-controlled trial. *Biology of the Neonate, 81*(3), 163–169.

Ray, L. A., Mackillop, J., & Monti, P. M. (2010). Subjective responses to alcohol consumption as endophenotypes: Advancing behavioral genetics in etiological and treatment models of alcoholism. *Substance Use and Misuse, 45*(11), 1742–1765.

Ready, R. E., Marquez, D. X., & Akerstedt, A. (2009). Emotion in younger and older adults: Retrospective and prospective associations with sleep and physical activity. *Experimental Aging Research, 35*(3), 348–368.

Reed, J., & Buck, S. (2009). The effect of regular aerobic exercise on positive-activated affect: A meta-analysis. *Psychology of Sport and Exercise, 10*(6), 581–594.

Reed, J., & Ones, D. S. (2006). The effect of acute aerobic exercise on positive activated affect: A meta-analysis. *Psychology of Sport and Exercise, 7*(5), 477–514.

Rethorst, C. D., Wipfli, B. M., & Landers, D. M. (2009). The antidepressive effects of exercise: A meta-analysis of randomized trials. *Sports Medicine, 39*(6), 491–511.

Rimmele, U., Seiler, R., Marti, B., Wirtz, P. H., Ehlert, U., & Heinrichs, M. (2009). The level of physical activity affects adrenal and cardiovascular reactivity to psychosocial stress. *Psychoneuroendocrinology, 34*(2), 190–198.

Rimmele, U., Zellweger, B. C., Marti, B., Seiler, R., Mohiyeddini, C., Ehlert, U., et al. (2007). Trained men show lower cortisol, heart rate and psychological responses to psychosocial stress compared with untrained men. *Psychoneuroendocrinology, 32*(6), 627–635.

Rogers, P. J. (1995). Food, mood and appetite. *Nutrition Research Reviews, 8*(1), 243–269.

Rogers, P. J., & Smit, H. J. (2000). Food craving and food "addiction": A critical review of the evidence from a biopsychosocial perspective. *Pharmacology, Biochemistry, and Behavior, 66*(1), 3–14.

Sagaspe, P., Sanchez-Ortuno, M., Charles, A., Taillard, J., Valtat, C., Bioulac, B., et al. (2006). Effects of sleep deprivation on color-word, emotional, and specific Stroop interference and on self-reported anxiety. *Brain and Cognition, 60*(1), 76–87.

Sayette, M. A. (1993). An appraisal-disruption model of alcohol's effects on stress responses in social drinkers. *Psychological Bulletin, 114*(3), 459–476.

Sayette, M. A. (1999). Does drinking reduce stress? *Alcohol Research and Health, 23*(4), 250–255.

Schneider, M. L., & Graham, D. J. (2009). Personality, physical fitness, and affective response to exercise among adolescents. *Medicine and Science in Sports and Exercise, 41*(4), 947–955.

Schneider, S., Askew, C. D., Diehl, J., Mierau, A., Kleinert, J., Abel, T., et al. (2009). EEG activity and mood in health orientated runners after different exercise intensities. *Physiology and Behavior, 96*(4–5), 709–716.

Schoenfeld, T. J., Rada, P., Pieruzzini, P. R., Hsueh, B., & Gould, E. (2013). Physical exercise prevents stress-induced activation of granule neurons and enhances local inhibitory mechanisms in the dentate gyrus. *Journal of Neuroscience, 33*(18), 7770–7777.

Sciolino, N. R., Dishman, R. K., & Holmes, P. V. (2012). Voluntary exercise offers anxiolytic potential and amplifies galanin gene expression in the locus coeruleus of the rat. *Behavioural Brain Research, 233*(1), 191–200.

Sciolino, N. R., & Holmes, P. V. (2012). Exercise offers anxiolytic potential: A role for stress and brain noradrenergic–galaninergic mechanisms. *Neuroscience and Biobehavioral Reviews, 36*(9), 1965–1984.

Scott-Sheldon, L. A. J., Terry, D. L., Carey, K. B., Garey, L., & Carey, M. P. (2012). Efficacy of expectancy challenge interventions to reduce college student drinking: A meta-analytic review. *Psychology of Addictive Behaviors, 26*(3), 393–405.

Sher, K. J., & Walitzer, K. S. (1986). Individual differences in the stress-response-dampening effect on alcohol: A dose–response study. *Journal of Abnormal Psychology, 95*(2), 159–167.

Sinha, R., & Jastreboff, A. M. (2013). Stress as a common risk factor for obesity and addiction. *Biological Psychiatry, 73*(9), 827–835.

Smith, B. A., Fillion, T. J., & Blass, E. M. (1990). Orally mediated sources of calming in 1- to 3-day-old human infants. *Developmental Psychology, 26*(5), 731–737.

Smith, J. C. (2013). Effects of emotional exposure on state anxiety after acute exercise. *Medicine and Science in Sports and Exercise, 45*(2), 372–378.

Spielberger, C. D. (2005). State-Trait Anxiety Inventory. In *Corsini encyclopedia of psychology* (pp. 1698–1699). Hoboken, NJ: Wiley.

Steele, C. M., & Josephs, R. A. (1988). Drinking your troubles away: II. An attention-allocation model of alcohol's effect on psychological stress. *Journal of Abnormal Psychology, 97*(2), 196–205.

Steele, C. M., & Josephs, R. A. (1990). Alcohol myopia: Its prized and dangerous effects. *The American Psychologist, 45*(8), 921–933.

Steptoe, A., Kimbell, J., & Basford, P. (1998). Exercise and the experience and appraisal of daily stressors: A naturalistic study. *Journal of Behavioral Medicine, 21*(4), 363–374.

Steptoe, A., O'Donnell, K., Marmot, M., & Wardle, J. (2008). Positive affect, psychological well-being, and good sleep. *Journal of Psychosomatic Research, 64*(4), 409–415.

Stritzke, W. G., Lang, A. R., & Patrick, C. J. (1996). Beyond stress and arousal: A reconceptualization of alcohol–emotion relations with reference to psychophysiological methods. *Psychological Bulletin, 120*(3), 376–395.

Stroehle, A. (2009). Physical activity, exercise, depression and anxiety disorders. *Journal of Neural Transmission, 116*(6), 777–784.

Stunkard, A. J. (1957). The dieting depression: Incidence and clinical characteristics of untoward responses to weight reduction regimens. *American Journal of Medicine, 23*(1), 77–86.

Stunkard, A. J., & Rush, J. (1974). Dieting and depression reexamined: A critical review of reports of untoward responses during weight reduction for obesity. *Annals of Internal Medicine, 81*(4), 526–533.

Stunkard, A. J., & Waterland, R. (1997). The Three Factor Eating Questionnaire Eating Inventory. In S. St. Jeor (Ed.), *Obesity assessment: Tools, methods, interpretations* (pp. 343–351). New York: Chapman and Hall.

Tempest, G. D., Eston, R. G., & Parfitt, G. (2014). Prefrontal cortex haemodynamics and affective responses during exercise: A multi-channel near infrared spectroscopy study. *PloS One, 9*(5), e95924.

Teychenne, M., Ball, K., & Salmon, J. (2010). Sedentary behavior and depression among adults: A review. *International Journal of Behavioral Medicine, 17*(4), 246–254.

Thorndike, F. P., Ritterband, L. M., Gonder-Frederick, L. A., Lord, H. R., Ingersoll, K. S., & Morin, C. M. (2013). A randomized controlled trial of an internet intervention for adults with insomnia: Effects on comorbid psychological and fatigue symptoms. *Journal of Clinical Psychology, 69*(10), 1078–1093.

Tomiyama, A. J., Dallman, M. F., & Epel, E. S. (2011). Comfort food is comforting to those most stressed: Evidence of the chronic stress response network in high stress women. *Psychoneuroendocrinology, 36*(10), 1513–1519.

Tomiyama, A. J., Mann, T., Vinas, D., Hunger, J. M., Dejager, J., & Taylor, S. E. (2010). Low calorie dieting increases cortisol. *Psychosomatic Medicine, 72*(4), 357–364.

Traustadóttir, T., Bosch, P. R., Cantu, T., & Matt, K. S. (2004). Hypothalamic-pituitary-adrenal axis response and recovery from high-intensity exercise in women: Effects of aging and fitness. *Journal of Clinical Endocrinology and Metabolism, 89*(7), 3248–3254.

Tryon, M. S., DeCant, R., & Laugero, K. D. (2013). Having your cake and eating it too: A habit of comfort food may link chronic social stress exposure and acute stress-induced cortisol hyporesponsiveness. *Physiology and Behavior, 114–115*, 32–7.

Tsuno, N., Besset, A., & Ritchie, K. (2005). Sleep and depression. *Journal of Clinical Psychiatry, 66*(10), 1254–1269.

Tucker, J. A., Vuchinich, R. E., & Sobell, M. B. (1982). Alcohol's effects on human emotions: A review of the stimulation/depression hypothesis. *International Journal of the Addictions, 17*(1), 155–180.

Van Strien, T., Frijters, J. G. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional and external eating behavior. *International Journal of Eating Disorders, 5*, 747–755.

Van Strien, T., Roelofs, K., & de Weerth, C. (2013). Cortisol reactivity and distress-induced emotional eating. *Psychoneuroendocrinology, 38*(5), 677–684.

Vandekerckhove, M., & Cluydts, R. (2010). The emotional brain and sleep: An intimate relationship. *Sleep Medicine Reviews, 14*(4), 219–226.

Wadden, T. A., Foster, G. D., Sarwer, D. B., Anderson, D. A., Gladis, M., Sanderson, R. S., et al. (2004). Dieting and the development of eating disorders in obese women: Results of a randomized controlled trial. *American Journal of Clinical Nutrition, 80*(3), 560–568.

Wadden, T. A., Stunkard, A. J., & Smoller, J. W. (1986). Dieting and depression: A methodological study. *Journal of Consulting and Clinical Psychology, 54*(6), 869–871.

Wagner, H. S., Ahlstrom, B. K., Vickers, Z., Redden, J., Mann, T., & Scherschel, H. (2014). The myth of comfort food. *Health Psychology, 33*(12), 1552–1557.

Walker, M. P., & Harvey, A. G. (2010). Obligate symbiosis: Sleep and affect. *Sleep Medicine Reviews, 4*(4), 215–217.

Walker, M. P., & van der Helm, E. (2009). Overnight therapy?: The role of sleep in emotional brain processing. *Psychological Bulletin, 135*(5), 731–748.

Wardle, J., Chida, Y., Gibson, E. L., Whitaker, K. L., & Steptoe, A. (2011). Stress and adiposity: A meta-analysis of longitudinal studies. *Obesity, 19*(4), 771–778.

Welch, A. S., Hulley, A., & Beauchamp, M. (2010). Affect and self-efficacy responses during moderate-intensity exercise among low-active women: The effect of cognitive appraisal. *Journal of Sport and Exercise Psychology, 32*(2), 154–175.

Welch, A. S., Hulley, A., Ferguson, C., & Beauchamp, M. (2007). Affective responses of inactive women to a maximal incremental exercise test: A test of the dual mode model. *Psychology of Sport and Exercise, 8*(4), 401–423.

Wichers, M., Peeters, F., Rutten, B. P. F., Jacobs, N., Derom, C., Thiery, E., et al. (2012). A time-lagged momentary assessment study on daily life physical activity and affect. *Health Psychology, 31*(2), 135–144.

Williams, D. M., Dunsiger, S., Ciccolo, J. T., Lewis, B. A., Albrecht, A. E., & Marcus, B. H. (2008). Acute affective response to a moderate-intensity exercise stimulus predicts physical activity participation 6 and 12 months later. *Psychology of Sport and Exercise, 9*(3), 231–245.

Wills, T. A., & Shiffman, S. (1985). Coping and substance use: A conceptual framework. In S. Shiffman & T. A. Wills (Eds.), *Coping and substance abuse* (pp. 3–24). Orlando, FL: Academic Press.

Wilson, G. T. (1988). Alcohol and anxiety. *Behaviour Research and Therapy, 26*(5), 369–381.

Wing, R. R., Epstein, L. H., Marcus, M. D., & Kupfer, D. J. (1984). Mood changes in behavioral weight loss programs. *Journal of Psychosomatic Research, 28*(3), 189–196.

Wipfli, B. M., Rethorst, C. D., & Landers, D. M. (2008). The anxiolytic effects of exercise: A meta-analysis of randomized trials and dose-response analysis. *Journal of Sport and Exercise Psychology, 30*(4), 392–410.

Woo, M., Kim, S., Kim, J., Petruzzello, S. J., & Hatfield, B. D. (2009). Examining the exercise–affect dose–response relationship: Does duration influence frontal EEG asymmetry? *International Journal of Psychophysiology, 72*(2), 166–172.

Woo, M., Kim, S., Kim, J., Petruzzello, S. J., & Hatfield, B. D. (2010). The influence of exercise intensity on frontal electroencephalographic asymmetry and self-reported affect. *Research Quarterly for Exercise and Sport, 81*(3), 349–359.

Wurtman, R. J., Hefti, F., & Melamed, E. (1980). Precursor control of neurotransmitter synthesis. *Pharmacological Reviews, 32*(4), 315–335.

Yoo, S. S., Hu, P. T., Gujar, N., Jolesz, F. A., & Walker, M. P. (2007). A deficit in the ability to form new human memories without sleep. *Nature Neuroscience, 10*, 385–392.

Zohar, D., Tzischinsky, O., Epstein, R., & Lavie, P. (2005). The effects of sleep loss on medical residents' emotional reactions to work events: A cognitive-energy model. *Sleep, 28*(1), 47–54.

CHAPTER 41

STRESS AND EMOTION

Embodied, in Context, and across the Lifespan

Barbara Ganzel, Jason R. D. Rarick, and Pamela A. Morris

In this chapter, we examine the relationship between stress and emotion within the context of a novel bioecological model, *triple-network allostasis* (Ganzel & Morris, 2016). Triple-network allostasis is the result of integrating a developmentally informed model of allostasis (Ganzel, Morris, & Wethington, 2010; Ganzel & Morris, 2011) with new findings about the large-scale functional architecture of the brain. We initially presented triple-network allostasis as a lifespan diathesis-stress model (Ganzel & Morris, 2016); this allowed us to more closely examine mechanisms through which life stress interacts with an individual's accumulating physiological predispositions to impact the large-scale neural networks of the brain, thus driving psychopathology onset and the course of mental illness. Here, we expand this model to include nonclinical populations, using it to examine long-term developmental and stress-related changes in core affect and emotional response in individuals who do not have a clinical disorder. In doing so, we raise novel questions about the relationships among stress, distress, core affect, and emotion across the lifespan. These, in turn, have implications for interventions to promote social-emotional well-being at all ages. We conclude by arguing that allostatic models need not and should not be limited to representation of the stress process, but rather may serve as a more general framework for modeling an organism's biopsychosocial functioning in a changing, challenging environment, over time and across the lifespan.

We write this chapter from our perspective as developmental psychosocial stress researchers. Taken together, our own published work spans multiple levels of analysis from neurons to national policy, and from infancy to the end of life. From this stance, it is a short step to embracing the human brain as developing, embodied, and intrinsically embedded in a dynamic social and physical environment. The core tenets of our argument may appear obvious: stress impacts health and behavior; brain function links a psychosocial stressor to stress-related behavior and changes in health; the brain exists in a body; the body exists in context; age-related brain/body change doesn't stop until brain/body function stops. We have found, however, that careful analysis of these associations leads to unexpected insights, as well as novel and interesting questions for future research (Ganzel et al., 2010; Ganzel & Morris, 2011; Ganzel & Morris, 2016). Our goal for this chapter is to expand this work to include a consideration of core affect and emotional response, and to examine the implications of this new model for theory and intervention.

Based on our prior work, we consider the entire stress process to be *relational* in that there are profound reciprocal influences among a given stressor, the individual (body, brain, and mind) in which the stress process occurs/manifests, and the broader physical and social environment in which the individual is embedded. As such, *the stress process itself* can be expected to change as a function of events or chronic conditions in the physical and social environment. We have examined mechanisms and supporting evidence for this phenomenon, concluding with a bioecological model of the stress process based in the concepts of allostasis and allostatic load (Ganzel et al., 2010). The theory of allostasis places the brain at the center of this interplay over time among a stressor (in its context), stress-related changes in physiology and mental state, and stress-related behavioral and health outcomes (Bronfenbrenner & Morris, 1998; McEwen & Stellar, 1993; Sterling, 2004; Sterling & Eyer, 1981).

The stress process is also *embodied*, in that it occurs within the body and as a function of bodily physiology. As noted, allostasis requires that the stress process be mediated by the brain (Ganzel et al., 2010; Sterling & Eyer, 1981; Sterling, 2004). Because of this central mediation, we have argued that *the stress process itself changes continuously across the lifespan* as a function of ongoing age-related physiological change (particularly in the brain). Thus, stress outcomes would be expected to vary systematically as a function of age across the lifespan. We have examined evidence for these effects in prior work, concluding with a developmentally informed allostatic model of the stress process (Ganzel & Morris, 2011, 2016).

At the heart of the present chapter are the relationships between stress processing and emotion processing in the brain and body. These processing streams have outcomes variously termed "distress," "core affect" and/or "emotion," and "emotion regulation," depending on the field of research. These concepts and terms are not often considered together in the literature. We argue here that these are related, often overlapping constructs that are united by their common neurobiology within the framework of *salience processing*, described below. The implications of these relationships are potentially far-reaching, as we discuss throughout and especially in our section "Future Directions."

In the section that follows, we review the relationship between *stress* and *distress* as these constructs developed in biology, sociology, and psychosocial stress research. We follow that with a discussion of the neural mechanisms of stress processing and introduce triple-network allostasis in more detail. In the process, we also introduce the concept of salience, along with salience processing, the salience network, and the other canonical large-scale neural networks of the brain. We next discuss the extensive overlaps in the function and neurobiology of stress-related distress, core affect, and indeed emotion itself. We then extend this to a discussion of emotion regulation, a highly related concept with direct applications to intervention. The implications of these associations are addressed, and we present a lifespan model of triple-network allostasis that includes these outcomes. We end our chapter with "Future Directions," where we discuss the next stages of work that might follow from this new model, with relevance for intervention as well as for a future research agenda to test the opportunities and constraints of our new model. We conclude briefly in the final section.

Stress and Distress

The General Adaptation Syndrome

"Stress" and "distress" are terms used in sociological, biological, and psychosocial stress research (e.g., Lagner & Michael, 1963; Ward et al., 2008). These domains of inquiry have their roots in the mid-20th century, when Hans Selye (e.g., 1956) described a general-purpose multistage physiological syndrome that occurs in response to threats to the integrity of the organism; he called this the general adaptation syndrome (GAS). The lynchpin of Selye's (1950, 1956) GAS is activation of the hypothalamic–pituitary–adrenal (HPA) axis, resulting in the production of corticosteroids (cortisol, in humans and other primates). Corticosteroids, in turn, act globally but relatively slowly to mobilize the body's energy resources to help resist the precipitating threat.

Selye (1956) redefined the colloquial term "stress" to mean "that which stimulates the GAS response" (p. 54). Using rodents as his laboratory models, Selye (1950) tested the uniformity (a.k.a. the *nonspecificity*) of the GAS across a very broad range of physical threats. He concluded that threats to the biological integrity of the organism invariably activated the stress response (1956). Selye's work prompted literally thousands of articles across the fields of medicine, biology, psychology, and sociology (Goldstein, 1995b; Mason, 1975a). In many of these discussions, stress (more properly, the *stressor*) came to mean any stimulus that prompts HPA axis activation and increases production of cortisol, which in turn became synonymous with a generalized, nonspecific *stress process*.

The GAS was thus conceptualized as the process linking stress and *distress* (i.e., negative mental states; Wheaton & Montazer, 2010) and it was often considered to be the physiological link between stressor exposure and adverse mental and physical health.

Over time, it became clear that Selye's (1950, 1956) GAS incompletely describes the human stress process. The GAS does not, for example, explain the importance of cognitive and emotional responses to a stressor (anticipation, appraisal, coping, learning) in determining health outcomes (e.g., Foa & Kozak, 1986; Lazarus, 1991; Siegel & Allan, 1998; Sterling & Eyer, 1988; Stone, 1995; Toates, 1995; Tolin & Foa, 2002; Wheaton, 1985). Nor does the GAS account for the critical contributions of past and current stressor context, such as socioeconomic status or social support (e.g., Baltes & Baltes, 1990; Furstenberg, Brooks-Gunn, & Morgan, 1987; Lazarus, 1993, 1999; Masten et al., 1988; McEwen & Gianaros, 2010; Rutter, 1979; Sameroff, Seifer, Barocas, Zax, & Greenspan, 1987; Taylor, Karlamangla, Friedman, & Seeman, 2011). Moreover, the "nonspecificity" of the GAS has come under challenge because the valence and type of stressor often lend substantial variance to stress–health associations (e.g., Mason, 1971, 1975a; Pacák & Palkovits, 2001; Schulkin, 2003). In short, psychological aspects of stressor exposure often play a pivotal role in the human stress response.

Apropos of this point, John W. Mason (1971), an early stress researcher, noted that whenever it is possible to substantially reduce or remove the psychologically "noxious" nature of the stressor, then there *is* no GAS response (p. 326; 1975b). He (1975a) commented that "the knowledge that the psyche is superimposed upon the humoral machinery for endocrine regulation drastically complicates our whole view" (p. 177).

Homeostasis versus the Psyche

Other major theories of physiological regulation have run afoul of the psyche. There has been an ongoing struggle to modernize the core principles of homeostasis (Cannon, 1920, 1932, 1935) in response to concerns similar to Mason's (1975a, 1975b) above. Homeostasis was developed to describe well-defined disturbances to key elements of regulatory physiology that maintain life, such as body temperature and blood oxygen (Ramsay & Woods, 2014). With the application of cybernetics and engineering control theory, homeostasis became synonymous with self-regulation via interrelated negative feedback loops with fixed "set points" (Langley, 1973; Mrosovsky, 1990; Wiener, 1948). Over time, however, there has been growing dissatisfaction regarding the mismatch between the classic homeostatic model and observations of physiological regulation in functioning organisms as they navigate their environments (e.g., Chrousos & Gold, 1992; Goldstein, 1995a, 1995b; Hammel, 1988; Levine & Ursin, 1991; Moore-Ede, 1986; Mrosovsky, 1990; Schultz, 1996; Sterling & Eyer, 1988; Waddington, 1957, 1968). It has been argued that an understanding of integrated, high-level whole-animal physiological regulation is unlikely to come from applications of homeostatic control theory at the molecular level (Woods & Ramsay, 2007; see also von Bertalanffy, 1952, on general systems theory as applied to biology). Furthermore, Ramsay and Woods (2014, p. 236) argue that there is "no indication" that homeostasis as initially conceived was intended to "address the effect of complex psychosocial stressors on physiological processes relevant to health and illness" (see also Woods & Ramsay, 2007).

But what is and is not a "complex psychosocial stressor" in the alert individual with a functioning brain (as compared with an organism that is, for eample, dissected and *in vitro*)? Sensory input from all types of stressors is channeled through the brain before affecting any other physiological regulatory response, and this input is modified by expectation and evaluation. Levine and Ursin (1991) argued that this is true even for stressors that do not appear overtly "psychological," such as cold exposure and tissue damage; this is because novelty, expectation, and efforts to avoid noxious stimuli will all activate memory and cognitive-emotional response (e.g., Pessoa, 2015). Any two individuals have unique biologies, life experiences, and contexts, so that their memories and cognitive-emotional responses will differ, even to a stressor held in common. In fact, it is argued that virtually *no* type of life event is uniformly viewed as negative or positive (Hardy, Concanto, & Gill, 2002; Hughes, George, & Blazer, 1988), which suggests that there is a critical psychosocial component to all occasions of stressor exposure.

Allostasis

These and similar questions prompted Sterling and Eyer (1988) to introduce *allostasis*, a replacement (Sterling, 2004) or update (e.g., McEwen, 2004) of classical homeostasis in which the brain exerts control over internal regulation in order to match physiological and behavioral response to environmental demand (Schulkin, 2003). Under allostasis, the brain is the central mediator of physiological and behavioral regulation in the alert and functioning organism. As such, it is the primary point of interface between a given stressor (in its physical and social context) and stress-related changes in health and behavior. To this theory, McEwen and Stellar (1993) added the concept of *allostatic load*, wherein adaptive changes to achieve the regulatory goals of allostasis create physiological wear and tear (the accumulating cost of allostatic adaptation). In this theory, allostasis provides adaptive regulation and reduces distress in the short run—but accumulating allostatic load may result in increased distress, dysregulation, and ill health if the individual lives long enough to experience the long-term costs of adaptation (e.g., Repetti, Robles, & Reynolds, 2011). The broad dissemination and application of allostatic theory has given it the status of "a new conceptual framework" for the study of stress (Schulkin, Gold, & McEwen, 1998, p. 220), with applications in both the social and life sciences (e.g., Koob & Le Moal, 1997, 2001, 2005; McEwen, 1998, 2000, 2003a, 2003b, 2003c; McEwen & Gianaros, 2010; McEwen & Seeman, 1999, 2003; McEwen & Stellar, 1993; Ramsay & Woods, 2014; Schulkin et al., 1998; Schulkin, McEwen, & Gold, 1994; Schulkin, 2003, 2004; Singer, Ryff, & Seeman, 2004).

Stress and Salience

Our exercise here is to extend theories of allostasis beyond the stress process; to do so, we draw now on the concept of salience and salience processing. This allows us to move toward our discussion of emotion, which we link to concepts of stress in the section "Stress and Emotion."

A Consideration of Salience and Two Propositions

A salient stimulus stands out. It attracts attention and is motivating because of its innate or learned biological relevance (e.g., Phan et al., 2004). A charging tiger and a delectable dessert are both salient, as is a winning lottery ticket or an angry manager at your workplace. Human and nonhuman primates can learn about a stimulus's salience vicariously (e.g., by social observation; Öhman & Mineka, 2001), and humans have the added advantage of being able to learn about the salience of a stimulus through instruction (Hugdahl & Öhman, 1977; Olsson & Phelps, 2004). For humans, salience-related processing can be triggered by even mild experimental stimuli, such as losing an intangible representation of money during a computer game (e.g., De Martino, Kumaran, Seymour, & Dolan, 2006; De Martino, Camerer, & Adolphs, 2010).

Proposition 1: Bridging salience and stress. *Stressors are intrinsically salient. Moreover, any salient stimulus can be defined as a stressor if it has the quality of being undesirable (i.e., aversive or "noxious").*

Proposition 1 is plausible because stressors and aversive salient stimuli are both defined as having innate or learned "biological relevance" (Phan et al., 2004). They are both intrinsically motivational because of their significance to reducing threat and preserving the safety, health, and/or the "operating integrity of the organism" (Wheaton & Montazer, 2010, p. 173). We argue, in addition, that these constructs are functionally interchangeable—an aversive salient stimulus functions as a stressor and a stressor constitutes an aversive salient stimulus. Stressors must, at their root, have the quality of being aversive in order to engender distress and have negative effects on mental and physical health (Elder, George, & Shanahan, 1996).

Notably, this proposition does not imply that salient events that are typically viewed as positive or desirable may not trigger a stress response. The stress literature initially included many positive life events within the category of stressors (e.g., weddings, promotions; Holmes & Rahe, 1967). This was under the assumption that the important factor was "life change" (i.e., the need for readjustment). However, the weight of research since then has suggested that *undesirability* is the key factor that links stressor exposure, distress, and negative mental and physical health outcomes (e.g., Mueller, Edwards, & Yarvis, 1977; Vinokur & Selzer, 1975). And, of course, we recognize that characteristics of the individual such as self-esteem (Brown & McGill, 1989) or role strain (Thoits, 1992) can make some positive events function as stressors. Proposition 1 leads directly to Proposition 2, in which we adopt the neurobiology of salience processing of aversive stimuli as the core neural mechanism of the stress process—and the central mediator of allostasis.

Proposition 2: Bridging stress processing and salience processing in the brain. *The neurobiology of salience processing (for aversive stimuli) is functionally identical to the neural substrates of the stress process, and thus it constitutes the central mediator of allostasis.*

Substantial gains have been made in recent years in delineating the neurobiology of salience processing. Below, we briefly review this work, with emphasis on the mechanisms and role of salience processing within the large-scale functional architecture of the brain. We then outline the key features of our current model of allostasis, which has salience processing at its core.

Salience Processing in the Human Brain

From this point in the chapter, we use the term "salience" to refer to the negatively valenced salience associated with aversive, threat-related stimuli. The needs of survival require that these stimuli have a privileged status in the brain, even relative to salient stimuli with a positive valence (e.g., Ito, Larsen, Smith, & Cacioppo, 1998; Smith, Cacioppo, Larsen, & Chartrand, 2003). Aversive stimuli co-opt attention and are prioritized in the competition for neural processing resources (e.g., Anderson, 2005; Corbetta, Patel, & Shulman, 2008; Öhman, Flykt, & Esteves, 2001; Vuilleumier, Armony, Driver, & Dolan, 2001; see also Schneider & Shiffrin, 1977). Salient stimuli trigger bottom-up, norepinephrine-driven activation of a large-scale array of coactivating neurons referred to as the *salience network* (Seeley et al., 2007), which is also called the *ventral attention network* (Corbetta et al., 2008; Yeo et al., 2011). This is a rapid and robust (usually temporary) reorganization of neural function that serves to maximize rapid behavioral response (Hermans et al., 2011).

Synchronous neural firing within the salience network generates oscillatory activity across a broad neuronal assembly that has anchoring nodes in the right anterior insula (right AI) and dorsal anterior cingulate cortex (dACC; Seeley et al., 2007; although see Yarkoni, Poldrack, Nichols, Van Essen, & Wager, 2011), as well as the right temporoparietal junction (right TPJ) and right inferotemporal regions (right IFG). Activation of the salience network diverts neural processing resources to reorient attention and foster rapid information processing in network nodes involved in autonomic and neuroendocrine "emergency response" systems (Hermans et al., 2011). Within this network, the right AI plays a prominent role in monitoring and subjective evaluation of personally salient information from outside and inside the body, regardless of whether the precipitating stimulus is cognitive, affective, or homeostatic (e.g., Borsook, Edwards, Elman, Becerra, & Levine, 2013; Downar, Mikulis, & Davis, 2003; Seeley et al., 2007; Uddin, Supekar, Ryali, & Menon, 2011: see Touroutoglou, Hollenbeck, Dickerson, & Feldman Barrett, 2012, for finer-grained distinctions within this system). The dACC has been implicated in both physical and social pain (rejection) detection, as well as in modulation of responses in the sensory cortex, motor cortex (e.g., motor planning), and association cortex (e.g., executive function; Bush, Luu, & Posner, 2000; Eisenberger, Lieberman, & Williams, 2003; Kempermann, Kuhn, & Gage, 1998). The right AI and dACC, in turn, prompt activation in the medial frontal, IFG, and TPJ regions, which underlie the reorienting of attention (e.g., Corbetta et al., 2008) that is necessary to implement behavioral response to a new or unexpected salient stimulus. This functionally integrative network shows heightened activity to negatively valenced stimuli, including uncertainty, pain, empathy for pain, social pain/rejection, metabolic stress, temperature variation, and hunger (Büchel, Morris, Dolan, & Friston, 1998; Craig, 2003, 2008; Critchley, 2004; Critchley et al., 2003; Critchley, Weins, Rotshtein, Öhman, & Dolan, 2004; Downar, Crawley, Mikulis, & Davis, 2002; Downar et al., 2003; Eisenberger et al., 2003; Rainville, Duncan, Price, Carrier, & Bushnell, 1997; Singer et al., 2004; Taylor, Seminowicz, & Davis, 2009; Touroutoglou et al., 2012). The salience network is also responsive to a lesser degree to positive stimuli, such as pleasant touch and seeing the faces of loved ones or friends (Bartels & Zeki, 2004; Craig, 2003).

Studies of the large-scale functional architecture of the human brain have isolated a number of other stable neural[1] networks that are fundamental to the organization of information processing (e.g., Fox & Raichle, 2007; Yeo et al., 2011). For this chapter, we briefly discuss two additional networks, the *central executive network* and the *default network* (Sridharan, Levitan, & Menon, 2008). Together with the salience network, these comprise the primary large-scale neurocognitive networks that underlie attention, memory, and information processing (also called the canonical large-scale networks of the brain; see Plate 41.1a in color insert).

In brief, the central executive network (CEN) shows synchronous activity at its nodes during top-down processing (i.e., in situations that require information maintenance and manipulation in order to generate task-specific, goal-directed behavior; e.g., Anderson, Fincham, Qin, & Stocco, 2008; Koechlin & Summerfield, 2007; Miller & Cohen, 2001; Seeley et al., 2007; Spreng, Sepulcre, Turner, Stevens, & Schacter, 2013). The primary nodes in this network are the dorsolateral prefrontal cortex (PFC) and lateral posterior parietal cortex (PPC), with multiple additional nodes making up this extended neural network (e.g., Habas et al., 2009; Seeley et al., 2007; Tomasi & Volkow, 2011).

In contrast to the CEN, the default network was initially characterized as having synchronous regional activity at rest, rather than during task-specific behavior (Raichle, 2001). Its primary nodes are located in the medial PFC, posterior cingulate cortex, and the posterior inferior parietal lobules (Binder et al., 1999; Fox et al., 2005; Greicius, Srivastava, Reiss, & Menon, 2004; Greicius, Krasnow, Reiss, & Menon, 2003; McKiernan, D'Angelo, Kaufman, & Binder, 2006; Raichle, 2001), with additional nodes in the superior/inferior frontal gyri and the medial/lateral temporal lobes (Buckner, Andrews-Hanna, & Schacter, 2008; Spreng et al., 2013). Previously, default network activation was thought to reflect the internal, intrinsic consideration of one's own experience (thoughts, feelings, memories, goals, and mental "time traveling"; Gusnard & Raichle, 2001; Kelley et al., 2002; Northoff & Bermpohl, 2004; Whitfield-Gabrieli et al., 2011). More recent thinking places the default network in a more dynamic role, in which it actively interacts with elements of the CEN to direct self-generated thought (Andrews-Hannah, Smallwood, & Spreng, 2014; Spreng, 2012). Activity and connectivity in this network have been associated with tasks that involve memory retrieval, reasoning about moral dilemmas, theory of mind, self-reflection, and planning for/thinking about the future (Andrews-Hannah et al., 2014), as well as social cognition (Spunt & Lieberman, 2013), monitoring of the surrounding environment (Gusnard & Raichle, 2001), and the integration of cognition and emotion (Greicius et al., 2003).

Importantly for our models, research indicates that the salience network plays a "critical and causal role" in toggling between the CEN and the default network, thus serving as *a critical hub for internetwork neural switching* (Sridharan et al., 2008). In this role, the salience network detects biologically salient[2] events and has executive control in directing processing resources among the large-scale neural networks to access memory resources, plan goal-directed action, and modulate autonomic response (Kempermann et al., 1998). Central to this role are the right AI and the dACC, which appear to be the key players in salience detection (e.g., Critchley et al., 2004; Critchley, 2005).

This large-scale salience network serves as a "general-purpose" modulatory system for input from multiple overlapping subcortical salience subnetworks ("survival" circuits; LeDoux, 2012). Each of these subnetworks detects a particular class of trigger stimulus that has intrinsic biological value or learned personal value (e.g., avoidance/defense, approach/reward, fluid balance, thermoregulation; LeDoux, 2012). Upon detecting its particular trigger, a salience subnetwork then integrates relevant sensory and motor information to drive appropriate adaptive behavior (e.g., Jennings et al., 2013; Kim et al., 2013; see also Hermans et al., 2011; Seeley et al., 2007). These specific subnetworks, combined with modulation by the large-scale salience network, form an integrated and flexible neural array that serves to represent salient stimuli and produce and regulate behavioral response. We argue that this *extended salience network* underlies an individual's motivational mental state and behavioral response to stressor exposure (Ganzel & Morris, 2016; see also Barrett, Mesquita, Ochsner, & Gross, 2007; Bechara, Damasio, Damasio, & Anderson, 1994; Damasio, 1999; LeDoux, 2012; Rosen & Schulkin, 1998).

Triple-Network Allostasis

We identify this extended salience network as the primary neural mediator of allostasis (Ganzel & Morris, 2016). This concept is at the heart of our triple-network model of allostasis, which is an integration of our prior brain-based models of lifespan allostasis (Ganzel et al., 2010; Ganzel & Morris, 2011) with Menon's (2011) triple-network model of psychopathology (see Ganzel & Morris, 2016, for a full discussion). Here, though, we expand this model to include normative populations.

The extended salience network serves as the central mediator of allostasis because it is the key player in detecting the "biological" significance of external stimuli and/or internal events, and because of its executive role in switching between default network and CEN activity (see previous discussion). The salience network is positioned to integrate information from the salience subnetworks (Cameron, Woolley, McEwen, & Gould,

1993) with interoceptive information (e.g., Damasio, 2003; Rakic, 2009) to facilitate threat evaluation, selection of motor and homeostatic response, and modulation of behavioral response (Touroutoglou et al., 2012). Moreover, the ability of the AI/dACC hub to switch among canonical networks (Kempermann et al., 1998; Sridharan et al., 2008) provides flexible access to autobiographical memory, prospection, and semantic memory via the default network, and to executive control and goal-directed planning via the CEN. Thus, the survival/salience network is the most current and precise representation of an organizing force linking salient stimuli with behavioral and physiological outcome. As such, we argue that the extended salience network necessarily constitutes the primary regulator of allostasis, to which all other physiological and behavioral allostatic accommodation is secondary.

Simplified/No Load. In Plate 41.1b, we present a stress model in standard form: *stressor* → stress response → distress (Wheaton & Montazer, 2010). The *stressor* is the current challenge to the organism, detected via aggregated interoceptive and exteroceptive sensory information (including that from current contextual risks and resources). The *stress response* refers to the perturbation and reestablishment of physiological equilibrium following this challenge. Under allostasis, this may include the resetting of homeostatic set points to establish a *new* physiological equilibrium that is more appropriate to the organism's circumstances (e.g., Sterling & Eyer, 1988; Sterling, 2004). Model outcomes may include mental and physical health (Ganzel et al., 2010; Ganzel & Morris, 2011) or mental and physical state (Ganzel & Morris, 2016). In keeping with our stressor–stress–distress format, above, we elect here to designate our outcome simply *distress*. Stress-related distress is usually defined as a "negative mental state" (e.g., Wheaton & Montazer, 2010) that is associated with broad stress-related changes in physiology and/or health (see Ganzel et al., 2010, for a review).

Starting on the right-hand side of the model in Plate 41.1b, we show how information about the current environmental stressor (in combination with current contextual risks/resources) is processed via the sensory systems to impact the expanded salience network. This network does the work of *central allostasis*, and it serves as the central mediator of physiological and behavioral response to a current stressor. Brain-based central allostasis drives *peripheral allostasis* in stress-responsive systems outside the central nervous system (see Ganzel et al., 2010, for a full discussion). These peripheral processes, in turn, feed back on the brain via interoceptive, hormonal, catecholamine, and immune signals (e.g., Damasio, 2003; Davidson, Maxwell, & Shackman, 2004; Sapolsky, 1998) and generate reverberating psychophysiological effects over time in response to the initial stressor.

Note that this version of triple-network allostasis does not include allostatic load (an omission we correct very soon; see below). In this simplified model, we assume that the individual has no prior experience and thus has acquired no physiological "wear and tear" (load) from accommodating to stress, and also none of the cognitive/emotional associations created by prior stressful experiences. Moreover, we assume here that there are no initial individual differences in physiology and no systematic stress-related changes in physiology over time. In short, we are modeling only the immediate effects of a stressor event, with no effects of prior experience, trait/genetic differences, or lifespan development.

Full Model. Exposure to a significant current stressor stimulates allostasis (as above). In addition, our full model (Plate 41.1c) includes the impact of allostatic load from prior stressor exposure.

Allostatic load accumulates due to chronic, intense, and/or repeated stressor exposure, during which the adaptive gains of allostasis may be reduced and previously helpful adaptations may become problematic (e.g., McEwen, 1998; McEwen & Stellar, 1993; Sterling & Eyer, 1988). We have argued that the extended salience network is the neural locus of allostatic regulation (above). If so, then the subnetworks and primary nodes of the salience network would be expected to accumulate allostatic load at a faster pace than surrounding tissue (see Ganzel et al., 2010; Ganzel & Morris, 2016, for a full discussion and accumulating evidence). Said differently, the function and structure of the salience network is likely to be critically influenced by individual differences in life experience. This, in turn, would impact the mechanisms of allostasis and the future accumulation of central and peripheral allostatic load.

To the left of Plate 41.1c, we show how central and peripheral allostatic load may accrue within the physiological mechanisms of allostasis, affecting an individual's ability to adapt to subsequent stressors (e.g., Ganzel, Kim, Glover, & Temple, 2008; Geronimus, Hicken, Keene, & Bound, 2006). In other words, the stress process itself can be expected to change as a function of prior stressor exposure (Ganzel et al., 2010). In this way, an individual's life history is written into his or her physiology to influence his or her responses to future events. An understanding of these processes is critical to the understanding and prediction of the physiological and behavioral consequences of adversity. This will, in turn, allow more precision in intervention strategies to aid populations at risk.

Stress and Emotion

Affect, Core Affect, and Emotion

Here, we consider the concepts of *emotion*, *affect*, and *core affect*, and their instantiation in the brain. These are identified as "central motive states" or "states of the brain" that underlie behavioral adaptation to the environment (Rosen & Schulkin, 1998; Russell, 1980, 2003). Our next steps in examining the relationship between stress and emotion will be to distinguish these concepts in the context of key theoretical models associating motivated behavior with brain structure and function, including the large-scale functional architecture of the brain.

Emotion

Models of the neural basis of the central motive states associated with emotion have increased in complexity over time and with advances in technologies that allow measurement of emotions "at their source" (Wager et al., 2009). In all of these models, neurotransmitters and neurohormones participate in system regulation, which in turn impacts—and is impacted by—peripheral physiology and behavioral response (see Gunnar & Quevedo, 2007; Schulkin, 2003; Salamone & Correa, 2002, for reviews). Early single-system models of emotion processing (e.g., MacLean, 1949, 1952) have been supplanted by dual- and multisystem models (e.g., Cacioppo & Berntson, 1994; Davidson, 1984; Fodor, 1983; Panksepp, 1998). These latter approaches, in turn, have been increasingly sharing the floor with models of large-scale functional neural networks that interact to produce emotion and cognition (e.g., Barrett & Satpute, 2013; Duncan & Barrett, 2007; Pessoa, 2015).

MacLean (1949, 1952, 1993), for example, developed one of the best-known early single-system models (see also Papez, 1937). In this approach, a unitary subsystem of specialized brain regions (the limbic system) mediates the processing of all types of emotion. This and other single-system models (e.g., single-hemisphere models; Sackeim, Gur, & Saucy, 1978; Schwartz, Davidson, & Maer, 1975) were challenged for reasons of theory (Calder, Lawrence & Young, 2001; Ekman, 1999; Russell, 1980; Watson, Wiese, Vaiya, & Tellegen, 1999) and anatomy (e.g., LeDoux, 1996, Panksepp, 2000).

Critics of single-system models argued for a limited number of discrete state or emotion programs (*affect programs*), each of which is associated with one specialized neural circuit and one complex emotional response, such as fear or happiness (Ekman, 1999; LeDoux, 1991, 2000; Öhman & Mineka, 2001; Panksepp, 1998; Panksepp & Miller, 1996; Rosen & Schulkin, 1998). In this view, discrete emotions are generated within a limited number of emotion-related brain circuits that are interconnected but functionally independent from one another and from dedicated cognitive systems.

These multisystem models arose in parallel with dual-system models. In dual-system models, emotional experience and/or emotion expression is argued to map onto dichotomous dimensions that represent constructs such as arousal (high vs. low), pleasure (pleasant vs. unpleasant), or valence (positive vs. negative; see Buck, 1999; Gainotti, Caltagirone, & Zoccolotti, 1993; Murphy, Nimmo-Smith, & Lawrence, 2003, for reviews). For example, Davidson and colleagues have argued for a valence asymmetry model. In this model, activity in the left hemisphere (especially the prefrontal and anterior temporal cortices) is associated with approach-related emotional expression such as happiness; activity in similar regions in the right hemisphere is associated with withdrawal-related emotions such as disgust (Davidson, 1984; Davidson, Ekman, Saron, Senulis, & Friesen, 1990).

Recently, increasing attention has focused on dual-system models of approach- and avoidance-related emotional expression that are mediated by highly evolved subcortical structures (Barton & Aggleton, 2000; Gerfen, 1992). The neural hubs within this dual-system model are identified as the amygdala/extended amygdala and the ventral striatum (e.g., Lang & Bradley, 2010). In general, activity in the ventral striatum and orbitofrontal cortex is associated with approach behavior, motivation, and positive incentive (e.g., Haber, Kim, Mailly, & Calzavara, 2006; Knutson, Adams, Fong, & Hommer, 2001). In contrast, the amygdala and extended amygdala have been associated with fearful, anxious, and avoidance-related behavior (e.g., Davis, Walker, & Lee, 1997; LeDoux, 1996; Phelps, 2004, 2006). Notably, these neural functions have been increasingly seen as distributed throughout the brain (e.g., Liu, Hairston, Schrier, & Fan, 2011), as research shows these brain structures to be interconnected with one another and with key neural systems underlying perception, cognition, bodily representation, homeostasis, and behavior (e.g., Gottfried, O'Doherty, & Dolan, 2003; Phillips, Ahn, & Howland, 2003; Pessoa, 2008).

The introduction of meta-analytic techniques appropriate to neuroimaging has provided a new lens through which to view all of these models (Kober & Wager, 2010). In general, meta-analyses of neuroimaging studies of emotion have not found strong support for multisystem models (i.e., one-to-one relationships between discrete brain circuits and discrete emotional states of happiness, fear, anger, surprise, etc.; e.g., Phan, Wager, Taylor, & Liberzon, 2002; Wager, Phan, Liberzon, & Taylor, 2003; Murphy et al., 2003). Instead, this meta-analytic work has largely supported the view that the brain regions central to emotion act in a coordinated way to process stimuli that have threat or reward value (e.g., Phan et al., 2002). While this might appear to support a dual-system model, the amygdala and striatum have been observed to be multifunctional in that they are each involved in the processing of *both* reward and threat (Wager et al., 2008). Within each of these superordinate structures there are subgroups of neurons that are dedicated to processing aspects of threat and other subgroups dedicated to processing aspects of reward. Moreover, meta-analyses suggest that these regions act in concert with other similarly multifunctional regions (e.g., orbitofrontal cortex, AI; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012) to generate the full array of emotional experience (Wager et al., 2009; Wilson-Mendenhall, Barrett, & Barsalou, 2013; see also Hamann, 2012). Consideration of multifunctional circuitry that might give rise to *all* emotional states set the stage for new approaches to modeling emotion processing.

Increased awareness of the functional architecture of the human brain has drawn attention to the relationship between emotion processing and the large-scale neural networks previously discussed (see the section "Stress and Salience"). For example, when an individual experiences emotions of different categories, peaks in neural activity typically occur within these networks of intrinsic functional connectivity—particularly in the salience network and the default network (Touroutoglou, Lindquist, Dickerson, & Barrett, 2015). Negative emotionality (fear, anger, sadness, disgust) is especially likely to generate activity in nodes of the salience network (Touroutoglou et al., 2015). This is consistent with the hypothesis that the salience network acts to orient attention and neural processing resources from internal events toward biologically relevant external information, such as threat or loss (Barrett & Satpute, 2013; Lindquist & Barrett, 2012; see also the section "Stress and Salience" concerning the salience network's sensitivity to negative stimuli). Cross-category emotion processing also generates activity in the nodes of the default network (e.g., Lindquist, Satpute, Wager, Weber, & Barrett, 2015; Touroutoglou et al., 2015). The role of the default network in memory retrieval, self-reflection, and planning (again, see the section "Stress and Salience") has led to the hypothesis that this network serves to create "mental models" of biologically relevant exteroceptive and interoceptive information provided by the salience network; these are argued to be experienced by the individual as mental states, such as emotion and/or cognition (Barrett & Satpute, 2013; Lindquist & Barrett, 2012; see also Barrett, Wilson-Mendenhall, & Barsalou, 2014). All of the large-scale functional networks of the brain are thought to flexibly combine to generate the full range of human experience. However, the salience network is conceptualized as the critical link between a stimulus and the associated "states of the brain" that are interpreted by the individual as emotion (e.g., Barrett & Satpute, 2013).

Core Affect

The terms "affect" and "emotion" are often used interchangeably to describe unpleasant or pleasant "states of the brain" associated with biologically salient stimuli (Batson, Shaw, & Oleson, 1992; Wager et al., 2008), although *affect* is argued to apply specifically to the feeling or mental counterpart of emotion (e.g., Barrett, 2013). "Core affect," however, is a stronger term that refers to the "simplest raw (nonreflective) feelings evident in moods and emotions" (Russell, 2003, p. 148). This is conceived as a "psychological primitive" that is irreducible, a fundamental element of emotion. Core affect is experienced as varying states of *pleasantness* and *unpleasantness* (e.g., Cunningham, Dunfield, & Stillman, 2013; Russell, 2003) imbued with varying degrees of *arousal* (e.g., Barrett & Russell, 1999; Russell, 1980; Schachter & Singer, 1962).

Core affect is argued to underlie the experience of emotions, such as fear, happiness, or anger (the nature of this association is a source of disagreement in emotion research; see Lindquist et al., 2012, plus associated commentary). A parsimonious interpretation of the human imaging literature suggests that core affect represents the *embodiment of* intrinsic motivation and its most primitive mental representation.

A salient stimulus is registered in the brain via the sensory systems and the mechanisms of central allostasis. This information stimulates activation of a very broad array of peripheral/visceral systems via the sympathetic arm of the autonomic nervous system (rapid response) and the HPA axis (which works more slowly). Core affect is argued to derive, in part or in whole, from feedback from visceral (proprioceptive, kinesthetic, somatovisceral, neurochemical) systems that signal the body's valuation of biologically salient stimuli (e.g., Barrett, 2013; Lindquist et al., 2012). This interoceptive information is detected via the AI (e.g., Craig, 2002, 2009) and represented in the brain as mental states of varying degrees of approach/desire and avoidance/aversion (e.g., Barrett & Satpute, 2013; Lindquist et al., 2012; see also Damasio, 1999; 2003; Damasio & Carvalho, 2013). This is consistent with our allostatic model (see previous sections), in which top-down insemination and regulation is heavily influenced by interoceptive feedback from the physiological periphery, generating an iterative response that reverberates between central and peripheral allostasis (see Plates 41.1b and 41.1c).

To summarize, core affect indicates the motivational salience of a stimulus to the individual (Lindquist et al., 2012, p. 125). Put differently, the outcome of salience processing is change in core affect, which is experienced as mental states of approach/desire and avoidance/aversion with varying degrees of arousal (as discussed above). For example, if the initial stimulus is perceived as negatively valenced (undesirable), then the outcome of salience processing will be increased aversion/avoidance (i.e., an upswing in negatively valenced core affect).

Recall that Proposition 1 identifies stressors with salient stimuli, and Proposition 2 identifies the neurobiology of the stress process with the neurobiology of salience processing. Recall also that *stress* predicts *distress*, so that distress is the motivational mental state associated with the stress process. Taken together, this suggests the following third and fourth propositions, stated below:

Proposition 3: Bridging distress, salience, and core affect. *The construct of stress-related distress is functionally identical to salience-related aversion/avoidance and with negatively valenced core affect.*

Our second proposition not only equated the neurobiology of salience processing with the neurobiology of the stress process, it also identified salience processing as the neural keystone of central allostasis. This, combined with our third proposition, suggests the following:

Proposition 4: Bridging allostasis and core affect. *Negative core affect is a primary outcome of central allostasis.*

Core affect has been described as a "homeostatic barometer" (Lindquist et al., 2012) in that it reflects the physiological indicators of a cue's salience. As such, we argue here that it is a central outcome of the allostatic process. If core affect is a basic building block of emotion, as previously discussed, then discreet emotions will likewise arise as emergent properties of a complex allostatic system.

Stress and Emotion Regulation across the Lifespan

Emotion regulation is defined as the processes, whether automatic or controlled, that individuals use to influence which, how, and when emotions are experienced; as such, it is ideally suited to serve as an example of the psychobiological interplay between life stress and emotion, in context and across the lifespan (Thompson, 1994; Gross, 1998; John & Gross, 2004). Establishing healthy emotion regulation skills (e.g., the ability to recognize and label emotional states accurately, the ability to control which emotion is displayed, and coping with affective arousal) enable people across the lifespan to adaptively modulate the interaction between environmental stimuli and personal affect (Izard et al., 2001). Because of this, emotion regulation is a frequent target of interventions to improve social-emotional functioning and mental health in individuals of all ages.

Next, we present a brief overview of the literature on emotion regulation in the context of stress, with particular attention to the implications for psychobiological development at critical windows of vulnerability across the lifespan.

Prenatal Maternal Stress and Infant Emotion Regulation

Stressor exposure within early sensitive periods may be especially important for the healthy development of emotion regulatory systems, with one or more critical windows occurring before birth. Maternal exposure to stressors, reports of distress, and maternal biomarkers of stress during pregnancy have all been linked to emotional and behavioral problems for their children (Glover, 2011; Bolten et al., 2013; Davis, Sandman, Buss, Wing, & Head, 2013). A recent study of low-income Mexican American families demonstrated an inverse relationship between maternal prenatal stress and infant regulatory processes, offering early evidence of the influence of stress *in utero* (Lin, Crnic, Luecken, & Gonzales, 2014). In another study, maternal levels of cortisol were associated with plasma and amniotic fluid cortisol concentration in the womb, which was in turn associated with lower birth weights and emotion regulation difficulties for fear and distress for 3-month-old infants (Baibazarova et al., 2013). In another study, higher levels of maternal cortisol in the second and third trimesters were associated with larger infant cortisol and behavioral responses to a heel-stick blood draw done 24 hours after birth, suggesting that maternal psychosocial stress programs the child's stress regulation systems (Davis, Glynn, Waffarn, & Sandman, 2011). Additionally, fetal exposure to glucocorticoids was inversely associated with bilateral cortical thinning in preadolescents ages 6–10 years old, with the largest group differences detected in the rostral ACC (Davis et al., 2013). This has direct implications for stress and emotion regulation, since reduced anterior cingulate cortical activity has been associated with reduced emotion regulation and impaired top-down attentional control in an array of anxiety disorders in later stages of development (Blair & Raver, 2012).

These studies provide the psychobiological undergirding for research showing an association between self-reported stress measures and biomarkers of stress. For example, Gutteling and colleagues (2005) showed that maternal anxiety during pregnancy predicted elevated reactivity to stimulation and irritability in their 27-month-old toddlers. Perceived distress and anxiety in expectant mothers is similarly associated with increased irritability and crying behavior in their 6-month-old babies (Bolten, Fink, & Stadler, 2012). However, other studies have incongruent findings, such as higher levels of maternal prenatal emotional distress associated with their children's lowered affective reactivity and less crying in new and challenging situations (Rothenberger, Resch, Doszpod, & Moehler, 2011; Möhler, Parzer, Brunner, Wiebel, & Resch, 2006).

These inconsistencies suggest the importance of differential stress susceptibility as a factor for prenatal programming of emotion regulation. Specifically, many of the factors associated with more stressful prenatal environments, such as neonatal stress reactivity or low birth weight, can be considered physiological susceptibility factors that moderate how children interact "for better or worse" with their environment across time (Pluess & Belsky, 2011). For example, a recent study of prenatal development has shown that reactivity to stimulation at 6 months of age was associated with maternal basal and reactive cortisol during pregnancy, adjusting for child's temperament as determined in the neonatal period (Bolten et al., 2013). Children with high neonatal stress reactivity demonstrated deficits in emotion regulation if the mother's cortisol levels were high during pregnancy, whereas children with high neonatal reactivity and low maternal cortisol during pregnancy demonstrated positive emotion regulation. Thus, neonatal temperament moderated the relationship between maternal prenatal stress and later infant emotion regulation, which is consistent with the differential susceptibility hypothesis.

Genetics can present another susceptibility factor linking environment to infant negative emotionality. For example, the relationship between a mother's prenatal anxiety and her infant's negative emotionality appears to be moderated by a common polymorphism of the serotonin transporter gene, such that having a short allele predicts increased infant negatively valenced emotionality (Pluess et al., 2011).

Early Childhood Stress and Emotion Regulation

Early childhood stressor exposure represents another important developmental window. For example, early childhood life stress has been associated with diminished emotional and cognitive capacity, which in turn lessens the ability to delay gratification, manage conflict, and engage in goal-oriented and sustained learning efforts (Carlson & Wang, 2007; Denham & Burton, 2003; Trentacosta & Izard, 2007). Stressor exposure in early childhood is associated with alterations in the neural mechanisms that underlie emotion regulation. For example, in a neuroimaging study of children who were institutionalized in infancy (orphanage care), children who were in institutions longer tended to have larger amygdala volumes and these, in turn, were associated with increased difficulty in emotion regulation (Tottenham et al., 2010). Similarly, dysregulated patterns of connectivity between medial prefrontal cortex (mPFC) and amygdala have been observed in youth with a history of early maternal deprivation (e.g., orphanage care). When viewing emotional faces, these youth showed amygdala hyperactivity and a hypermature pattern of amygdala–prefrontal connectivity (Gee, Gabard-Durnam, et al., 2013; Gee, Humphreys, et al., 2013). This research is consistent with animal studies of maternal separation that show accelerated emergence of adult-like fear and extinction learning in young rats (Callaghan & Richardson, 2011; Muhammad, Carroll, & Kolb, 2012).

Early childhood stressor exposure has also been shown to have effects that endure into adulthood. Specifically, healthy adults who grew up in risky families (i.e., family environments that are harsh, neglectful, highly chaotic, and/or conflict ridden; Repetti, Taylor, Seeman, 2002) showed evidence of alterations in the neural mechanisms underlying emotion regulation and threat detection (Taylor, Eisenberger, Saxbe, Lehman, & Lieberman, 2006). Adult offspring of risky families showed a blunted amygdala response to the presentation of standardized emotional facial stimuli (negative vs. neutral faces). These individuals also had an atypical relationship between prefrontal activation and amygdala activation, suggesting a long-term alteration in response to emotional stimuli (Taylor et al., 2006).

Adolescent Stress and Emotion Regulation

Adolescence presents another developmental period in which allostasis is likely to be qualitatively or quantitatively different from other stages of development. The emergence of adolescence brings heightened significance of identity and social relationships that generate new and additional environmental stressors. Changes in the social environment typically result in adolescents spending more time with peers than adults, as well as increased conflict with parents regarding issues of autonomy and individuating identity (Steinberg & Morris, 2001; Baumrind, 2005). In parallel, adolescents are experiencing heightened amygdala activity in response to emotional stimuli, relative to younger children and to adults (Hare et al., 2008). The amygdala functions as a critical "salience detector" in the brain (Cunningham & Brosch, 2012), so that heightened activity here will prompt increased activity within the large-scale salience network that we have placed at the heart of allostatic regulation (see the section "Stress and Salience").

Other changes in the neural circuitry of emotion regulation are taking place during adolescence. By this stage, the neural underpinnings of complex motor skills are nearly matured (e.g., Kurth et al., 2012), as are the striatal regions, which are heavily implicated in reward-related behavior (e.g., Galvan et al., 2006) and positive core affect (Hermes, Hagemann, Naumann, & Walter, 2011). However, the superior and lateral prefrontal regions that underlie complex cognition and planning are not fully developed until well into early adulthood (e.g., Kurth et al., 2012). The maximum imbalance in the maturity of these systems occurs during adolescence, and evidence suggests that this underlies at least some of the increase in risk-taking behavior observed during this developmental period (Casey, Getz, & Galvan, 2008; Casey, Jones, & Hare, 2008; Steinberg, 2008). Neuroimaging studies of adolescents demonstrate the extensive functional and structural reorganization of brain regions that underlie response inhibition, affect modulation, and discrimination of emotional cues; these, in turn, are argued to contribute to the developmental changes in emotion regulation seen in adolescence and young adulthood (Yurgelun-Todd, 2007).

Stress and Emotion Regulation in Adulthood

While the above evidence supports the hypothesis that life stress impacts emotion regulation uniquely during different development periods, evidence also supports the importance of their interactions across the lifespan (see Ganzel & Morris, 2016, for a detailed discussion). In adults, chronic stress interferes with several important regulatory systems necessary for healthy lifespan development—such as working memory, attention, inhibitory control, and planning—all of which are necessary for healthy coping and self-regulation (Evans, Kim, Ting, Tesher, & Shannis, 2007; Blair & Raver, 2012). Acute stress, such as trauma exposure, predicts persistent increases in amygdala reactivity in healthy adults; not only to trauma reminders (Admon et al., 2009; Sharot, Martorella, Delgado, & Phelps, 2007) but also to standardized affective stimuli (images of emotional faces; Ganzel, Casey, Glover, Voss, & Temple, 2007; Ganzel et al., 2008). Evidence for these effects persists years after exposure to the target trauma, which is consistent with a model of heightened amygdala reactivity following psychological trauma exposure, with recovery on the order of decades (even in the absence of clinical disorder; Ganzel et al., 2007). As noted above, heightened amygdala activity will prompt increased activity within the salience network and alter the central mechanisms of allostatic regulation.

There are also significant differences across adulthood in how stress affects emotion processing and emotion regulation. Older adults show increased sensitivity to stress relative to young adults, as demonstrated by increased stress-related dysregulation of the cardiovascular and immune systems (e.g., Ong, Rothstein, & Uchino, 2012; Uchino, Birmingham, & Berg, 2010). Along with heightened stress vulnerability, older adult humans show a strong goal-directed decrease in attention to negative stimuli (a *positivity bias*), which is believed to be motivated by an increased interest in preserving positive emotionality and well-being (e.g., Carstensen, Gross, & Fung, 1997; Fischer et al., 2005; Gross et al., 1997; Mather et al., 2004; Mather & Carstensen, 2003; St. Jacques, Dolcos, & Cabeza, 2010; Tessitore et al., 2005; Urry et al., 2006). Despite this positivity bias, increased stress sensitivity in older adults combines with increased exposure to stressors (a normal hazard of aging) to predict age-related declines in health (e.g., Cohen & Williamson, 1991; Kiecolt-Glaser & Glaser, 2001). This synergy of sensitivity and exposure is exacerbated by contextual factors, such as increased loneliness (Cole et al., 2007; Ong et al., 2012).

There is also emerging evidence that prior trauma exposure carries unique risks for older adults. Older adults with a history of trauma exposure in adulthood have a higher likelihood of dementia than older adults with no history of adult trauma (Burri, Maercker, Krammer, & Simmen-Janevska, 2013; Tsolaki et al., 2010; Yaffe et al., 2010). Notably, older adults with a history of *childhood* trauma do not appear to share this increased risk of dementia (e.g., Burri et al., 2013; Ravona-Springer, Beeri, & Goldbourt, 2011), but they are more at risk for geriatric depression (Kuhlman, Maercker, Bachem, Simmen, & Burri, 2013). Thus, the developmental timing of stress and trauma continues to be an important modulating factor in emotion regulation, even into old age.

Implications

We have argued that allostasis is relational, in that there are profound reciprocal influences between a given stressor, an individual, and his or her broader physical and social environment. As noted in the beginning of this chapter, the stress process itself can be expected to change as a function of life experience (e.g., traumatic events or chronically stressful conditions), even in individuals who do not have a mental disorder. Thus, it follows from Proposition 4 that when central allostasis varies as a function of life experience, then so will negative core affect. This concept is pivotal in our use of triple-network allostasis as a diathesis-stress model predicting psychopathology onset and the course of mental illness (Ganzel & Morris, 2016). Here, we expand this concept to include individuals with and *without* mental disorder (i.e., everybody).

We have also argued that the stress process is embodied and thus changes continuously across the lifespan as a function of ongoing age-related neurophysiological change (Ganzel & Morris, 2011, 2016). Thus, it follows from Proposition 4 that systematic age-related change in central allostasis can be expected to drive age-related change in negative core affect. These effects may be observed as changes in baseline negative core affect, changes in affective reactivity to negative stimuli, or both (e.g., Rosen & Schulkin, 1998). Moreover, we have argued here that these systematic developmental changes in core affect are typical of normal development. Figure 41.1 includes both of these effects in depicting stress-related changes in allostasis over the lifespan. In this model, ongoing allostasis and accumulating allostatic load exert long-term influences on baseline core affect and/or reactivity to aversive stimuli.

There is considerable evidence that stressor exposure during a particular stress-sensitive period can have reverberating consequences for the magnitude, duration, and intensity of the stress response (e.g., Caldji, Diorio, & Meaney, 2000; Pryce et al., 2005; Sanchez, Ladd, & Plotsky, 2001). We have argued that the stress response itself is different within these time windows and thus produces different stress-related physiological and behavioral outcomes (see the beginning

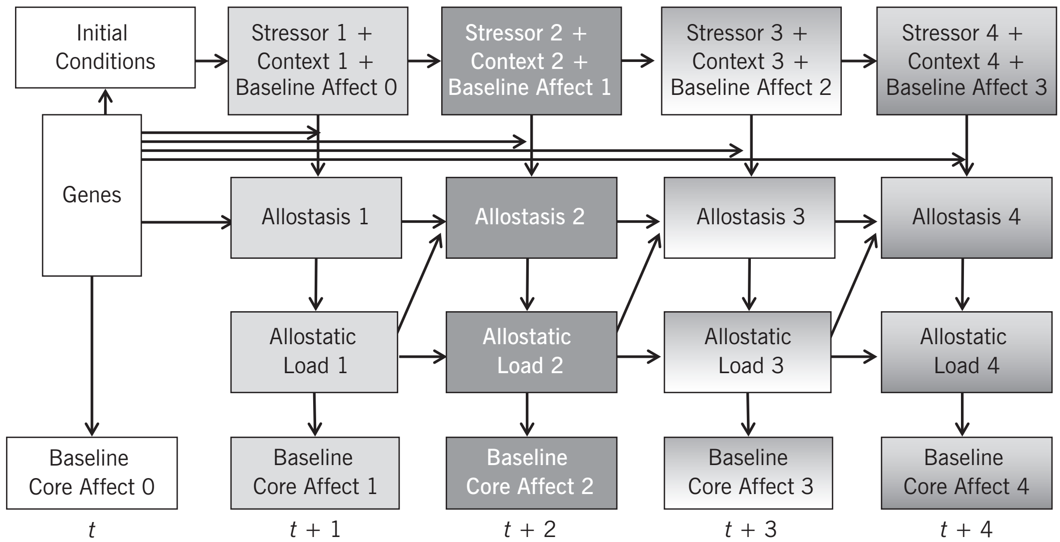

FIGURE 41.1. *Modulated allostasis predicting negative core affect.* Here we model ongoing allostasis in response to current stressors (columns at each time point: $t + n$) and ongoing accumulation of allostatic load over time (horizontal axis). In this model, both processes are modulated by developmental timing; the different shading in each column indicates varying stress sensitivity across the lifespan. Stressors that occur at different developmental periods are expected to have different long-term consequences for baseline core affect and/or reactivity to aversive stimuli. Not drawn: genes → stressor + context (all); baseline affect ($t + n$) = → stressor + context ($t + n$). Based on Ganzel and Morris, 2011.

of the chapter). Put differently, there are certain points in development in which the *mechanisms of allostasis* are uniquely constrained or expanded, or qualitatively changed. These changes may be temporary (a window) or long term (a stage). A stressor that occurs during this time period will have a qualitatively or quantitatively different impact on the processing of negative core affect, as compared with a stressor that occurs before this window opened or this stage began (see Ganzel & Morris, 2011, for a discussion). Moreover, a stressor that occurs during this time period will also generate a characteristic pattern of physiological "wear and tear" within the mechanisms of allostasis, and this will uniquely constrain future attempts at allostasis. The additional allostatic load from this stressor will be unique to this stressor *and* to this developmental period, with distinctive long-term consequences for baseline core affect and/or reactivity to aversive/negative stimuli.

As discussed in the previous sections, discrete emotions are argued to be constructed from the basic building blocks of core affect. If so, then any discrete emotion based in negative core affect will also *be expected to change systematically with life experience and age*. At present, these conclusions apply only to negative core affect, although see the section "Future Directions" for a discussion of the ways in which positive core affect may enter this model. Next, we consider the translational implications of this model.

Future Directions

Based on the models presented here, we urge future research to address questions of developmental timing in emotion processing by including developmental comparison groups. Ideally, these studies would compare across small-enough age intervals to build, over time, a detailed developmental time line of negative and positive core affect and affective reactivity across the lifespan.

We also urge research into how life stress influences these effects, namely, developmental timing of emotion processing. We discussed one example (above) in which early maternal deprivation was associated with amygdala hyperactivity and early maturation of amygdala-PFC connectivity (Gee, Gabard-Durnam, et al., 2013). This raises the question of the effects of attachment disruptions at other points in development. In general, it will be important to know the effects of similar stressors on core affect, affective reactivity, and emotion regulation in different developmental periods (in early childhood, middle childhood, and adolescence, etc.). And how would attachment disruptions differ with other types of social stressors, or from physical threats? There is growing evidence that these different types of stressors are processed somewhat differently in the brain and body (Alleva & Santucci, 2001; Pruessner et al., 2008), and thus could be expected to have different effects on affective and emotion-related outcomes.

Finally, we advocate for intervention research that includes not only developmental sensitivity but also sensitivity to the potential influences of life stress on emotion processing and regulation. For example, interventions targeting low-income children often consider home and neighborhood stressors as risk factors for emotional and behavioral difficulties (Dodge, Pettit, & Bates, 1994; Fantuzzo et al., 1999; Farmer, Stangl, Burns, Costello, & Angold, 1999). Because of this, emotion regulation interventions targeting stress have support in the literature. Below, we provide an overview of this emerging field.

Implications for Intervention

Emotion Regulation Interventions in Early Childhood

Early emotion regulation interventions have primarily targeted the fundamental social and emotional skills that underlie children's academic success, including competent social interactions with teachers and children and their attention to learning tasks. Some models target teacher behavioral strategies, building on the theory that teachers' behavior plays an important role in children's modulation of their attention, emotion, and behavior (Chryssanthopoulou, Turner-Cobb, Lucas, & Jessop, 2005; Hoglund & Leadbeater, 2004; Webster-Stratton, Reid, & Hammond, 2001).

In contrast, a second set of models relies on emotions-based curricula; these use organized instruction to teach specific affective and social-cognitive skills, such as emotions knowledge and social problem-solving skills (Cook, Greenberg, & Kusche, 1994; Crick & Dodge, 1994; Eisenberg, 1986; Kellam, Rebok, Ialongo, & Mayer, 1994; Spivack & Shure, 1974). Building on work that suggests that children's ability to recognize and label different emotions is critical to their development, a number of early educational programs have implemented emotions-based curricula to help children appropriately identify, choose, and enact prosocial solutions to typical social problems, such as dealing with peer conflicts. Meta-analyses of universal prevention programs during the elementary school years indicate that such programs significantly improve social-cognitive abilities and social adjustment (Beelmann, Pfingsten, & Lösel, 1994; Denham & Almeida, 1987; Durlak, 1995). The PATHS curriculum (Kusché & Greenberg, 1994) is one of the most successful of these programs, and focuses on the developmental integration of affect (and emotion language), behavior, and cognitive understanding as they relate to social and emotional competence.

Theory and empirical research would suggest that (1) social-cognitive processes are a key mediating mechanism in the link between early life experiences and aggression in later childhood and adolescence (Dodge, 2006) and (2) children's self-regulatory skills as promoted by effective classroom environments can have long-term implications for children's approach to learning (Raver, 2004). However, the work on which these theories are based is largely observational (i.e., nonexperimental) in nature. Furthermore, they neglect to consider the neurological mechanisms that undergird these processes. Emerging developmental neuroscience research has inspired a wave of interest in interventions that consider neurological systems related to cognition and emotion, but the bulk of this attention has been devoted to executive function (Diamond & Lee, 2011). Consideration of intervention-related change in the neural underpinnings of emotion regulation is a topic for further research, particularly with attention to determining the key sources of modulation within each child's environmental context and prior life experience.

An emerging line of research is investigating the role of aerobic exercise for improving executive function and emotion regulation. A supporting hypothesis for how this relationship works suggests that physiological changes induced by exercise, such as increases in capillary blood supply to the cortex and changes in neurotransmitter levels, elevate the function of emotion regulating systems in the brain (Davis et al., 2011). Indeed, animal research has shown that nonspecific neural activation associated with exercise drives durable neurogenesis in learning and memory centers in the brain (Best, 2010). To date, no intervention has addressed the relationship between exercise and emotion regulation, but a few studies have targeted the related process of executive function (Best, 2010). For instance, a randomized experiment was conducted for an exercise-based afterschool program for children between the ages of 7 and 9. Significant improvements on complex memory tasks were detected for the children who participated in 40 minutes of rigorous physical activity and then 30 minutes of an organized sport (Kamijo et al., 2011). We note the substantial overlap in the brain systems associated with executive function and those associated with emotion regulation strategies (e.g., suppression and reappraisal; Goldin, McRae, Ramel, & Gross, 2008) and suggest exercise-based interventions for emotion regulation as a topic for future research. Again, it would be of interest to determine how these effects are modulated by each child's environmental context and prior life experience.

Emotion Regulation Interventions in Adolescence and Beyond

Interventions for adolescents' emotion regulation in the context of life stress primarily concern mindfulness. This growing field of research has inspired promising interventions seeking to ameliorate the negative effects of stress and improve emotion regulation, although there has been limited attention to the neurological mechanisms of change. Mindfulness interventions targeting urban youth, coupled with basic yoga practices, have been shown to promote improved stress reactivity, depressive symptoms, and peer relations between baseline and 12 weeks later (Mendelson et al., 2010). Yoga also has an array of cognitive benefits across the lifespan into older adulthood (Hillman, Erickson & Kramer, 2008). Research is building on the underlying neurological mechanisms that drive the improvements demonstrated in mindfulness intervention, but the role of stress is not often emphasized. One study (Zylowska et al., 2008) reported lower symptoms of attention-deficit/hyperactivity disorder (ADHD), anxiety, and depression following an 8-week mindfulness meditation intervention. In another study, women diagnosed with an anxiety disorder showed increased activity in brain systems associated with attentional deployment (ventromedial and dorsomedial PFC, posterior cingulate, and amygdala), reductions in amygdala activity, and decreased negative emotion experience following a mindfulness-based intervention (Goldin & Gross, 2010). Mindfulness meditation is also associated with neuroplastic changes in the ACC, AI, and the TPJ (Hölzel et al., 2011), which are nodes in the salience network that is at the core of our triple-network model of allostasis (see the section "Stress and Salience"). Consideration of mindfulness-related change in the neural underpinnings of emotion regulation is a topic for further research, particularly with attention to isolating the ongoing effects of age, context, and prior life experience.

Eustress and Positive Core Affect

In this chapter, we have proposed relationships among the constructs of stress-related distress, salience-related aversion/avoidance, and negative core affect (Proposition 3). This, in turn, led us to propose that negative core affect is an outcome of central allostasis (Proposition 4). Is positive core affect similarly associated with the stress process?

Some researchers argue that positive core affect is at the opposite pole—but on the same axis—as negative core affect (Barrett & Bliss-Moreau, 2009; Barrett & Russell, 1999; Russell, 2003). In this case, positive core affect is entrained to negative core affect (they are inversely correlated) and changing one will change the other. Our Proposition 4 may then be expanded to say that the construct of core affect *as a whole* is linked to central allostasis.

Other researchers argue that positive core affect (manifested as positive emotionality) and negative core affect (manifested as negative emotionality) are independent from each other (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000; Larsen, McGraw, & Cacioppo, 2001). In this case, our new models apply to negative core affect, with few implications for positive core affect.

A third set of arguments suggests that the relationship between positive core affect and negative core affect depends on the stress level of the individual (Zautra, 2003). To understand the latter argument, it is useful to first consider the nonlinear (*U*-shaped) relationship between stressor exposure and distress (e.g., McEwen & Lasley, 2002). Both ends of the *U*-shaped curve mark progressively unhealthy levels of stressor exposure (too much stimulation or too little stimulation) that are accompanied by increased levels of distress. Healthy exercise, for example, can progress to being worked to death (Selye, 1950, 1956). At the opposite end of the spectrum, enforced immobility causes muscle wasting, dysregulated endocrine function, and sharply increased indicators of distress (e.g., Blanchard, Sakai, McEwen, Weiss, &

Blanchard, 1993; Blanchard et al., 1995; Radley et al., 2006; Vyas, Mitra, Shankaranarayana Rao, & Chattarji, 2002).[3] Closer to the bottom (middle) of the *U*-shaped curve are more normative, adaptive amounts of stimulation (e.g., healthy exercise; healthy intellectual challenge), termed "eustress" ("good stress"; Lazarus, 1966; Selye, 1974). Eustress is associated with enhanced neurogenesis (e.g., Kirby et al., 2013; McEwen & Lasley, 2002; Rhodes et al., 2003), improved brain metabolism and enhancements of neuronal architecture (e.g., Kempermann et al., 1998; Sirevaag & Greenough, 1988), improved executive and immune function (Colcombe et al., 2004; Sapolsky, Romero, & Munck, 2000), and improved psychological health (Gibbons, Dempster, & Moutray, 2008; Milsum, 1985).

Interestingly, eustress is not firmly associated with positive mental states (with positive core affect) in the same way that high levels of stressor exposure predict negative mental states (distress). In fact, at moderate levels of environmental stimulation (eustress), there is evidence that positive and negative mental states are largely independent phenomena (e.g., Cacioppo et al., 2000; Larsen et al., 2001; Reich, Zautra, & Davis, 2003; Ryff et al., 2006; Zautra & Reich, 1983). However, research suggests that positive and negative mental states become inversely coupled under stress, so that they are canalized onto a single positive/negative axis (e.g., Reich et al., 2003; Zautra, 2003; Zautra, Reich, Davis, Potter, & Nicolson, 2000). This is thought to streamline information processing (e.g., Zautra, 2003), a hypothesis that is supported by observations of enhanced negative reactivity under stress (e.g., Potter & Zautra, 1997; Zautra, Berkof, & Nicolson, 2002). Under these circumstances, central allostasis would predict overall core affect (positive *and* negative) with implications for the generation of all discrete emotions (see the section "Affect, Core Affect, and Emotion").

Stress-related canalization of positive and negative core affect may actually benefit intervention efforts. If positive core affect and negative core affect collapse onto opposite poles of the same axis, then the two states are effectively harnessed together. Under these circumstances, negative core affect (distress) can now be impacted by effecting changes in positive core affect. This hypothesis is supported by research showing that positive mental states can buffer distress in stressful situations (e.g., Keltner & Bonnano, 1997; Fredrickson & Levenson, 1998). A definitive understanding of the physiology underlying the relationships among positive core affect, negative core affect, and stress would help to optimize these interventions. It remains to future research to do this work.

New Directions in Integrative Research

We call attention here to the considerable overlap between the salience network (Plate 41.2C) and the neural locus of brain–body regulatory functions (Plate 41.2A). Brain–body medicine has taken an exciting step forward with the identification of remarkable commonalities in the brain mechanisms that regulate the human autonomic, endocrine, and immune systems (e.g., Gianaros & Sheu, 2009; Ohira et al., 2009; Urry, van Reekum, Johnstone, & Davidson, 2009; Wager et al., 2009). The neural loci of these brain–body interfaces fall along an axis that starts at the superior medial PFC and descends along the midline of the PFC and down into the brainstem. Thus, these neural brain–body regulatory mechanisms share significant common ground with the extended salience network (Plate 41.2C). Moreover, both the salience network and this brain–body "medial PFC-brainstem axis" (Lane & Wager, 2009, p. 1136) overlap with brain areas showing evidence of long- and short-term stress-related change in humans (Plate 41.2b; e.g., Ganzel et al., 2008; Gianaros, Horenstein, et al., 2007; Gianaros, Jennings, et al., 2007; Liston, McEwen, & Casey, 2009) and animals (Cerqueira et al., 2005; Vyas et al., 2002), which we have argued is indicative of central allostatic load. See Ganzel and Morris (2016) for a detailed discussion. Finally, all three of these systems share considerable overlap with the neural loci of affective processing and discrete emotion (Plate 41.2D; also called the "neural reference space for discrete emotions"; Lindquist et al., 2012, p. 126).

While this four-way overlap is highly consistent with our theoretical models, there is little research examining the linkages among life experience, emotion processing/regulation, and brain–body regulation within the context of the large-scale functional architecture of the brain. We commend this topic to future research.

Conclusion: Triple-Network Allostasis as an Organizing Concept

The goal of this chapter was to examine the relationship between stress and emotion using the newest version of our model of the stress process:

triple-network allostasis (Ganzel & Morris, 2016). To do this, we took a developmentally informed approach to bridging research on the neurobiology of the stress process (Ganzel et al., 2010; Ganzel & Morris, 2011, 2016) with research on emotion, core affect, and emotion regulation. As part of this process, we reviewed the neurobiology of the stress process and the relevant role of the salience network, as well as the neurobiology of core affect and emotion. Our analysis of these topics suggests the following propositions: (1) that stressors are intrinsically salient; (2) the neurobiology of the salience processing (for aversive stimuli) is functionally identical to that of the stress process; (3) that the construct of stress-related distress is functionally identical to salience-related aversion/avoidance and negatively valenced core affect; and, as such, (4) negative core affect is a primary outcome of allostasis. We concluded with a new triple-network model in which ongoing allostasis and accumulating allostatic load exert long-term influences on baseline core affect and/or reactivity to negative stimuli.

We offer this model as a useful tool for conceptualizing pathways to integrating research on stress, emotion, and the neurobiology of salience. In prior work, we modeled allostasis as *relational*, proposing that the stress process itself can be expected to change as a function of life experience (discussed before, see also Ganzel et al., 2010; Ganzel & Morris, 2011, 2016). In the current chapter, we have argued that if the stress process itself changes with life experience, then so will negative core affect and any discrete emotions based on negative core affect (see the section "Stress and Emotion Regulation across the Lifespan"). We have also, in prior work, modeled allostasis as *embodied*; as such, it undergoes continuous change across the lifespan as a function of systematic age-related physiological development and senescence (particularly within the brain; see Ganzel et al., 2010; Ganzel & Morris, 2016). In the current chapter, we argued that age-related change in central allostasis can also be expected to drive age-related change in baseline negative core affect, reactivity to negative stimuli, and any discrete emotions based on negative core (see the section "Implications"). This brings a developmental perspective to affective/emotion processing and emotion regulation, highlighting the sensitivity of key ages and stages, as well as the neurospecificity that a lifespan developmental view implies.

In sum, we offer triple-network allostasis as an organizing concept to aid in integrating multiple domains of academic inquiry, including biomedical and psychosocial stress research (Ganzel et al., 2010); human development and lifespan developmental neuroscience (Ganzel & Morris, 2011); developmental psychopathology and the large-scale functional architecture of the brain (Ganzel & Morris, 2016); and research on core affect, emotion, and emotion regulation (this current chapter). Given the breadth of its application, we suggest here that triple-network allostasis is most accurately characterized as a *multilevel theory of lifespan development*, rather than a model of the stress process or even a diathesis-stress model of developmental psychopathology (although we have shown that it can be informative in both of these roles; Ganzel et al., 2010; Ganzel & Morris, 2016).

Notes

1. As the brain matures, populations of neurons are increasingly able to fire rhythmically and in synchrony, creating oscillating networks that link neural activity across multiple spatial and temporal levels of analysis (Barrett et al., 2007; Dosenbach et al., 2010; Engel, 1977). In this way, the firing of a single neuron in a local network may be linked to oscillatory activity in vast neural assemblies that span the brain (Convit, Wolf, Tarshish, & De Leon, 2003; Uhlhaas & Singer, 2012).
2. Events, including social events that have value to survival and/or reproduction. Examples for humans would include social or financial threat or reward.
3. These indicators of distress vary as a function of species, sex, age, genetic characteristics (e.g., knock-out mice), physiological state, and/or environment (e.g., laboratory housing)—for example, inbred strains of laboratory mice typically differ from each other and from wild-type mice with respect to physiology, sensory, motor, and behavioral traits, and so can be expected to respond differently to stressor exposure across all of these parameters (Ward et al., 2008). In humans and other animals, distress is inferred from observable changes in behavior. In addition, many humans have the ability to report their own distress levels, but again, responses may vary as a function of age, sex, genetics, physiological state, and environment.

References

Admon, R., Lubin, G., Stern, O., Rosenberg, K., Sela, L., Ben-Ami, H., et al. (2009). Human vulnerability to stress depends on amygdala's predisposition and hippocampal plasticity. *Proceedings of the National Academy of Sciences, 106*(33), 14120–14125.

Alleva, E., & Santucci, D. (2001). Psychosocial vs. "physical" stress situations in rodents and humans: Role of neurotrophins. *Physiology and Behavior, 73*, 313–320.

Anderson, J. R. (2005). *Cognitive psychology and its implications*. New York: Macmillan.

Anderson, J. R., Fincham, J. M., Qin, Y., & Stocco, A. (2008). A central circuit of the mind. *Trends in Cognitive Sciences, 12*(4), 136–143.

Andrews-Hanna, J. R., Smallwood, J., & Spreng, R. N. (2014). The default network and self-generated thought: Component processes, dynamic control, and clinical relevance. *Annals of the New York Academy of Sciences*.

Baibazarova, E., van de Beek, C., Cohen-Kettenis, P. T., Buitelaar, J., Shelton, K. H., & van Goozen, S. H. (2013). Influence of prenatal maternal stress, maternal plasma cortisol and cortisol in the amniotic fluid on birth outcomes and child temperament at 3 months. *Psychoneuroendocrinology, 38*(6), 907–915.

Baltes, P. B., & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. *Successful Aging: Perspectives From the Behavioral Sciences, 1*, 1–34.

Barrett, L. F. (2013). Psychological construction: The Darwinian approach to the science of emotion. *Emotion Review, 5*(4), 379–389.

Barrett, L. F., & Bliss-Moreau, E. (2009). Affect as a psychological primitive. *Advances in Experimental Social Psychology, 41*, 167–218.

Barrett, L. F., Mesquita, B., Ochsner, K. N., & Gross, J. J. (2007). The experience of emotion. *Annual Review of Psychology, 58*, 373.

Barrett, L. F., & Russell, J. A. (1999). The structure of current affect controversies and emerging consensus. *Current Directions in Psychological Science, 8*(1), 10–14.

Barrett, L. F., & Satpute, A. B. (2013). Large-scale brain networks in affective and social neuroscience: Towards an integrative functional architecture of the brain. *Current Opinion in Neurobiology, 23*(3), 361–372.

Barrett, L. F., Wilson-Mendenhall, C. D., & Barsalou, L. (2014). A psychological construction account of emotion regulation and dysregulation: The role of situated conceptualizations. In J. J. Gross (Ed.), *The handbook of emotion regulation* (2nd ed., pp. 447–465). New York: Guilford Press.

Bartels, A., & Zeki, S. (2004). The neural correlates of maternal and romantic love. *NeuroImage, 21*(3), 1155–1166.

Barton, R. A., & Aggleton, J. P. (2000). Primate evolution and the amygdala. In J. P. Aggleton (Ed.), *The amygdala: A functional analysis* (pp. 480–508). Oxford, UK: Oxford University Press.

Batson, C. D., Shaw, L. L., & Oleson, K. C. (1992). Differentiating affect, mood, and emotion: Toward functionally based conceptual distinctions. In M. S. Clark (Ed.), *Review of personality and social psychology* (Vol. 13, pp. 294–326). Newbury Park, CA: Sage.

Baumrind, D. (2005). Patterns of parental authority and adolescent autonomy. *New Directions for Child and Adolescent Development, 2005*(108), 61–69.

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50*(1), 7–15.

Beelmann, A., Pfingsten, U., & Lösel, F. (1994). Effects of training social competence in children: A meta-analysis of recent evaluation studies. *Journal of Clinical Child Psychology, 23*(3), 260–271.

Best, J. R. (2010). Effects of physical activity on children's executive function: Contributions of experimental research on aerobic exercise. *Developmental Review, 30*(4), 331–351.

Binder, J. R., Frost, J. A., Hammeke, T. A., Bellgowan, P. S. F., Rao, S. M., & Cox, R. W. (1999). Conceptual processing during the conscious resting state: A functional MRI study. *Journal of Cognitive Neuroscience, 11*(1), 80–93.

Blair, C., & Raver, C. C. (2012). Child development in the context of adversity: Experiential canalization of brain and behavior. *American Psychologist, 67*(4), 309.

Blanchard, D. C., Sakai, B. S., McEwen, B. S., Weiss, S. M., & Blanchard, R. J. (1993). Subordinate stress: Behavioral, brain, and neuroendocrine correlates. *Behavioural Brain Research, 58*, 113–121.

Blanchard, D. C., Spencer, R., Wiess, S., Blanchard, R., McEwen, B., & Sakai, R. (1995). Visible burrow system as a model of chronic social stress: Behavioral and neuroendocrine correlates. *Psychoneuroendocrinology, 20*, 117–134.

Bolten, M., Nast, I., Skrundz, M., Stadler, C., Hellhammer, D. H., & Meinlschmidt, G. (2013). Prenatal programming of emotion regulation: Neonatal reactivity as a differential susceptibility factor moderating the outcome of prenatal cortisol levels. *Journal of Psychosomatic Research, 75*(4), 351–357.

Bolten, M. I., Fink, N. S., & Stadler, C. (2012). Maternal self-efficacy reduces the impact of prenatal stress on infant's crying behavior. *Journal of Pediatrics, 161*(1), 104–109.

Borsook, D., Edwards, R., Elman, I., Becerra, L., & Levine, J. (2013). Pain and analgesia: The value of salience circuits. *Progress in Neurobiology, 104*, 93–105.

Bressler, S. L., & Menon, V. (2010). Large-scale brain networks in cognition: Emerging methods and principles. *Trends in Cognitive Science, 14*(6), 277–298.

Bronfenbrenner, U., & Morris, P. A. (1998). The ecology of developmental processes. In R. M. Lerner (Ed.), *Theoretical models of human development: Handbook of child psychology* (5th ed., pp. 993–1028). New York: Wiley.

Brown, J. D., & McGill, K. L. (1989). The cost of good fortune: When positive life events produce negative health consequences. *Journal of Personality and Social Psychology, 57*(6), 1103.

Büchel, C., Morris, J., Dolan, R. J., & Friston, K. J. (1998). Brain systems mediating aversive conditioning: An event-related fMRI study. *Neuron, 20*(5), 947–957.

Buck, R. (1999). The biological affects: A typology. *Psychological Review, 106*, 301–336.

Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L.

(2008). The brain's default network. *Annals of the New York Academy of Sciences, 1124*(1), 1–38.

Burri, A., Maercker, A., Krammer, S., & Simmen-Janevska, K. (2013). Childhood trauma and PTSD symptoms increase the risk of cognitive impairment in a sample of former indentured child laborers in old age. *PLoS ONE, 8*(2), e57826.

Bush, G., Luu, P., & Posner, M. I. (2000). Cognitive and emotional influences in anterior cingulate cortex. *Trends in Cognitive Sciences, 4*(6), 215–222.

Cacioppo, J. T., & Berntson, G. G. (1994). Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates. *Psychological Bulletin, 115*(3), 401.

Cacioppo, J. T., Berntson, G. G., Larsen, J. T., Poehlmann, K. M., & Ito, T. A. (2000). The psychophysiology of emotion. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed., pp. 173–191). New York: Guilford Press.

Calder, A. J., Lawrence, A. D., & Young, A. W. (2001). Neuropsychology of fear and loathing. *Nature Reviews Neuroscience, 2*(5), 352–363.

Caldji, C., Diorio, J., & Meaney, M. J. (2000). Variations in maternal care in infancy regulate the development of stress reactivity. *Biological Psychiatry, 48*(12), 1164–1174.

Callaghan, B. L., & Richardson, R. (2011). Maternal separation results in early emergence of adult-like fear and extinction learning in infant rats. *Behavioral Neuroscience, 125*(1), 20.

Cameron, H. A., Woolley, C. S., McEwen, B. S., & Gould, E. (1993). Differentiation of newly born neurons and glia in the dentate gyrus of the adult rat. *Neuroscience, 56*(2), 337–344.

Cannon, W. B. (1920). *Bodily changes in pain, hunger, fear, and rage* (2nd ed.). New York: Appleton-Century-Crofts.

Cannon, W. B. (1932). *The wisdom of the body.* New York: Norton.

Cannon, W. B. (1935). Stresses and strains of homeostasis. *American Journal of the Medical Sciences, 189*(1), 13–14.

Carlson, S. M., & Wang, T. S. (2007). Inhibitory control and emotion regulation in preschool children. *Cognitive Development, 22*(4), 489–510.

Carstensen, L. L., Gross, J. J., & Fung, H. H. (1997). The social context of emotional experience. *Annual Review of Gerontology and Geriatrics, 17*, 325–352.

Casey, B. J., Getz, S., & Galvan, A. (2008). The adolescent brain. *Developmental Review, 28*, 62–77.

Casey, B. J., Jones, R. M., & Hare, T. A. (2008). The adolescent brain. *Annals of the New York Academy of Sciences, 1124*(1), 111–126.

Cerqueira, J. J., Pêgo, J. M., Taipa, R., Bessa, J. M., Almeida, O. F., & Sousa, N. (2005). Morphological correlates of corticosteroid-induced changes in prefrontal cortex-dependent behaviors. *Journal of Neuroscience, 25*(34), 7792–7800.

Chrousos, G. P., & Gold, P. W. (1992). The concepts of stress and stress system disorders: Overview of physical and behavioral homeostasis. *JAMA, 267*(9), 1244–1252.

Chryssanthopoulou, C. C., Turner-Cobb, J. M., Lucas, A., & Jessop, D. (2005). Childcare as a stabilizing influence on HPA axis functioning: A reevaluation of maternal occupational patterns and familial relations. *Developmental Psychobiology, 47*(4), 354–368.

Cohen, S., & Williamson, G. M. (1991). Stress and infectious disease in humans. *Psychological Bulletin, 109*(1), 5.

Colcombe, S. J., Kramer, A. F., Erickson, K. I., Scalf, P., McAuley, E., Cohen, N. J., et al. (2004). Cardiovascular fitness, cortical plasticity, and aging. *Proceedings of the National Academy of Sciences of the United States of America, 101*(9), 3316–3321.

Cole, S. W., Hawkley, L. C., Arevalo, J. M., Sung, C. Y., Rose, R. M., & Cacioppo, J. T. (2007). Social regulation of gene expression in human leukocytes. *Genome Biology, 8*(9), R189.

Convit, A., Wolf, O. T., Tarshish, C., & De Leon, M. J. (2003). Reduced glucose tolerance is associated with poor memory performance and hippocampal atrophy among normal elderly. *Proceedings of the National Academy of Sciences, 100*(4), 2019–2022.

Cook, E. T., Greenberg, M. T., & Kusche, C. A. (1994). The relations between emotional understanding, intellectual functioning, and disruptive behavior problems in elementary-school-aged children. *Journal of Abnormal Child Psychology, 22*(2), 205–219.

Corbetta, M., Patel, G., & Shulman, G. L. (2008). The reorienting system of the human brain: From environment to theory of mind. *Neuron, 58*(3), 306–324.

Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. *Nature Reviews Neuroscience, 3*, 655–666.

Craig, A. D. (2003). Pain mechanisms: Labeled lines verses convergence in central processing. *Annual Review of Neuroscience, 21*(1), 1–30.

Craig, A. D. (2008). Interoception and emotion: A neuroanatomical perspective. In M. Lewis, J. Haviland-Jones, & L. Barrett (Eds.), *Handbook of emotions* (pp. 272–287). New York: Guilford Press.

Craig, A. D. (2009). Emotional moments across time: A possible neural basis for time perception in the anterior insula. *Philosophical Transactions: Biological Sciences, 364*(1525), 1933–1942.

Crick, N. R., & Dodge, K. A. (1994). A review and reformulation of social information-processing mechanisms in children's social adjustment. *Psychological Bulletin, 115*(1), 74.

Critchley, H. D. (2004). The human cortex responds to an introceptive challenge. *Proceedings of the National Academy of Sciences of the United States of America, 101*, 6333–6334.

Critchley, H. D. (2005). Neural mechanisms of autonomic, affective, and cognitive integration. *Journal of Comparative Neurology, 493*(1), 154–166.

Critchley, H. D., Mathias, C. J., Josephs, O., O'Doherty, J., Zanini, S., Dewar, B. K., et al. (2003). Human cingulate cortex and autonomic control: Converging neuroimaging and clinical evidence. *Brain, 126*(10), 2139–2152.

Critchley, H. D., Wiens, S., Rotshtein, P., Öhman, A., &

Dolan, R. J. (2004). Neural systems supporting interoceptive awareness. *Nature Neuroscience, 7*(2), 189–195.

Cunningham, W. A., & Brosch, T. (2012). Motivational salience amygdala tuning from traits, needs, values, and goals. *Current Directions in Psychological Science, 21*(1), 54–59.

Cunningham, W. A., Dunfield, K. A., & Stillman, P. E. (2013). Emotional states from affective dynamics. *Emotion Review, 5*(4), 344–355.

Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness.* New York: Harcourt Brace.

Damasio, A. R. (2003). Feelings of emotion and the self. *Annals of the New York Academy of Sciences, 1001*(1), 253–261.

Damasio, A. R., & Carvalho, G. B. (2013). The nature of feelings: Evolutionary and neurobiological origins. *Nature Reviews Neuroscience, 14*(2), 143–152.

Davidson, R. J. (1984). Affect, cognition and hemispheric specialization. In C. E. Izard, J. Kagan, & R. Zajonc (Eds.), *Emotion, cognition and behavior* (pp. 320–365). New York: Cambridge University Press.

Davidson, R. J., Ekman, P., Saron, C. D., Senulis, J. A., & Friesen, W. V. (1990). Approach–withdrawal and cerebral asymmetry: Emotional expression and brain physiology. *Journal of Personality and Social Psychology, 58*, 330–341.

Davidson, R. J., Maxwell, J. S., & Shackman, A. J. (2004). The privileged status of emotion in the brain. *Proceedings of the National Academy of Sciences of the United States of America, 101*(33), 11915–11916.

Davis, E. P., Glynn, L. M., Waffarn, F., & Sandman, C. A. (2011). Prenatal maternal stress programs infant stress regulation. *Journal of Child Psychology and Psychiatry, 52*(2), 119–129.

Davis, E. P., Sandman, C. A., Buss, C., Wing, D. A., & Head, K. (2013). Fetal glucocorticoid exposure is associated with preadolescent brain development. *Biological psychiatry, 74*(9), 647–655.

Davis, M., Walker, D. L., & Lee, Y. (1997). Roles of the amygdala and bed nucleus of the stria terminalis in fear and anxiety measured with the acoustic startle reflex. *Annals of the New York Academy of Sciences, 821*(1), 305–331.

De Martino, B., Camerer, C. F., & Adolphs, R. (2010). Amygdala damage eliminates monetary loss aversion. *Proceedings of the National Academy of Sciences, 107*(8), 3788–3792.

De Martino, B., Kumaran, D., Seymour, B., & Dolan, R. J. (2006). Frames, biases, and rational decision-making in the human brain. *Science, 313*(5787), 684–687.

Denham, S. A., & Almeida, M. C. (1987). Children's social problem-solving skills, behavioral adjustment, and interventions: A meta-analysis evaluating theory and practice. *Journal of Applied Developmental Psychology,* 8(4), 391–409.

Denham, S. A., & Burton, R. (2003). *Social and emotional prevention and intervention programming for preschoolers.* New York: Kluwer Academic/Plenum.

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science, 333*(6045), 959–964.

Dodge, K. A. (2006). Translational science in action: Hostile attributional style and the development of aggressive behavior problems. *Development and Psychopathology, 18*(3), 791–814.

Dodge, K. A., Pettit, G. S., & Bates, J. E. (1994). Socialization mediators of the relation between socioeconomic status and child conduct problems. *Child Development, 65*(2), 649–665.

Dosenbach, N. U., Nardos, B., Cohen, A. L., Fair, D. A., Power, J. D., Church, J. A., et al. (2010). Prediction of individual brain maturity using fMRI. *Science, 329*(5997), 1358–1361.

Downar, J., Crawley, A. P., Mikulis, D. J., & Davis, K. D. (2002). A cortical network sensitive to stimulus salience in a neutral behavioral context across multiple sensory modalities. *Journal of Neurophysiology, 87*(1), 615–620.

Downar, J., Mikulis, D. J., & Davis, K. D. (2003). Neural correlates of the prolonged salience of painful stimulation. *NeuroImage, 20*(3), 1540–1551.

Duncan, S., & Barrett, L. F. (2007). Affect is a form of cognition: A neurobiological analysis. *Cognition and Emotion, 21*(6), 1184–1211.

Durlak, J. A. (1995). *School-based prevention programs for children and adolescents* (Vol. 34). Newbury Park, CA: Sage.

Eisenberg, N. I. (1986). *Altruistic emotion, cognition, and behavior.* Hillsdale, NJ: Erlbaum.

Eisenberger, N. I., Lieberman, M. D., & Williams, K. D. (2003). Does rejection hurt?: An fMRI study of social exclusion. *Science, 302*(5643), 290–292.

Ekman, P. (1999). Basic emotions. In T. Dalgleish & M. J. Power (Eds.), *Handbook of cognition and emotion* (pp. 45–60). Chichester, UK: Wiley.

Elder, G. H., Jr., George, L. K., & Shanahan, M. J. (1996). Psychosocial stress over the life course. In H. B. Kaplan (Ed.), *Psychosocial stress: Perspectives on structure, theory life course, and methods* (pp. 247–292). Orlando, FL: Academic Press.

Engel, G. (1977). The need for a new medical model: A challenge for biomedicine. *Science, 196*(4286), 129–136.

Evans, G. W., Kim, P., Ting, A. H., Tesher, H. B., & Shannis, D. (2007). Cumulative risk, maternal responsiveness, and allostatic load among young adolescents. *Developmental Psychology, 43*, 341–351.

Fantuzzo, J., Stoltzfus, J., Noone Lutz, M., Hamlet, H., Balraj, V., Turner, C., et al. (1999). An evaluation of the special needs referral process for low-income preschool children with emotional and behavioral problems. *Early Childhood Research Quarterly, 14*(4), 465–482.

Farmer, E. M., Stangl, D. K., Burns, B. J., Costello, E. J., & Angold, A. (1999). Use, persistence, and intensity: Patterns of care for children's mental health across one year. *Community Mental Health Journal, 35*(1), 31–46.

Fischer, H., Sandblom, J., Gavazzeni, J., Fransson, P., Wright, C. I., & Bäckman, L. (2005). Age-differential patterns of brain activation during perception of angry faces. *Neuroscience Letters, 386*(2), 99–104.

Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin, 99*(1), 20.

Fodor, J. A. (1983). *The modularity of mind: An essay on faculty psychology.* Cambridge, MA: MIT Press.

Fox, M. D., & Raichle, M. E. (2007). Spontaneous fluctuations in brain activity observed with functional magnetic resonance imaging. *Nature Reviews Neuroscience, 8*(9), 700–711.

Fox, M. D., Snyder, A. Z., Vincent, J. L., Corbetta, M., Van Essen, D. C., & Raichle, M. E. (2005). The human brain is intrinsically organized into dynamic, anticorrelated functional networks. *Proceedings of the National Academy of Sciences of the United States of America, 102*(27), 9673–9678.

Fredrickson, B. L., & Levenson, R. W. (1998). Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. *Cognition and Emotion, 12,* 191–220.

Furstenberg, F. F., Jr., Brooks-Gunn, J., & Morgan, S. P. (1987). Adolescent mothers and their children in later life. *Family Planning Perspectives, 19*(4), 142–151.

Gainotti, G., Caltagirone, C., & Zoccolotti, P. (1993). Left/right and cortical/subcortical dichotomies in the neuropsychological study of human emotions. *Cognition and Emotion, 7*(1), 71–93.

Galvan, A., Hare, T. A., Parra, C. E., Penn, J., Voss, H., Glover, G., et al. (2006). Earlier development of the accumbens relative to orbitofrontal cortex might underlie risk-taking behavior in adolescents. *Journal of Neuroscience, 26*(25), 6885–6892.

Ganzel, B., Casey, B. J., Glover, G., Voss, H. U., & Temple, E. (2007). The aftermath of 9/11: Effect of intensity and recency of trauma on outcome. *Emotion, 7*(2), 227.

Ganzel, B. L., Kim, P., Glover, G. H., & Temple, E. (2008). Resilience after 9/11: Multimodal neuroimaging evidence for stress-related change in the healthy adult brain. *NeuroImage, 40*(2), 788–795.

Ganzel, B. L., & Morris, P. A. (2011). Allostasis and the developing human brain: Explicit consideration of implicit models. *Development and Psychopathology, 23*(4), 955–974.

Ganzel, B. L., & Morris, P. A. (2016). Typical and atypical brain development across the lifespan: Contributions to a diathesis–stress model of psychopathology. In D. Cicchetti (Ed.), *Handbook of developmental psychopathology* (3rd ed.). Hoboken, NJ: Wiley.

Ganzel, B. L., Morris, P. A., & Wethington, E. (2010). Allostasis and the human brain: Integrating models of stress from the social and life sciences. *Psychological Review, 117*(1), 134.

Gee, D. G., Gabard-Durnam, L. J., Flannery, J., Goff, B., Humphreys, K. L., Telzer, E. H., et al. (2013). Early developmental emergence of human amygdala–prefrontal connectivity after maternal deprivation. *Proceedings of the National Academy of Sciences, 110*(39), 15638–15643.

Gee, D. G., Humphreys, K. L., Flannery, J., Goff, B., Telzer, E. H., Shapiro, M., et al. (2013). A developmental shift from positive to negative connectivity in human amygdala–prefrontal circuitry. *Journal of Neuroscience, 33*(10), 4584–4593.

Gerfen, C. R. (1992). The neostriatal mosaic: Multiple levels of compartmental organization. In *Advances in neuroscience and schizophrenia* (pp. 43–59). Vienna, Austria: Springer.

Geronimus, A. T., Hicken, M., Keene, D., & Bound, J. (2006). "Weathering" and age patterns of allostatic load scores among blacks and whites in the United States. *Journal Information, 96*(5), 826–833.

Gianaros, P. J., Horenstein, J. A., Cohen, S., Matthews, K. A., Brown, S. M., Flory, J. D., et al. (2007). Perigenual anterior cingulate morphology covaries with perceived social standing. *Social Cognition and Affective Neuroscience, 2,* 161–173.

Gianaros, P. J., Jennings, J. R., Sheu, L. K., Greer, P. J., Kuller, L. H., & Matthews, K. A. (2007). Prospective reports of chronic life stress predict decreased grey matter volume in the hippocampus. *NeuroImage, 35,* 795–803.

Gianaros, P. J., & Sheu, L. K. (2009). A review of neuroimaging studies of stressor-evoked blood pressure reactivity: Emerging evidence for a brain–body pathway to coronary heart disease risk. *NeuroImage, 47,* 922–936.

Gibbons, C., Dempster, M., & Moutray, M. (2008). Stress and eustress in nursing students. *Journal of Advanced Nursing, 61*(3), 282–290.

Glover, V. (2011). Annual research review: Prenatal stress and the origins of psychopathology: An evolutionary perspective. *Journal of Child Psychology and Psychiatry, 52*(4), 356–367.

Goldin, P. R., & Gross, J. J. (2010). Effects of mindfulness-based stress reduction (MBSR) on emotion regulation in social anxiety disorder. *Emotion, 10*(1), 83.

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: Reappraisal and suppression of negative emotion. *Biological Psychiatry, 63*(6), 577–586.

Goldstein, D. S. (1995a). Stress as a scientific idea: Homeostatic theory of stress and distress. *Homeostasis, 36,* 117–215.

Goldstein, D. S. (1995b). *Stress, catecholamines, and cardiovascular disease.* New York: Oxford University Press.

Gottfried, J. A., O'Doherty, J., & Dolan, R. J. (2003). Encoding predictive reward value in human amygdala and orbitofrontal cortex. *Science, 301*(5636), 1104–1107.

Greicius, M. D., Krasnow, B., Reiss, A. L., & Menon, V. (2003). Functional connectivity in the resting brain: A network analysis of the default mode hypothesis. *Proceedings of the National Academy of Sciences, 100*(1), 253–258.

Greicius, M. D., Srivastava, G., Reiss, A. L., & Menon, V. (2004). Default-mode network activity distinguishes Alzheimer's disease from healthy aging: Evidence from functional MRI. *Proceedings of the National Academy of Sciences of the United States of America, 101*(13), 4637–4642.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*(3), 271.

Gross, J. J., Carstensen, L. L., Pasupathi, M., Tsai, J., Götestam Skorpen, C., & Hsu, A. Y. C. (1997). Emotion and aging: Experience, expression, and control. *Psychology and Aging, 12*(4), 590.

Gunnar, M., & Quevedo, K. (2007). The neurobiology of stress and development. *Annual Review of Psychology, 58*, 145–173.

Gusnard, D. A., & Raichle, M. E. (2001). Searching for a baseline: Functional imaging and the resting human brain. *Nature Reviews Neuroscience, 2*(10), 685–694.

Gutteling, B. M., de Weerth, C., Willemsen-Swinkels, S. H., Huizink, A. C., Mulder, E. J., Visser, G. H., et al. (2005). The effects of prenatal stress on temperament and problem behavior of 27-month-old toddlers. *European Child and Adolescent Psychiatry, 14*(1), 41–51.

Habas, C., Kamdar, N., Nguyen, D., Prater, K., Beckmann, C. F., Menon, V., et al. (2009). Distinct cerebellar contributions to intrinsic connectivity networks. *Journal of Neuroscience, 29*(26), 8586–8594.

Haber, S. N., Kim, K. S., Mailly, P., & Calzavara, R. (2006). Reward-related cortical inputs define a large striatal region in primates that interface with associative cortical connections, providing a substrate for incentive-based learning. *Journal of Neuroscience, 26*(32), 8368–8376.

Hamann, S. (2012). Mapping discrete and dimensional emotions onto the brain: Controversies and consensus. *Trends in Cognitive Sciences, 16*(9), 458–466.

Hammel, H. T. (1988). Anesthetics and body temperature regulation. *Anesthesiology, 68*(6), 833–835.

Hardy, S. E., Concato, J., & Gill, T. M. (2002). Stressful life events among community-living older persons. *Journal of General Internal Medicine, 17*(11), 841–847.

Hare, T. A., Tottenham, N., Galvan, A., Voss, H. U., Glover, G. H., & Casey, B. J. (2008). Biological substrates of emotional reactivity and regulation in adolescence during an emotional go-nogo task. *Biological Psychiatry, 63*(10), 927–934.

Hermans, E. J., van Marle, H. J., Ossewaarde, L., Henckens, M. J., Qin, S., van Kesteren, M. T., et al. (2011). Stress-related noradrenergic activity prompts large-scale neural network reconfiguration. *Science, 334*(6059), 1151–1153.

Hermes, M., Hagemann, D., Naumann, E., & Walter, C. (2011). Extraversion and its positive emotional core—Further evidence from neuroscience. *Emotion, 11*(2), 367.

Hillman, C. H., Erickson, K. I., & Kramer, A. F. (2008). Be smart, exercise your heart: Exercise effects on brain and cognition. *Nature Reviews Neuroscience, 9*(1), 58–65.

Hoglund, W. L., & Leadbeater, B. J. (2004). The effects of family, school, and classroom ecologies on changes in children's social competence and emotional and behavioral problems in first grade. *Developmental Psychology, 40*(4), 533.

Holmes, T., & Rahe, R. (1967). The social adjustment rating scale. *Journal of Psychosomatic Research, 11*, 213–218.

Hölzel, B. K., Carmody, J., Vangel, M., Congleton, C., Yerramsetti, S. M., Gard, T., et al. (2011). Mindfulness practice leads to increases in regional brain gray matter density. *Psychiatry Research: Neuroimaging, 191*(1), 36–43.

Hugdahl, K., & Öhman, A. (1977). Effects of instruction on acquisition and extinction of electrodermal responses to fear-relevant stimuli. *Journal of Experimental Psychology: Human Learning and Memory, 3*(5), 608.

Hughes, D. C., George, L. K., & Blazer, D. G. (1988). Age differences in life event qualities: Multivariate controlled analyses. *Journal of Community Psychology, 16*(2), 161–174.

Ito, T. A., Larsen, J. T., Smith, N. K., & Cacioppo, J. T. (1998). Negative information weighs more heavily on the brain: The negativity bias in evaluative categorizations. *Journal of Personality and Social Psychology, 75*(4), 887.

Izard, C., Fine, S., Schultz, D., Mostow, A., Ackerman, B., & Youngstrom, E. (2001). Emotion knowledge as a predictor of social behavior and academic competence in children at risk. *Psychological Science, 12*(1), 18–23.

Jennings, J. H., Sparta, D. R., Stamatakis, A. M., Ung, R. L., Pleil, K. E., Kash, T. L., et al. (2013). Distinct extended amygdala circuits for divergent motivational states. *Nature, 496*(7444), 224–228.

John, O. P., & Gross, J. J. (2004). Healthy and unhealthy emotion regulation: Personality processes, individual differences, and life span development. *Journal of Personality, 72*(6), 1301–1334.

Kamijo, K., Pontifex, M. B., O'Leary, K. C., Scudder, M. R., Wu, C. T., Castelli, D. M., et al. (2011). The effects of an afterschool physical activity program on working memory in preadolescent children. *Developmental Science, 14*(5), 1046–1058.

Kellam, S. G., Rebok, G. W., Ialongo, N., & Mayer, L. S. (1994). The course and malleability of aggressive behavior from early first grade into middle school: Results of a developmental epidemiologically-based preventive trial. *Journal of Child Psychology and Psychiatry, 35*(2), 259–281.

Kelley, W. M., Macrae, C. N., Wyland, C. L., Caglar, S., Inati, S., & Heatherton, T. F. (2002). Finding the self?: An event-related fMRI study. *Journal of Cognitive Neuroscience, 14*(5), 785–794.

Keltner, D., & Bonanno, G. A. (1997). A study of laughter and dissociation: Distinct correlates of laughter and smiling during bereavement. *Journal of Personality and Social Psychology, 73*(4), 687.

Kempermann, G., Kuhn, H. G., & Gage, F. H. (1998). Experience-induced neurogenesis in the senescent dentate gyrus. *Journal of Neuroscience, 18*(9), 3206–3212.

Kiecolt-Glaser, J. K., & Glaser, R. (2001). Stress and immunity: Age enhances the risks. *Current Directions in Psychological Science, 10*(1), 18–21.

Kim, S. Y., Adhikari, A., Lee, S. Y., Marshel, J. H., Kim, C. K., Mallory, C. S., et al. (2013). Diverging neural pathways assemble a behavioural state from separable features in anxiety. *Nature, 496*(7444), 219–223.

Kirby, E. D., Muroy, S. E., Sun, W. G., Covarrubias, D., Leong, M. J., Barchas, L. A., et al. (2013). Acute stress enhances adult rat hippocampal neurogenesis and activation of newborn neurons via secreted astrocytic FGF2. *Elife, 2*.

Knutson, B., Adams, C. M., Fong, G. W., & Hommer, D. (2001). Anticipation of increasing monetary reward selectively recruits nucleus accumbens. *Journal of Neuroscience, 21*(16), RC159.

Kober, H., & Wager, T. D. (2010). Meta-analysis of neuroimaging data. *Wiley Interdisciplinary Reviews: Cognitive Science, 1*(2), 293–300.

Koechlin, E., & Summerfield, C. (2007). An information theoretical approach to prefrontal executive function. *Trends in Cognitive Science, 11*, 229–235.

Koob, G. F., & Le Moal, M. (1997). Drug abuse: Hedonic homeostatic dysregulation. *Science, 278*(5335), 52–58.

Koob, G. F., & Le Moal, M. (2001). Drug addiction, dysregulation of reward, and allostasis. *Neuropsychopharmacology, 24*, 97–129.

Koob, G. F., & Le Moal, M. (2005). Plasticity of reward neurocircuitry and the "dark side" of drug addiction. *Nature Neuroscience, 8*(11), 1442–1444.

Kuhlman, K. R., Maercker, A., Bachem, R., Simmen, K., & Burri, A. (2013). Developmental and contextual factors in the role of severe childhood trauma in geriatric depression: The sample case of former indentured child laborers. *Child Abuse and Neglect, 37*(11), 969–978.

Kurth, S., Ringli, M., LeBourgeois, M. K., Geiger, A., Buchmann, A., Jenni, O. G., et al. (2012). Mapping the electrophysiological marker of sleep depth reveals skill maturation in children and adolescents. *NeuroImage, 63*(2), 959–965.

Kusché, C. A., & Greenberg, M. T. (1994). *The PATHS curriculum*. Seattle, WA: Developmental Research and Programs.

Lagner, T. S., & Michael, S. T. (1963). *Life stress and mental health*. London: Free Press of Glencoe.

Lane, R. D., & Wager, T. D. (2009). The new field of brain–body medicine: What have we learned and where are we headed? *NeuroImage, 47*, 1135–1140.

Lang, P. J., & Bradley, M. M. (2010). Emotion and the motivational brain. *Biological Psychology, 84*(3), 437–450.

Langley, L. L. (Ed.). (1973). *Homeostasis: Origins of the concept*. Stroudsburg, PA: Dowden, Hutchinson & Ross.

Larsen, J. T., McGraw, P., & Cacioppo, J. T. (2001). Can people feel happy and sad at the same time? *Journal of Personality and Social Psychology, 81*, 684–696.

Lazarus, R. S. (1966). *Psychological stress and the coping process*. New York: McGraw-Hill.

Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

Lazarus, R. S. (1993). Coping theory and research: Past, present, and future. *Psychosomatic Medicine, 55*(3), 234–247.

Lazarus, R. S. (1999). Hope: An emotion and a vital coping resource against despair. *Social Research, 66*, 653–678.

LeDoux, J. E. (1991). Emotion and the limbic system concept. *Concepts in Neuroscience, 2*, 169–199.

LeDoux, J. E. (1996). Emotional networks and motor control: A fearful view. *Progress in Brain Research, 107*, 437–446.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review Neuroscience, 23*, 155–184.

LeDoux, J. E. (2012). Rethinking the emotional brain. *Neuron, 73*(4), 653–676.

Levine, S., & Ursin, H. (1991). What is stress? In M. R. Brown, G. F. Koob, & C. Rivier (Eds.), *Stress: Neurobiology and neuroendocrinology* (pp. 3–21). New York: Dekker.

Lin, B., Crnic, K. A., Luecken, L. J., & Gonzales, N. A. (2014). Maternal prenatal stress and infant regulatory capacity in Mexican Americans. *Infant Behavior and Development, 37*(4), 571–582.

Lindquist, K. A., & Barrett, L. F. (2012). A functional architecture of the human brain: Emerging insights from the science of emotion. *Trends in Cognitive Sciences, 16*(11), 533–540.

Lindquist, K. A., Satpute, A. B., Wager, T. D., Weber, J., & Barrett, L. F. (2015). The brain basis of positive and negative affect: Evidence from a meta-analysis of the human neuroimaging literature. *Cerebral Cortex*.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*(3), 121–143.

Liston, C., McEwen, B. S., & Casey, B. J. (2009). Psychosocial stress reversibly disrupts prefrontal processing and attentional control. *Proceedings of the National Academy of Sciences, 106*(3), 912–917.

Liu, X., Hairston, J., Schrier, M., & Fan, J. (2011). Common and distinct networks underlying reward valence and processing stages: A meta-analysis of functional neuroimaging studies. *Neuroscience and Biobehavioral Reviews, 35*(5), 1219–1236.

MacLean, P. D. (1949). Psychosomatic disease and the "visceral brain": Recent developments bearing on the Papez theory of emotion. *Psychosomatic Medicine, 11*, 338–353.

MacLean, P. D. (1952). Some psychiatric implications of physiological studies on frontotemporal portion of limbic system (visceral brain). *Electroencephalography and Clinical Neurophysiology, 4*, 407–418.

MacLean, P. D. (1993). Cerebral evolution of emotion. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 67–83). New York: Guilford Press.

Mason, J. W. (1971). A re-evaluation of the concept of "non-specificity" in stress theory. *Journal of Psychiatric Research, 8*(3), 323–333.

Mason, J. W. (1975a). Emotion as reflected in patterns of endocrine integration. In L. Levi (Ed.), *Emotions: Their parameters and measurement* (pp. 143–181). New York: Raven Press.

Mason, J. W. (1975b). A historical view of the stress field. *Journal of Human Stress, 1*(2), 22–36.

Masten, A. S., Garmezy, N., Tellegen, A., Pellegrini, D. S., Larkin, K., & Larsen, A. (1988). Competence and stress in school children: The moderating effects of individual and family qualities. *Journal of Child Psychology and Psychiatry, 29*(6), 745–764.

Mather, M., Canli, T., English, T., Whitfield, S., Wais, P., Ochsner, K., et al. (2004). Amygdala responses to emotionally valenced stimuli in older and younger adults. *Psychological Science, 15*(4), 259–263.

Mather, M., & Carstensen, L. L. (2003). Aging and attentional biases for emotional faces. *Psychological Science, 14*(5), 409–415.

McEwen, B. S. (1998). Stress, adaptation, and disease: Allostasis and allostatic load. *Annals of the New York Academy of Sciences, 840*(1), 33–44.

McEwen, B. S. (2000). The neurobiology of stress: From serendipity to clinical relevance. *Brain Research, 886*(1), 172–189.

McEwen, B. S. (2003a). Early life influences on life-long patterns of behavior and health. *Mental Retardation and Developmental Disabilities Research Reviews, 9*(3), 149–154.

McEwen, B. S. (2003b). Interacting mediators of allostasis and allostatic load: Towards an understanding of resilience in aging. *Metabolism, 52*, 10–16.

McEwen, B. S. (2003c). Mood disorders and allostatic load. *Biological Psychiatry, 54*(3), 200–207.

McEwen, B. S. (2004). Protection and damage from acute and chronic stress: Allostasis and allostatic overload and relevance to the pathophysiology of psychiatric disorders. *Annals of the New York Academy of Sciences, 1032*(1), 1–7.

McEwen, B. S., & Gianaros, P. J. (2010). Central role of the brain in stress and adaptation: Links to socioeconomic status, health, and disease. *Annals of the New York Academy of Sciences, 1186*(1), 190–222.

McEwen, B. S., & Lasley, E. N. (2002). *The end of stress as we know it.* Washington, DC: Joseph Henry Press.

McEwen, B. S., & Seeman, T. (1999). Protective and damaging effects of mediators of stress: Elaborating and testing the concepts of allostasis and allostatic load. *Annals of the New York Academy of Sciences*, 896(1), 30–47.

McEwen, B. S., & Seeman, T. (2003). Stress and affect: Applicability of the concepts of allostasis and allostatic load. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 1117–1137). New York: Oxford University Press.

McEwen, B. S., & Stellar, E. (1993). Stress and the individual: Mechanisms leading to disease. *Archives of Internal Medicine, 153*(18), 2093–2101.

McKiernan, K. A., D'Angelo, B. R., Kaufman, J. N., & Binder, J. R. (2006). Interrupting the "stream of consciousness": An fMRI investigation. *NeuroImage, 29*(4), 1185–1191.

Mendelson, T., Greenberg, M. T., Dariotis, J. K., Gould, L. F., Rhoades, B. L., & Leaf, P. J. (2010). Feasibility and preliminary outcomes of a school-based mindfulness intervention for urban youth. *Journal of Abnormal Child Psychology, 38*(7), 985–994.

Menon, V. (2011). Large-scale brain networks and psychopathology: A unifying triple network model. *Trends in Cognitive Sciences, 15*(10), 483–506.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience, 24*(1), 167–202.

Milsum, J. H. (1985). A model of the eustress system for health/illness. *Behavioral Science, 30*(4), 179–186.

Möhler, E., Parzer, P., Brunner, R., Wiebel, A., & Resch, F. (2006). Emotional stress in pregnancy predicts human infant reactivity. *Early Human Development, 82*(11), 731–737.

Moore-Ede, M. C. (1986). Physiology of the circadian timing system: Predictive versus reactive homeostasis. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology, 250*(5), R737–R752.

Mrosovsky, N. (1990). *Rheostasis: The physiology of change* (pp. vii–183). New York: Oxford University Press.

Mueller, D. P., Edwards, D. W., & Yarvis, R. M. (1977). Stressful life events and psychiatric symptomatology: Change or undesirability? *Journal of Health and Social Behavior, 18*, 307–317.

Muhammad, A., Carroll, C., & Kolb, B. (2012). Stress during development alters dendritic morphology in the nucleus accumbens and prefrontal cortex. *Neuroscience, 216*, 103–109.

Murphy, F. C., Nimmo-Smith, I. A. N., & Lawrence, A. D. (2003). Functional neuroanatomy of emotions: A meta-analysis. *Cognitive, Affective, & Behavioral Neuroscience, 3*(3), 207–233.

Northoff, G., & Bermpohl, F. (2004). Cortical midline structures and the self. *Trends in Cognitive Sciences, 8*(3), 102–107.

Ohira, H., Fukuyama, S., Kimura, K., Nomura, M., Isowa, T., Ichikawa, N., et al. (2009). Regulation of natural killer cell redistribution by prefrontal cortex during stochastic learning. *NeuroImage, 47*, 897–907.

Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General, 130*(3), 466.

Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review, 108*(3), 483.

Olsson, A., & Phelps, E. A. (2004). Learned fear of "unseen" faces after Pavlovian, observational, and instructed fear. *Psychological Science, 15*(12), 822–828.

Ong, A. D., Rothstein, J. D., & Uchino, B. N. (2012). Loneliness accentuates age differences in cardiovascular responses to social evaluative threat. *Psychology and Aging, 27*(1), 190.

Pacák, K., & Palkovits, M. (2001). Stressor specificity of central neuroendocrine responses: Implications for stress-related disorders. *Endocrine Reviews, 22*(4), 502–548.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions*. New York: Oxford University Press.

Panksepp, J. (2000). The riddle of laughter neural and psychoevolutionary underpinnings of joy. *Current Directions in Psychological Science, 9*(6), 183–186.

Panksepp, J., & Miller, A. (1996). Emotions and the aging brain: Regrets and remedies. In C. Magai & S. H. Mc-

Fadden (Eds.), *Handbook of emotion, adult development and aging* (pp. 3–26). San Diego, CA: Academic Press.

Papez, J. W. (1937). A proposed mechanism of emotion. *Archives of Neurology and Psychiatry, 38*(4), 725–743.

Pessoa, L. (2008). On the relationship between emotion and cognition. *Nature Reviews Neuroscience, 9*(2), 148–158.

Pessoa, L. (2015). The cognitive-emotional brain. *Behavioral and Brain Sciences, 38*, e71.

Phan, K. L., Taylor, S. F., Welsh, R. C., Ho, S. H., Britton, J. C., & Liberzon, I. (2004). Neural correlates of individual ratings of emotional salience: A trial-related fMRI study. *NeuroImage, 21*(2), 768–780.

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *NeuroImage, 16*(2), 331.

Phelps, E. A. (2004). Human emotion and memory: Interactions of the amygdala and hippocampal complex. *Current Opinion in Neurobiology, 14*(2), 198–202.

Phelps, E. A. (2006). Emotion and cognition: Insights from studies of the human amygdala. *Annual Review of Psychology, 57*, 27–53.

Phillips, A. G., Ahn, S., & Howland, J. G. (2003). Amygdalar control of the mesocorticolimbic dopamine system: Parallel pathways to motivated behavior. *Neuroscience and Biobehavioral Reviews, 27*(6), 543–554.

Pluess, M., & Belsky, J. (2011). Prenatal programming of postnatal plasticity? *Development and Psychopathology, 23*(1), 29–38.

Pluess, M., Velders, F. P., Belsky, J., van IJzendoorn, M. H., Bakermans-Kranenburg, M. J., Jaddoe, V. W., et al. (2011). Serotonin transporter polymorphism moderates effects of prenatal maternal anxiety on infant negative emotionality. *Biological Psychiatry, 69*(6), 520–525.

Potter, P. T., & Zautra, A. J. (1997). Stressful life events' effects on rheumatoid arthritis disease activity. *Journal of Consulting and Clinical Psychology, 65*(2), 319.

Pruessner, J. C., Dedovic, K., Khalili-Mahani, N., Engert, V., Pruessner, M., Buss, C., et al. (2008). Deactivation of the limbic system during acute psychosocial stress: Evidence from positron emission tomography and functional magnetic resonance imaging studies. *Biological Psychiatry, 63*(2), 234–240.

Pryce, C. R., Rüedi-Bettschen, D., Dettling, A. C., Weston, A., Russig, H., Ferger, B., et al. (2005). Long-term effects of early-life environmental manipulations in rodents and primates: Potential animal models in depression research. *Neuroscience and Biobehavioral Reviews, 29*(4), 649–674.

Radley, J. J., Rocher, A. B., Miller, M., Janssen, W. G., Liston, C., Hof, P. R., et al. (2006). Repeated stress induces dendritic spine loss in the rat medial prefrontal cortex. *Cerebral Cortex, 16*, 313–320.

Raichle, M. E. (2001). Cognitive neuroscience: Bold insights. *Nature, 412*(6843), 128–130.

Rainville, P., Duncan, G. H., Price, D. D., Carrier, B., & Bushnell, M. C. (1997). Pain affect encoded in human anterior cingulate but not somatosensory cortex. *Science, 277*(5328), 968–971.

Rakic, P. (2009). Evolution of the neocortex: A perspective from developmental biology. *Nature Reviews Neuroscience, 10*(10), 724–735.

Ramsay, D. S., & Woods, S. C. (2014). Clarifying the roles of homeostasis and allostasis in physiological regulation. *Psychological Review, 121*(2), 225.

Raver, C. C. (2004). Placing emotional self-regulation in sociocultural and socioeconomic contexts. *Child Development, 75*(2), 346–353.

Ravona-Springer, R., Beeri, M. S., & Goldbourt, U. (2011). Exposure to the Holocaust and World War II concentration camps during late adolescence and adulthood is not associated with increased risk for dementia at old age. *Journal of Alzheimer's Disease, 23*(4), 709–716.

Reich, J. W., Zautra, A. J., & Davis, M. (2003). Dimensions of affect relationships: Models and their integrative implications. *Review of General Psychology, 7*(1), 66.

Repetti, R. L., Robles, T. F., & Reynolds, B. (2011). Allostatic processes in the family. *Development and Psychopathology, 23*(3), 921–938.

Repetti, R. L., Taylor, S. E., & Seeman, T. E. (2002). Risky families: Family social environments and the mental and physical health of offspring. *Psychological Bulletin, 128*(2), 330.

Rhodes, J. S., van Praag, H., Jeffrey, S., Girard, I., Mitchell, G. S., Garland, T., Jr., & et al. (2003). Exercise increases hippocampal neurogenesis to high levels but does not improve spatial learning in mice bred for increased voluntary wheel running. *Behavioral Neuroscience, 117*(5), 1006.

Rosen, J. B., & Schulkin, J. (1998). From normal fear to pathological anxiety. *Psychological Review, 105*(2), 325.

Rothenberger, S. E., Resch, F., Doszpod, N., & Moehler, E. (2011). Prenatal stress and infant affective reactivity at five months of age. *Early Human Development, 87*(2), 129–136.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39*(6), 1161.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*(1), 145.

Rutter, M. (1979). Maternal deprivation, 1972–1978: New findings, new concepts, new approaches. *Child Development, 50*(2), 283–305.

Ryff, C. D., Dienberg Love, G., Urry, H. L., Muller, D., Rosenkranz, M. A., Friedman, E. M., et al. (2006). Psychological well-being and ill-being: Do they have distinct or mirrored biological correlates? *Psychotherapy and Psychosomatics, 75*(2), 85–95.

Sackeim, H. A., Gur, R. E., & Saucy, M. C. (1978). Emotions are expressed more intensely on the left side of the face. *Science, 202*(4366), 434–436.

Salamone, J. D., & Correa, M. (2002). Motivational views of reinforcement: Implications for understanding the behavioral functions of nucleus accumbens dopamine. *Behavioural Brain Research, 137*(1), 3–25.

Sameroff, A. J., Seifer, R., Barocas, R., Zax, M., & Greenspan, S. (1987). Intelligence quotient scores of 4-year-old children: Social-environmental risk factors. *Pediatrics, 79*(3), 343–350.

Sanchez, M., Ladd, C. O., & Plotsky, P. M. (2001). Early adverse experience as a developmental risk factor for later psychopathology: Evidence from rodent and primate models. *Development and Psychopathology, 13*(3), 419–449.

Sapolsky, R. M. (1998). *Why zebras don't get ulcers.* New York: Freeman.

Sapolsky, R. M., Romero, L. M., & Munck, A. U. (2000). How do glucocorticoids influence stress responses?: Integrating permissive, suppressive, stimulatory, and preparative actions. *Endocrine Reviews, 21*(1), 55–89.

Schachter, S., & Singer, J. (1962). Cognitive, social, and physiological determinants of emotional state. *Psychological Review, 69*(5), 379.

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. Detection, search, and attention. *Psychological Review, 84*(1), 1.

Schulkin, J. (2003). Allostasis: A neural behavioral perspective. *Hormones and Behavior, 43*(1), 21–27.

Schulkin, J. (Ed.). (2004). *Allostasis, homeostasis, and the costs of physiological adaptation*. Cambridge, UK: Cambridge University Press.

Schulkin, J., Gold, P. W., & McEwen, B. S. (1998). Induction of corticotropin-releasing hormone gene expression by glucocorticoids: Implication for understanding the states of fear and anxiety and allostatic load. *Psychoneuroendocrinology, 23*(3), 219–243.

Schulkin, J., McEwen, B. S., & Gold, P. W. (1994). Allostasis, amygdala, and anticipatory angst. *Neuroscience and Biobehavioral Reviews, 18*(3), 385–396.

Schultz, S. G. (1996). Homeostasis, Humpty Dumpty, and integrative biology. *News in Physiological Sciences, 11*, 238–246.

Schwartz, G. E., Davidson, R. J., & Maer, F. (1975). Right hemisphere lateralization for emotion in the human brain: Interactions with cognition. *Science, 190*, 286–288.

Seeley, W. W., Menon, V., Schatzberg, A. F., Keller, J., Glover, G. H., Kenna, H., et al. (2007). Dissociable intrinsic connectivity networks for salience processing and executive control. *Journal of Neuroscience, 27*(9), 2349–2356.

Selye, H. (1950). *The physiology and pathology of exposure to stress: A treatise based on the concepts of the general-adaptation-syndrome and the diseases of adaptation.* Montreal, Canada: ACTA.

Selye, H. (1956). *The stress of life.* New York: McGraw-Hill.

Selye, H. (1974). *Stress without distress.* Philadelphia: Lippincott.

Sharot, T., Martorella, E. A., Delgado, M. R., & Phelps, E. A. (2007). How personal experience modulates the neural circuitry of memories of September 11. *Proceedings of the National Academy of Sciences, 104*(1), 389–394.

Siegel, S., & Allan, L. G. (1998). Learning and homeostasis: Drug addiction and the McCollough effect. *Psychological Bulletin, 124*(2), 230.

Singer, B., Ryff, C. D., & Seeman, T. (2004). Operationalizing allostatic load. In J. Schulkin (Ed.), *Allostasis, homeostasis, and the costs of physiological adaptation* (pp. 113–130). Cambridge, UK: Cambridge University Press.

Sirevaag, A. M., & Greenough, W. T. (1988). A multivariate statistical summary of synaptic plasticity measures in rats exposed to complex, social and individual environments. *Brain Research, 441*(1), 386–392.

Smith, N. K., Cacioppo, J. T., Larsen, J. T., & Chartrand, T. L. (2003). May I have your attention, please: Electrocortical responses to positive and negative stimuli. *Neuropsychologia, 41*(2), 171–183.

Spivack, G., & Shure, M. B. (1974). *Social adjustment of young children: A cognitive approach to solving real-life problems.* Oxford, UK: Jossey-Bass.

Spreng, R. N. (2012). The fallacy of a "task-negative" network. *Frontiers in Psychology, 3*, 145.

Spreng, R. N., Sepulcre, J., Turner, G. R., Stevens, W. D., & Schacter, D. L. (2013). Intrinsic architecture underlying the relations among the default, dorsal attention, and frontoparietal control networks of the human brain. *Journal of Cognitive Neuroscience, 25*(1), 74–86.

Spunt, R. P., & Lieberman, M. D. (2013). The busy social brain evidence for automaticity and control in the neural systems supporting social cognition and action understanding. *Psychological Science, 24*(1), 80–86.

Sridharan, D., Levitin, D. J., & Menon, V. (2008). A critical role for the right fronto-insular cortex in switching between central-executive and default-mode networks. *Proceedings of the National Academy of Sciences, 105*(34), 12569–12574.

St. Jacques, P., Dolcos, F., & Cabeza, R. (2010). Effects of aging on functional connectivity of the amygdala during negative evaluation: A network analysis of fMRI data. *Neurobiology of Aging, 31*(2), 315–327.

Steinberg, L. (2008). *Adolescence* (8th ed.). New York: McGraw-Hill.

Steinberg, L., & Morris, A. S. (2001). Adolescent development. *Journal of Cognitive Education and Psychology, 2*(1), 55–87.

Sterling, P. (2004). Principles of allostasis: Optimal design, predictive regulation, pathophysiology, and rational therapeutics. In J. Schulkin (Ed.), *Allostasis, homeostasis, and the costs of physiological adaptation* (pp. 17–64). Cambridge, UK: Cambridge University Press.

Sterling, P., & Eyer, J. (1981). Biological basis of stress-related mortality. *Social Science and Medicine. Part E: Medical Psychology, 15*(1), 3–42.

Sterling, P., & Eyer, J. (1988). Allostasis: A new paradigm to explain arousal pathology. In S. Fisher & J. Reason (Eds.), *Handbook of life stress, cognition and health* (pp. 629–649). Oxford, UK: Wiley.

Stone, A. A. (1995). Measurement of affective response. In S. Cohen & R. C. Kessler (Eds.), *Measuring stress: A guide for health and social scientists* (pp. 148–171). New York: Oxford University Press.

Taylor, K. S., Seminowicz, D. A., & Davis, K. D. (2009). Two systems of resting state connectivity between the insula and cingulate cortex. *Human Brain Mapping, 30*(9), 2731–2745.

Taylor, S. E., Eisenberger, N. I., Saxbe, D., Lehman, B. J., & Lieberman, M. D. (2006). Neural responses to emotional stimuli are associated with childhood family stress. *Biological Psychiatry, 60*(3), 296–301.

Taylor, S. E., Karlamangla, A. S., Friedman, E. M., & Seeman, T. E. (2011). Early environment affects neuroendocrine regulation in adulthood. *Social Cognitive and Affective Neuroscience,* 6(2), 244–251.

Tessitore, A., Hariri, A. R., Fera, F., Smith, W. G., Das, S., Weinberger, D. R., et al. (2005). Functional changes in the activity of brain regions underlying emotion processing in the elderly. *Psychiatry Research: Neuroimaging, 139*(1), 9–18.

Thoits, P. A. (1992). Identity structures and psychological well-being: Gender and marital status comparisons. *Social Psychology Quarterly, 55*(3), 236–256.

Thompson, R. A. (1994). Emotion regulation: A theme in search of definition. *Monographs of the Society for Research in Child Development, 59*(2–3), 25–52.

Toates, F. M. (1995). *Stress: Conceptual and biological aspects*. Chichester UK: Wiley.

Tolin, D. F., & Foa, E. B. (2002). Gender and PTSD: A cognitive model. In R. Kimerling, P. Ouimette, & J. Wolf (Eds.), *Gender and PTSD* (pp. 76–97). New York: Guilford Press.

Tomasi, D., & Volkow, N. D. (2011). Association between functional connectivity hubs and brain networks. *Cerebral Cortex, 21*(9), 2003–2013.

Tottenham, N., Hare, T. A., Quinn, B. T., McCarry, T. W., Nurse, M., Gilhooly, T., et al. (2010). Prolonged institutional rearing is associated with atypically large amygdala volume and difficulties in emotion regulation. *Developmental Science, 13*(1), 46–61.

Touroutoglou, A., Hollenbeck, M., Dickerson, B. C., & Feldman Barrett, L. (2012). Dissociable large-scale networks anchored in the right anterior insula subserve affective experience and attention. *NeuroImage, 60*(4), 1947–1958.

Touroutoglou, A., Lindquist, K. A., Dickerson B. C., & Barrett, L. F. (2015). Intrinsic connectivity in the human brain does not reveal networks for "basic" emotions. *Social Cognitive and Affective Neuroscience, 10*(9), 1257–1265.

Trentacosta, C. J., & Izard, C. E. (2007). Kindergarten children's emotion competence as a predictor of their academic competence in first grade. *Emotion, 7*(1), 77.

Tsolaki, M., Papaliagkas, V., Kounti, F., Messini, C., Boziki, M., Anogianakis, G., et al. (2010). Severely stressful events and dementia: A study of an elderly Greek demented population. *Psychiatry Research, 176*(1), 51–54.

Uchino, B. N., Birmingham, W., & Berg, C. A. (2010). Are older adults less or more physiologically reactive?: A meta-analysis of age-related differences in cardiovascular reactivity to laboratory tasks. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 65*(2), 154–162.

Uddin, L. Q., Supekar, K. S., Ryali, S., & Menon, V. (2011). Dynamic reconfiguration of structural and functional connectivity across core neurocognitive brain networks with development. *Journal of Neuroscience, 31*(50), 18578–18589.

Uhlhaas, P. J., & Singer, W. (2012). Neuronal dynamics and neuropsychiatric disorders: Toward a translational paradigm for dysfunctional large-scale networks. *Neuron, 75*(6), 963–980.

Urry, H. L., van Reekum, C. M., Johnstone, T., & Davidson, R. J. (2009). Individual differences in some (but not all) medial prefrontal regions reflect cognitive demand while regulating unpleasant emotion. *NeuroImage, 47*, 852–863.

Urry, H. L., van Reekum, C. M., Johnstone, T., Kalin, N. H., Thurow, M. E., Schaefer, H. S., et al. (2006). Amygdala and ventromedial prefrontal cortex are inversely coupled during regulation of negative affect and predict the diurnal pattern of cortisol secretion among older adults. *Journal of Neuroscience, 26*, 4415–4425.

Vinokur, A., & Selzer, M. L. (1975). Desirable versus undesirable life events: Their relationship to stress and mental distress. *Journal of Personality and Social Psychology, 32*(2), 329.

Von Bertalanffy, L. (1952). *Problems of life: An evaluation of modern biological thought*. Oxford, UK: Wiley.

Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2001). Effects of attention and emotion on face processing in the human brain: An event-related fMRI study. *Neuron, 30*(3), 829–841.

Vyas, A., Mitra, R., Shankaranarayana Rao, B. S., & Chattarji, S. (2002). Chronic stress induces contrasting patterns of dendritic remodeling in hippocampal and amygdaloid neurons. *Journal of Neuroscience, 22*, 6810–6818.

Waddington, C. H. (1957). *The strategy of the genes: A discussion of some aspects of theoretical biology*. New York: Rutledge.

Waddington, C. H. (1968). Towards 21 theoretical biology. *Nature, 218*, 525.

Wager, T. D., Barrett, L. F., Bliss-Moreau, E., Lindquist, K., Duncan, S., Kober, H., et al. (2008). The neuroimaging of emotion. In J. Lewis, J. M. Haviland-Jones, & L. Feldman Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 249–271). New York: Guilford Press.

Wager, T. D., Phan, K. L., Liberzon, I., & Taylor, S. F. (2003). Valence, gender, and lateralization of functional brain anatomy in emotions: A meta-analysis of findings from neuroimaging. *NeuroImage, 19*, 513–531.

Wager, T. D., Waugh, C. E., Lindquist, M., Noil, D. C., Fredrickson, B. L., & Taylor, S. F. (2009). Brain mediators of cardiovascular responses to social threat: Part 1. Reciprocal dorsal and ventral sub-regions of the medial prefrontal cortex and heart-rate reactivity. *NeuroImage, 47*, 821–835.

Ward, P. A., Blanchard, R. J., Bolivar, V., Brown, M. J., Chang, F., Herman, J. P., et al. (2008). *Recognition and alleviation of distress in laboratory animals*. Washington, DC: National Academies Press.

Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. *Journal of Personality and Social Psychology, 76*, 820–838.

Webster-Stratton, C., Reid, M. J., & Hammond, M. (2001). Preventing conduct problems, promoting social competence: A parent and teacher training partnership in Head Start. *Journal of Clinical Child Psychology, 30*(3), 283–302.

Wheaton, B. (1985). Models for the stress-buffering functions of coping resources. *Journal of Health and Social Behavior, 26*(4), 352–364.

Wheaton, B., & Montazer, S. (2010). Stressor, stress, and distress. In T. L. Scheid & T. N. Brown (Eds.), *A handbook for the study of mental health: Social contacts, theories, and systems* (2nd ed., pp. 171–199). Cambridge, UK: Cambridge University Press.

Whitfield-Gabrieli, S., Moran, J. M., Nieto-Castañón, A., Triantafyllou, C., Saxe, R., & Gabrieli, J. D. (2011). Associations and dissociations between default and self-reference networks in the human brain. *NeuroImage, 55*(1), 225–232.

Wiener, N. (1948). *Cybernetics: Control and communication in the animal and the machine*. New York: Wiley.

Wilson-Mendenhall, C. D., Barrett, L. F., & Barsalou, L. W. (2013). Neural evidence that human emotions share core affective properties. *Psychological Science, 24*(6), 947–956.

Woods, S. C., & Ramsay, D. S. (2007). Homeostasis: Beyond Curt Richter. *Appetite, 49*(2), 388–398.

Yaffe, K., Vittinghoff, E., Lindquist, K., Barnes, D., Covinsky, K. E., Neylan, T., et al. (2010). Posttraumatic stress disorder and risk of dementia among US veterans. *Archives of General Psychiatry, 67*(6), 608.

Yarkoni, T., Poldrack, R. A., Nichols, T. E., Van Essen, D. C., & Wager, T. D. (2011). Large-scale automated synthesis of human functional neuroimaging data. *Nature Methods, 8*(8), 665–670.

Yeo, B. T., Krienen, F. M., Sepulcre, J., Sabuncu, M. R., Lashkari, D., Hollinshead, M., et al. (2011). The organization of the human cerebral cortex estimated by intrinsic functional connectivity. *Journal of Neurophysiology, 106*(3), 1125–1165.

Yurgelun-Todd, D. (2007). Emotional and cognitive changes during adolescence. *Current Opinion in Neurobiology, 17*(2), 251–257.

Zautra, A. (2003). *Emotions, stress, and health*. Oxford, UK: Oxford University Press.

Zautra, A. J., Berkhof, J., & Nicolson, N. A. (2002). Changes in affect interrelations as a function of stressful events. *Cognition and Emotion, 16*(2), 309–318.

Zautra, A. J., & Reich, J. W. (1983). Life events and perceptions of life quality: Developments in a two-factor approach. *Journal of Community Psychology, 11*(2), 121–132.

Zautra, A. J., Reich, J. W., Davis, M. C., Potter, P. T., & Nicolson, N. A. (2000). The role of stressful events in the relationship between positive and negative affects: Evidence from field and experimental studies. *Journal of Personality, 68*(5), 927–951.

Zylowska, L., Ackerman, D. L., Yang, M. H., Futrell, J. L., Horton, N. L., Hale, T. S., et al. (2008). Mindfulness meditation training in adults and adolescents with ADHD: A feasibility study. *Journal of Attention Disorders, 11*(6), 737–746.

CHAPTER 42

Emotion-Related Symptoms of Neurodegenerative Dementias

Bradford C. Dickerson

The neurodegenerative diseases are a major medical and social burden in many societies, particularly with the growth of older population segments. Neurodegenerative diseases include dementias, movement disorders, cerebellar diseases, and motor neuron diseases. Treatments are very limited at present. In 2010, low estimates for dementia-related costs accounted for greater than 1% of the world gross domestic product. Without major "cures," projections—in the United States as well as globally—estimate potentially crippling dementia-related costs for world economies in the coming decades. But clinicians look beyond statistics; the devastation wrought by these illnesses upon each patient and family is immeasurable. Unfortunately, even today with growing public awareness, dementing illnesses often escape early diagnosis and appropriate clinical care, adversely impacting the patient, his or her family and caregivers, society, and public health in a multitude of ways.

Research investigating the neurobiology of neurodegenerative dementias and other diseases has deepened our understanding tremendously, providing insights into the pathologic accumulation of specific abnormal protein forms in these diseases. As the biology of these diseases is elucidated, hope is beginning to emerge for treatments targeted at modification of fundamental pathophysiological processes (Bertram & Tanzi, 2005; Trojanowski, 2004). However, at the same time, many clinicians points out that we desperately need new treatments targeting the symptoms of these diseases, while we continue to investigate underlying mechanisms and work toward treating them. Although cognitive symptoms are often the primary target of experimental symptomatic therapies, the field is increasingly recognizing the need to improve our understanding of and treatments for symptoms often referred to as "neuropsychiatric" or "behavioral and psychological" symptoms of dementias. At their root, many of these symptoms represent changes in normal emotional and social behavior. These symptoms can be very disruptive to relationships, often more so than cognitive or motor symptoms. A deeper understanding of changes in emotional behavior in the neurodegenerative dementias will undoubtedly help propel us toward better treatments.

Furthermore, as we develop better neuroimaging and brain mapping technologies for measuring the abnormalities of neuroanatomy, brain function, the connectivity of large-scale circuits, and molecular function and pathology in living people, we can study the neural basis of abnormal emotional behavior in patients with neurodegenerative diseases. This, along with studies of patients with other neurological and psychiatric disorders, will likely provide fundamental new insights into the brain circuitry of human emotion.

In this chapter, I review the classes of symptoms commonly used by clinicians and researchers studying abnormalities of emotional behavior in neurodegenerative dementias. I then delve into the three most common neurodegenerative dementias, describing their clinical and pathological features and probing our clinical and scientific understanding of changes in emotional behavior within each of these diseases.

Overview of Changes in Emotional Behavior in Neurodegenerative Dementias

A variety of changes in emotional behavior are well recognized as important elements of neurodegenerative dementias. These symptoms are often referred to as "neuropsychiatric" or "behavioral and psychological" symptoms. They may develop after, at the same time as, or prior to cognitive and functional impairment. Although cognitive and functional impairments in neurodegenerative dementias usually follow a more-or-less linear rate of progression, neuropsychiatric symptoms may evolve more variably, with waxing and waning characteristics. Some emotional symptoms tend to be prominent early in the disease and then remit as the disease progresses. The neuropathological correlates of neuropsychiatric symptoms are poorly understood. Generally speaking, it is thought that the reason some types of symptoms are more prominent in one of these diseases than in another is related to the localization of pathology, rather than its molecular type. Overlapping symptoms between different diseases may occur because different pathologies alter the function of one circuit. We are slowly accruing a body of neuroimaging research that is shedding light on these brain–behavior relationships.

Neuropsychiatric symptoms adversely impact not only patients but also their caregivers. Many symptoms have been shown to be associated with worse cognitive performance, reduced functional ability and quality of life, and increased caregiver and patient distress (D'Onofrio et al., 2012; Lechowski et al., 2009). They are a major reason for institutionalization and nursing home placement (Callahan et al., 2006).

Constructs of psychological and behavioral symptoms of dementias originate in long-standing concepts in psychiatry. These constructs are recently being updated to fit into new frameworks such as the Research Domain Criteria (RDoC; Insel et al., 2010), which are grounded in systems-based functional neuroanatomy. In this framework, the major domains include positive-valence systems, negative-valence systems, social function, cognitive function, and arousal/regulatory systems. In my discussion of the major types of psychological and behavioral symptoms of dementia, I attempt to refer to this new framework where possible, although research is only beginning to employ approaches such as this.

Depression

Depression is prevalent in patients with established dementia, and occurs at various stages. It occurs in 10–15% of patients with mild Alzheimer's disease (AD), but ≥ 50% of patients with moderate to severe AD. It is also very common in Lewy body dementia (LBD) and Parkinson's disease dementia (PDD), but somewhat less common in frontotemporal dementia (FTD). Depressive symptoms in AD have been shown to correlate with hypoperfusion or hypometabolism in the prefrontal cortical areas including the dorsolateral prefrontal cortex (DLPFC) and the anterior cingulate cortex (ACC), presumably as a result of the neurodegenerative process (Akiyama et al., 2008; Butters et al., 2008).

Depressive symptoms in dementia can be very similar to depressive syndromes in other contexts, such as major depressive disorder (Chemerinski, Petracca, Sabe, Kremer, & Starkstein, 2001). However, the cognitive deficits in dementia may make it difficult for the patient to realize the nature of the symptoms or describe them. The course of depression in dementia may be mild and self-remitting over time in some patients, or chronic and resistant to treatment in others (Starkstein et al., 1997). Even after remission or successful treatment, the recurrence rate of depression in dementia is high. Depression is often assessed using clinical instruments such as the Geriatric Depression Scale (Yesavage, Brink, Rose, Lum, Huang, et al., 1982), Beck Depression Inventory (Beck, Steer, & Brown, 1996), or the Hamilton Depression Scale (Hamilton, 1980).

At a high level, depression is generally considered to be related to dysfunction or imabalance of so-called positive- and negative-valence systems (Insel et al., 2010).

Apathy

The term "apathy" denotes poor motivation, goal-directed cognition or action, and/or a decrease in emotional responsiveness (Marin, 1990). Apathy is often mistaken as depression, but is thought to be a distinct syndrome with different characteristics and clinical course. Depression is neither necessary nor sufficient for apathy to be present (Levy et al., 1998). The proposed diagnostic criteria for the apathy syndrome include diminished motivation and loss of goal-directed behavior, cognitive function, or emotional expression or responsiveness (Robert et al., 2009).

Apathy is a common early feature in many neurodegenerative disorders. It is thought to result from dysfunction in the frontal-subcortical neural networks, particularly the dorso-medial prefrontal cortex and the ACC (Apostolova et al., 2007: Ott, Noto, & Fogel, 1996). The frequency of apathy in AD is unclear, from as few as 25% to as many as 75–80% (Landes, Sperry, & Strauss, 2005). It is one of the early symptoms in AD, but is also commonly seen in later disease stages. Apathy is the presenting symptom in a vast majority of patients with FTD and is nearly universal in this illness as it evolves (Mendez, Lauterbach, Sampson, & Research, 2008).

The construct of apathy is not thought to be associated with low mood, but rather with a lack of positive-valence system function that provides reward and potentially also a dysfunction of arousal and regulatory systems that drive motivated, volitional behavior.

Anxiety

Generalized anxiety is common in people with dementia, affecting as many as 40–70% of patients (Ballard, Bannister, Solis, Oyebode, & Wilcock, 1996). Anxiety often co-occurs with depression, with as many as 75% of patients with dementia and anxiety also exhibiting signs of depression. As dementia severity worsens, anxiety often becomes less prevalent, possibly in relation to loss of insight and self-awareness of impairment. Anxiety can be a feature of all major dementia syndromes, but seems to be particularly common in LBD and PDD.

Anxiety is usually thought of as originating in heightened fear circuitry, conceptualized in the framework of the RDoC as dysfunctional negative-valence systems.

Psychosis: Delusions and Hallucinations

Psychotic symptoms, including delusions and hallucinations, are less common than depression and apathy, but well recognized as part of many neurodegenerative diseases. They are traditionally classified under the rubric of psychiatric or behavioral symptoms, but rather than primarily being disorders of emotion, are usually considered to be "thought disorders." They are briefly reviewed here because they are so frequently included under the general category of psychiatric or behavioral symptoms.

Delusions are relatively common in neurodegenerative dementias, and are defined as fixed false beliefs. In patients with neurodegenerative dementias, the types of delusions often follow certain patterns, including those of theft, marital infidelity, and misidentification syndromes (Apostolova & Cummings, 2008). Misidentification syndromes include Capgras syndrome (believing that familiar individuals are replaced by an imposter), Fregoli syndrome (believing that strangers are familiar), Foley syndrome (believing that images in the mirror are of other individuals), and reduplicative paramnesia (believing that a familiar location is duplicated). Bizarre delusions, such as those commonly seen in schizophrenia are rare, but have recently been recognized as occurring in some patients with a particular genetic form of FTD due to a mutation in the chromosome 9 open-reading frame 72 gene (Boeve et al., 2012). Hallucinations are perceptual disturbances in which a patient hears or sees or otherwise perceives something that is not actually present. Visual hallucinations are more common than other perceptual disturbances in dementia, although all types of hallucinations can be seen, including olfactory and tactile hallucinations (Marin et al., 1997; Simard, van Reekum, & Cohen, 2000).

Psychotic symptoms may occur during the course of all dementias, but tend to occur early in LBD and in some cases of FTD, sometimes as the presenting symptom; they usually occur later in AD (Marin et al., 1997; Ballard et al., 1999; Simard et al., 2000). Patients with delusions or hallucinations tend to have more prominent cognitive impairment than patients without psychosis (Flynn, Cummings, & Gornbein, 1991). In many cases, psychotic symptoms improve as the disease progresses to later stages.

Psychosis is conceptualized as a thought disorder related to impairments in perceptual and cognitive systems, rather than emotional/affective systems per se.

Agitation and Irritability

"Agitation" is a term used to capture many disruptive behaviors, some of which are simply restless exploratory behaviors with no particular emotional expression, but a proportion of the behaviors described as agitated behaviors involve angry outbursts, often in relation to daily care activities. These include aggressive behaviors, angry or irritable behaviors, screaming, threatening behavior, or violent behaviors.

As many as 70% of patients with dementia exhibit agitation at some point in the illness, often in mid to later stages (Cohen-Mansfield, 1986). Agitation is common in AD and LBD, possibly less common in FTD. Agitation is associated with poorer prognosis with regard to cognitive or functional decline, and is a major reason for nursing home placement.

As is implied in the above description of a variety of behaviors, the origins of agitation vary widely. In some cases, agitation may be provoked specifically by caregiving activities, and is thought to be related to the combination of a patient's cognitive impairment and discomfort with another individual being present during an intimate activity, such as dressing or toileting. Agitation often occurs in patients with coexisting anxiety, suggesting that anxiety or fear may be a contributing factor (Twelftree & Qazi, 2006). In some cases, agitation appears to occur without an apparent environmental trigger, and may be associated with primary neurobiological changes related to the neuropathology of the disease, or active medical issues that may or may not be recognized, or may be related to medications.

Neuropsychological studies have demonstrated an association between agitation and executive dysfunction, raising the possibility that it may be another manifestation of frontal systems dysfunction (Chen, Sultzer, Hinkin, Mahler, & Cummings, 1998), possibly reflecting the loss of emotion regulation processes. Functional imaging has demonstrated frontal dysfunction in patients with agitation (Hirono, Mega, Dinov, Mishkin, & Cummings, 2000). In people with AD who have agitation, neuropathological studies have shown a greater density of neurofibrillary tangles in frontal regions compared with their age-matched peers (Tekin et al., 2001).

Agitation and irritability can be considered as disorders of the balance between negative-valence systems and regulatory or control systems.

Impulse Control and Obsessive–Compulsive Behaviors

Patients with dementia may also manifest other forms of related impulsive behaviors (such as binge eating, touching or kissing strangers, inappropriate sexual behavior, urinating in public), or of compulsive behaviors (such as collecting objects, organizing objects, walking repeated routes, rigid food preferences, or clock watching). These may be viewed as disorders of reward processing (increased positive value) or of disorders of cognitive control (reduced regulatory behavior). These changes can cause stress, frustration, and embarrassment to family and caregivers (Apostolova & Cummings, 2008).

Impulse control and compulsive behaviors are conceptualized as relating to a dysfunction of positive-valence and regulatory or control systems.

Major Neurodegenerative Dementias

Alzheimer's Disease

When first described in 1906 by Professor Alois Alzheimer (1907), the case of August Dieter, the first patient described with what was later called Alzheimer's disease (AD), this disease was believed to represent a very rare condition that caused "presenile dementia." It was not until the 1970s that experts began to realize that AD greatly contributed, if not caused, most cases of "senile dementia" in older individuals. In the past two decades, partly as a result of efforts by the Alzheimer's Association, the medical community has finally recognized that it is not normal for elderly individuals to become "senile," but rather that AD and other neurodegenerative diseases as well as cerebrovascular diseases are common pathologies that cause the loss of mental abilities with age.

AD is the most common cause of neurodegenerative dementia, affecting an estimated 5 million Americans and as many as 20–30 million people worldwide (Saxena, 2012; Wimo & Prince, 2010). With the growth of the elderly population, a worldwide pandemic of clinical AD and dementia is anticipated. And unfortunately, although great advances have been made in the past three decades in our understanding of the scope of the problem and our ability to diagnose patients, our understanding of the etiology, pathophysiology, and therapeutics of this disease remains in its infancy.

Neuropathology

In AD, like all other neurodegenerative conditions, the process that leads to symptoms is now believed to start decades prior to the onset of clinical symptoms. Jack et al. (2010) proposed a model of AD biomarker pathology that involves a progressive sequence of measurable biochemical, neurophysiological, and neuroanatomical alterations that can be potentially detected years prior to psychometrically and clinically noticeable deterioration in cognition, behavior, and function.

The neuropathology of AD usually starts and spreads in a reasonably consistent pattern. The neuropathological hallmarks of AD, visible under the microscope, include diffuse and neuritic beta-amyloid (Aß) plaques that are found outside of cells, and neurofibrillary tangles made up of tau protein that are found inside cells; in addition, there is substantial synaptic and neuronal loss (Braak, Alafuzoff, Arzberger, Kretzschmar, & Del Tredici, 2006; Hyman et al., 2012; Jellinger & Bancher, 1998; Parvizi, Van Hoesen, & Damasio, 2001). By the time of death, patients with AD have prominent loss of brain weight and atrophy (with shrinkage of gyri and widening of sulci) that is most notable in the temporal (particularly the hippocampi and medial temporal lobes), frontal, and parietal lobes. The hippocampal formation, entorhinal and perirhinal cortices, and their related memory networks show a selective vulnerability for the earliest pathology in AD. Heteromodal, paralimbic, and limbic cortices bear the brunt of the burden of AD pathology, with relative sparing of the primary motor and sensory cortices.

Though not specific to AD, the cholinergic neurons of the nucleus basalis of Meynert and substantia innominata undergo degeneration. This cholinergic deficit was the initial target for treatment, with modest success at improving symptoms. Limbic thalamic nuclei, including the anterior and dorsomedial nuclei, also appear selectively vulnerable to neurofibrillary tangles in AD and show neuronal loss. Patients with AD often also have neuropathological changes in the amygdala (Poulin et al., 2011) and in important brainstem adrenergic (locus coeruleus) and serotonergic (dorsal and median raphe) projection nuclei.

Major Clinical Features

The prototypical symptoms of AD include initial memory difficulties attributable to dysfunction of the medial temporal lobe structures, particularly the entorhinal cortex and hippocampus, and associated parietal memory processing regions (Dubois et al., 2010; McKhann et al., 2011). As the disease progresses, patients develop additional cognitive deficits especially including executive dysfunction (problems with organization, judgment, and problem solving), visuospatial impairment (including problems with navigation and complex spatial attention), and apraxia (difficulty with complex movement). Usually but not always language is disrupted later in the disease course. Most basic sensory and motor functions are preserved. Sometimes, patients will present atypically, with language or visuospatial or executive symptoms emerging before memory loss. The course of the disease is commonly 8–10 or more years from first symptoms to death, with many years of complete disability and dependence on others.

Emotion-Related Symptoms

In Professor Alzheimer's (1907) index case, he reported that the patient had significant behavioral and psychiatric symptoms in addition to memory and cognitive difficulties:

> The first noticeable symptom of illness shown by this 51-year old woman was suspiciousness of her husband. Soon, a rapidly increasing memory impairment became evident; she could no longer orient herself in her own dwelling, dragged objects here and there and hid them, and at times, believing that people were out to murder her, started to scream loudly. On observation at the institution, her entire demeanor bears the stamp of utter bewilderment. She is completely disoriented to time and place. Occasionally, she remarks that she does not understand anything and is at her wits' end. Sometimes she greets the doctor as if he were a visitor and excuses herself that she has not finished with her work; on other occasions, she screams that he wants to cut her open, and on yet others, she dismisses him, full of indignation and with expressions indicating that she fears him as a threat to her honor as a woman. At times, she is totally delirious, drags her bedding around, calls for her husband or daughter and seems to have auditory hallucinations. Often, she screams for many hours in a horrible voice.

Although AD has been viewed as predominantly a disorder of memory, executive function, and other cognitive abilities, the vast majority of patients with AD develop changes in emotional behavior, usually referred to as neuropsychiatric symptoms, during the course of the illness (Lyketsos et al., 2002). In some patients, these symptoms may emerge very early, sometimes even prior to cognitive impairment.

The neuropsychiatric profile of AD includes the breadth of neuropsychiatric symptoms described above. These symptoms may occur at any point during the course of the illness but certain features are more likely to appear at certain points along the course of the illness. A commonly used instrument to measure these symptoms is the Neuropsychiatric Inventory (NPI; Kaufer et al., 1998), a structured clinical interview (sometimes administered as a questionnaire). Research using the NPI has found that as many as 60% of patients with AD exhibit at least one neuropsychiatric symptom at the time of presentation. Two common early symptoms are depression and apathy. Apathy is present in nearly half of patients with mild AD and as many as 80–90% of patients with moderate to severe AD (Mega, Cummings, Fiorello, & Gornbein, 1996). Depressive symptoms are present in about half of patients with AD, and are associated with diminished quality of life, functional impairment, and institutionalization, as well as increased caregiver burden and depression (Chan, Kasper, Black, & Rabins, 2003). Psychotic symptoms occur in 30–40% of patients with AD, more often during the middle to late stages (Mega et al., 1996). They are a common reason for institutionalization and increased levels of caregiver burden (Steele, Rovner, Chase, & Folstein, 1990). Common delusional themes include theft, infidelity, and delusional misidentification syndromes, as described above. Hallucinations are less common, are typically visual, and tend to be relatively transient (weeks to months). Persons with AD usually have relatively intact social behavior in the early to mid stages of the disease, but a small percentage of patients who have AD pathology have a "frontal variant" clinical syndrome, in which socioaffective behavioral disturbances similar to FTD can be observed (see below; Johnson, Head, Kim, Starr, & Cotman, 1999).

LBD and PDD

LBD and PDD are neurodegenerative diseases with symptoms that include changes in movement, cognition, emotion, and autonomic function. LBD was relatively recently described, in 1961, but is thought to be the second most common cause of neurodegenerative dementia after AD, accounting for 15–30% of all dementia cases (Okazaki, Lipkin, & Aronson, 1961; Barker et al., 2002; Hulette et al., 1995; Lim et al., 1999). DLB usually appears in people 60–80 years of age (McKeith et al., 2005). The rate of decline is similar to that of AD, with average survival of 8–10 years.

LBD and PDD have overlapping clinical features with the distinction being the chronology and temporal course of symptoms. Patients who first develop a movement disorder consistent with PD and subsequently develop dementia are diagnosed as PDD, while those who develop dementia followed by parkinsonism or who develop both types of symptoms simultaneously are diagnosed as LBD. The clinical diagnostic criteria have reasonably good predictive accuracy for LBD pathology (McKeith, Perry, & Perry, 1999; McKeith et al., 2005; Emre et al., 2007).

Pathology of LBD

Both LBD and PDD are members of the class of neurodegenerative diseases collectively referred to as synucleinopathies; they are believed to represent two entities on the same disease spectrum with overlapping clinical, neurochemical, and pathological findings. The pathologic diagnosis of LBD requires the presence of Lewy bodies (LBs) within neurons. They can be seen in the brainstem nuclei (including autonomic nuclei), amygdala, basal ganglia and cerebral cortex, particularly the limbic and paralimbic cortices (Hansen et al., 1990). As with all neurodegenerative diseases, neuronal loss is also present. Alpha-synuclein is the major protein component of LBs (Spillantini, Crowther, Jakes, Hasegawa, & Goedert, 1998). In addition to LB pathology, 75–90% of patients with LBD also have amyloid plaques like AD, but in contrast to AD, neurofibrillary tangles are rare.

LBD pathology is associated with profound cholinergic and dopaminergic deficits (Perry et al., 1990). Like AD, a cholinergic deficit is present but is more prominent in LBD than in AD (Samuel, Alford, Hofstetter, & Hansen, 1997). A higher LB density in the limbic system (amygdala) is associated with visual hallucinations (Harding, Broe, & Halliday, 2002). In contrast to AD but like PD, a dopaminergic deficit is the other important neurochemical feature of LBD. Deficits may also be present in the serotoninergic and noradrenergic systems, with some evidence that this may relate to cognitive-behavioral impairment.

Major Clinical Features of LBD

Clinical features of LBD include cognitive, psychiatric, neurological, sleep, and autonomic symptoms. The cognitive profile of LBD includes major impairments in executive and visuospatial functions as well as attention (Calderon et al., 2001; Walker, Allen, Shergill, & Katona, 1997), often with minimal memory symptoms early in the disease. These symptoms typically fluctuate prominently, with pronounced variations in attention and alertness that may vary from hour to hour or day to day (Ferman et al., 2004).

Another core feature of LBD is the presence of parkinsonism, although as many as 25% of cases with LBD pathology may have had no parkinsonism. Neurologists diagnose parkinsonism when patients have a movement disorder including rigidity of the arms or legs, slowness of movement (bradykinesia), shuffling gait, stooped posture, and a "mask-like" facial expression, as well as a tremor at rest. There are many causes of parkinsonism, including so-called idiopathic PD and strokes; parkinsonism is a common side effect of many drugs used to treat psychiatric symptoms. Unlike PD, many patients with LBD do not have a resting tremor, but often have postural instability with falls.

Many patients also have prominent sleep disorders and autonomic symptoms, including blood pressure variation, impotence, urinary incontinence, or constipation.

Changes in Emotional Behavior in LBD

A core clinical feature—part of the diagnostic criteria—of LBD is persistent visual hallucinations. Hallucinations are usually present early in the course of illness; they are often recurrent, well formed, and detailed, but often do not disturb the patient (Mosimann et al., 2006). Many patients calmly describe being aware that they are seeing people or animals that are not real. Visual illusions are also common where patients perceive objects differently from their true identity. Auditory hallucinations occur in up to 25% of patients with LBD, olfactory hallucinations in 5–10%, and tactile hallucinations in up to 3%.

Delusions are less common, but may be similar to those seen in AD, such as the belief that strangers are living in the home (phantom boarder) or delusions of persecution; delusions of theft and infidelity may also occur. One neuroimaging study used single-photon emission computerized tomography (SPECT) scans in LBD patients to identify associations between visual hallucinations with reduced blood flow in the parietal and ventral occipital cortices, misidentifications with reduced blood flow in limbic–paralimbic structures, and delusions with reduced blood flow in the frontal cortices (Nagahama, Okina, Suzuki, & Matsuda, 2010).

Depression and anxiety may appear years before the onset of dementia and up to 40% of patients with LBD experience a major depressive episode in the course of their illness (Auning et al., 2011).

An important challenge in LBD is that patients tend to be very sensitive to adverse effects of antipsychotic medications, so that it can be quite difficult to treat psychosis in these patients.

Frontotemporal Dementia

In 1892, Arnold Pick described a 71-year-old patient with progressive cognitive decline, primarily manifesting as early loss of language (Pick, Girling, & Berrios, 1997), and subsequently reported three additional cases, noting the prominent frontal or anterior temporal lobe atrophy present postmortem. The associated abnormalities identified microscopically were later described by Alois Alzheimer (1907), and in the 1920s the term "Pick's disease" was coined. Subsequent investigators described the clinical course of the disease, highlighting the insidious early changes in behavior and personality and, in contrast with AD, the typical relative preservation of memory and orientation into the middle phases of the disease (Berrios & Girling, 1994). A resurgence of interest in these conditions occurred in the last two decades of the 20th century, and we now recognize patients with several major forms of the clinical entity "frontotemporal dementia" (FTD), including "behavioral variant of FTD" (bvFTD), "semantic dementia" (SD) or "semantic variant of primary progressive amnesia (PPA)," "nonfluent or agrammatic variant of PPA" (PNFA), and "logopenic variant of PPA." The neuropathological family of this complex set of conditions is termed "frontotemporal lobar degeneration" (FTLD). FTLD is a loosely knit group of neurodegenerative diseases that preferentially affect the frontal and anterior temporal lobes, with relative sparing of other cortical regions in many cases, and often affects basal ganglia and in some cases basal forebrain and brainstem nuclei.

FTLD is thought to be the third most common degenerative dementia, after AD and LBD, accounting for 5–15% of dementias. FTLD often strikes people at a younger age than AD or LBD, often in affecting patients who are 45–65 years old. It is probably the second most common cause of dementia in people younger than 65. Although detailed epidemiological studies are sparse, it is thought to be relatively rare, affecting somewhere between 50,000 and 300,000 Americans.

Neuropathology of FTLD

The hallmark of the neuropathology of FTLD is its topographic distribution—which in some cases is strikingly focal—in the frontal and anterior temporal lobes, as well as a number of subcortical structures. There are a variety of microscopic features associated with these abnormalities. In some cases, deposits of tau protein inside neurons are present; these are called "Pick bodies" (Onari & Spatz, 1926). Further investigations of this pathological form of FTLD has shown that atrophy and tau pathology occurs in the prefrontal cortex, frontoinsula, anterior cingulate, and anterior temporal cortex with relative sparing of the superior temporal gyrus, especially its posterior third, as well as the primary visual cortex (Hof, Bouras, Perl, & Morrison, 1994; Yoshimura, 1989). Prominent white matter tau pathology is commonly present (Zhukareva et al., 2002). The basal ganglia, basal forebrain, and brainstem structures are variably affected, with some patients showing minimal pathology and others exhibiting substantial pathology (Dickson, 2001). The spectrum of "pure tauopathies" (without the amyloid plaques seen in AD) also includes rare conditions called progressive supranuclear palsy and corticobasal degeneration. Other patients with FTLD have a protein called TDP-43 (transactive DNA-binding protein, molecular weight 43 kD) that is deposited in similar areas (Neumann et al., 2006; Mackenzie, Rademakers, & Neumann, 2010). Furthermore, TDP-43 has been found in most cases of amyotrophic lateral sclerosis (ALS). Thus, the FTLD spectrum is linked to multiple other neurodegenerative diseases.

It is unclear why particular brain regions are vulnerable to tau or TDP-43 pathology in FTLD. In 2006, Seeley et al. reported the selective loss of a specific cell type found in the anterior cingulate and frontoinsular cortex of great apes, whales, and humans. This spindle-shaped neuron, the von Economo cell, was reported to be reduced by more than 60% in these brain regions in FTLD but not in AD. Further research on this and potentially other selectively vulnerable cell types in FTLD may reveal new insights into the devastation of these cortical regions in FTLD syndromes.

Major Clinical Features of FTD

There are two major clinical types of FTD: the behavioral variant of FTD (bvFTD) and the language variant of FTD, also known as "primary progressive aphasia" (PPA).

Primary Progressive Aphasia. If a patient presents with an isolated, gradually progressive aphasia, he or she would be diagnosed by many specialists with PPA.

At present, such a patient would have been diagnosed as having a language-predominant form of FTD or FTLD, and further subtyped into one of three major clinical subtypes: the agrammatic variant of PPA (PPA-g, which likely captures most of the patients formerly diagnosed with PNFA), the semantic variant of PPA (PPA-s, which likely captures most of the patients formerly diagnosed with SD), and the logopenic variant of PPA (Gorno-Tempini et al., 2011). The former two subtypes are usually associated with FTLD pathology, while the logopenic variant of PPA (PPA-l) is most frequently associated with underlying AD pathology, and thus would not be considered a major clinical subtype of FTLD.

Although patients with progressive aphasias may have personality, comportmental, and social symptoms, they are by definition less prominent than the language impairment early in the course of the disorder. As PPA progresses, it evolves to affect other cognitive functions and many patients develop changes in emotional behavior (Modirrousta, Price, & Dickerson, 2013).

Changes in Emotion in PPA. Patients with the semantic variant of PPA (PPA-s) commonly exhibit neuropsychiatric symptoms, often relatively early and in a fairly stereotypical fashion. Many of these symptoms are similar to those of bvFTD, including loss of empathy, changes in eating behavior, compulsive behavior, and disinhibition (see below). In fact, in the prior diagnostic criteria for FTD, features considered supportive of a diagnosis of SD included loss of sympathy or empathy and narrowed preoccupations (mental rigidity; Neary et al., 1998). Depression is also reported as common in PPA-s in some studies; in my experience, however, at least some patients make negatively valenced statements (e.g., "I feel so stupid," "I know I'm going to die"), but express minimal affective behavior consistent with depression.

In PPA-g, neuropsychiatric symptoms are less frequent initially, but as the illness progresses it becomes increasingly common to see apathy, depression, or irritability. In some cases these symptoms are present early in the illness, which may lead to misdiagnosis as a primary psychiatric disorder (often depression).

In PPA-l, neuropsychiatric symptoms are relatively infrequent early but increase as the illness progresses and include agitation, anxiety, irritability, and apathy. In many cases we have seen, the clinical phenomenology of neuropsychiatric symptoms appears similar to that seen in AD (see above).

Behavioral Variant of FTD. Many of the core clinical features of bvFTD include disruptions of emotional behavior, described below. Cognitive symptoms are also often present, especially executive dysfunction (problems with organization, planning, sequencing, decision making, multitasking, or monitoring performance; Bozeat, Gregory, Ralph, & Hodges, 2000). Progressive loss of executive abilities may lead to job loss or mismanagement of money.

Another important clinical feature of bvFTD is lack of insight (Banks & Weintraub, 2008; Eslinger et al., 2005; Williamson et al., 2009), even when the patient is directly confronted with obvious impairments.

Compulsive, ritualistic, or repetitive behaviors are common in bvFTD, often early in the illness (Ames, Cummings, Wirshing, Quinn, & Mahler, 1994; Nyatsanza et al., 2003; Mendez, Perryman, Miller, Swartz, & Cummings, 1997), and may include repetitive "projects," chores, or playing of card or computer games or repetitive watching of a particular television show, or hoarding (Bozeat, Gregory, Ralph, & Hodges, 2000). Speech patterns may be stereotyped (e.g., catchphrases, telling of stories as if by a script). Some patients have very rigid routines that must be performed identically each day (often at a particular time, associated with "clock watching"). These symptoms may change as the disease progresses, in some cases becoming simpler.

Changes in eating behavior are common, and may include altered food preferences (such as an increased sweet tooth or a rigid stereotypy in the foods eaten from day to day) or gluttonous or binge-like eating (Bozeat et al., 2000; Miller, Darby, Swartz, Yener, & Mena, 1995).

Changes in Emotion in bvFTD. The core clinical features of bvFTD are socioaffective, and include the insidious development of changes in interpersonal and emotional behavior, commonly accompanied by executive dysfunction. Disinhibition is a common early symptom, and is often seen in social settings. For example, patients may act in an overly familiar manner with strangers, may violate social normative behavior such as public urination or changes in behavior during social meals, may make impulsive actions such as unnecessary or excessive purchasing or shoplifting (Miller et al., 1991; Miller, Darby, Benson, Cummings, & Miller, 1997; Snowden et al., 2001) or inappropriate sexual behavior. Disinhibition appears to be related particularly to orbitofrontal and cingulo-opercular abnormalities in FTD (O'Callaghan, Hodges, & Hornberger, 2013).

Another very common early symptom is apathy, including loss of interest in hobbies or social activities (Chow et al., 2009; Massimo et al., 2009; Shinagawa, Ikeda, Fukuhara, & Tanabe, 2006). In some patients with FTD, apathy is mistaken for depression, but patients with bvFTD do not usually exhibit sadness or cry and are often not particularly concerned or upset by their symptoms. Atrophy in the ACC, DLPFC (Massimo et al., 2009), and striatum (Rosen et al., 2005) has been observed in association with apathy in bvFTD.

Loss of empathy or sympathy is very common (Lough et al., 2006; Mendez & Perryman, 2003; Rankin, Kramer, & Miller, 2005). Because of the wide variability between healthy individuals in expressions of empathy, it can be difficult to be confident that some patients who may never have been particularly empathic have developed this symptom. In some cases, an abnormal response to an extreme emotional event (such as the death of a family member) may trigger a trip to the doctor. Even under these circumstances, the behavior is commonly attributed to depression or another psychiatric illness or to stress or a midlife crisis. Right anterior temporal cortex, anterior insula, and striatal abnormalities have been most consistently identified as related to loss of empathy (Perry et al., 2001; Rankin et al., 2006).

Another core feature of bvFTD is personality change. Alterations in personality can be prominent in bvFTD and also in semantic dementia (Rankin, Baldwin, Pace-Savitsky, Kramer, & Miller, 2005). Although questionnaire-based instruments to assess classical dimensional personality traits are readily available, changes in personality might be best understood by considering more specific process-oriented functions contributing to personality traits. Some symptoms may include changes in the expression or comprehension of emotion, social withdrawal or disinhibition, or loss of empathy. In some cases, a previously gruff or aggressive individual becomes docile.

Psychosis has been thought unusual in bvFTD, but the discovery of the *C9ORF72* expansion has highlighted the common presence of psychosis in patients as well as nondemented family members with this genetic mutation (Boeve et al., 2012).

Conclusions

Neurodegenerative dementias are a modern-day scourge of our society, affecting between 6 and 10 million people in the United States and an order of magnitude more around the world, and wreaking havoc not only on the patient's independent functioning but also on family life. Although cognitive and motor symptoms often receive the most attention from clinicians (particularly neurologists) providing care and conducting research in this field, emotional disorders are common problems and confer tremendous suffering. With important exceptions, neurologists are not systematically trained in the evaluation of these symptoms or their treatment, and psychiatrists who are trained in these areas are often not well versed in the neurobiology and functional neuroanatomy of neurodegenerative dementias. Contemporary behavioral neurology and neuropsychiatry training programs are beginning to provide the range of training in cognition, movement, and emotion that is required to provide comprehensive care for patients with these conditions, but in many cases, the care provided by a multidisciplinary team may be most optimal.

Constructs of psychological and behavioral symptoms of dementias are rooted in traditional psychiatry and psychology. These constructs are only recently being updated to incorporate new frameworks such as the RDoC within psychiatry (Insel et al., 2010), which are grounded in systems-based functional neuroanatomy. Insights gained from basic science studies of emotion will undoubtedly support continued progress in our understanding of the psychological processes and functional neuroanatomy of emotional disorders in neurodegenerative dementias. Hopefully, these insights will spark new ideas about treatments for these devastating symptoms.

References

Akiyama, H., Hashimoto, H., Kawabe, J., Higashiyama, S., Kai, T., Kataoka, K., et al. (2008). The relationship between depressive symptoms and prefrontal hypoperfusion demonstrated by eZIS in patients with DAT. *Neuroscience Letters, 441*, 328–331.

Alzheimer, A. (1907). Über eine eigenartige Erkrankung der Hirnrinde. Allgemeine Zeitschrift für Psychiatrie und phychish. *Gerichtliche Medizin, 64*, 146–148.

Ames, D., Cummings, J. L., Wirshing, W. C., Quinn, B., & Mahler, M. (1994). Repetitive and compulsive behavior in frontal lobe degenerations. *Journal of Neuropsychiatry and Clinical Neurosciences, 6*, 100–113.

Apostolova, L. G., Akopyan, G. G., Partiali, N., Steiner, C. A., Dutton, R. A., Hayashi, K. M., et al. (2007). Structural correlates of apathy in Alzheimer's disease. *Dementia and Geriatric Cognitive Disorders, 24*, 91–97.

Apostolova, L. G., & Cummings, J. L. (2008). Neuropsychiatric manifestations in mild cognitive impairment: A systematic review of the literature. *Dementia and Geriatric Cognitive Disorders, 25*, 115–126.

Auning, E., Rongve, A., Fladby, T., Booij, J., Hortobagyi, T., Siepel, F. J., et al. (2011). Early and presenting symptoms of dementia with lewy bodies. *Dementia and Geriatric Cognitive Disorders, 32*, 202–208.

Ballard, C., Bannister, C., Solis, M., Oyebode, F., & Wilcock, G. (1996). The prevalence, associations and symptoms of depression amongst dementia sufferers. *Journal of Affective Disorders, 36*, 135–144.

Ballard, C., Holmes, C., McKeith, I., Neill, D., O'Brien, J., Cairns, N., et al. (1999). Psychiatric morbidity in dementia with Lewy bodies: A prospective clinical and neuropathological comparative study with Alzheimer's disease. *American Journal of Psychiatry, 156*, 1039–1045.

Banks, S., & Weintraub, S. (2008). Self-awareness and self-monitoring of cognitive and behavioral deficits in behavioral variant frontotemporal dementia, primary progressive aphasia and probable Alzheimer's disease. *Brain and Cognition, 67*, 58–68.

Barker, W. W., Luis, C. A., Kashuba, A., Luis, M., Harwood, D. G., Loewenstein, D., et al. (2002). Relative frequencies of Alzheimer disease, Lewy body, vascular and frontotemporal dementia, and hippocampal sclerosis in the State of Florida Brain Bank. *Alzheimer Disease and Associated Disorders, 16*, 203–212.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck Depression Inventory–II*. San Antonio, TX: Psychological Corporation.

Berrios, G. E., & Girling, D. M. (1994). Introduction: Pick's disease and the "frontal lobe" dementias. *History of Psychiatry, 5*, 539–547.

Bertram, L., & Tanzi, R. E. (2005). The genetic epidemiology of neurodegenerative disease. *Journal of Clinical Investigation, 115*, 1449–1457.

Boeve, B. F., Boylan, K. B., Graff-Radford, N. R., DeJesus-Hernandez, M., Knopman, D. S., Pedraza, O., et al. (2012). Characterization of frontotemporal dementia and/or amyotrophic lateral sclerosis associated with the GGGGCC repeat expansion in C9ORF72. *Brain, 135*, 765–783.

Bozeat, S., Gregory, C. A., Ralph, M. A., & Hodges, J. R. (2000). Which neuropsychiatric and behavioural features distinguish frontal and temporal variants of frontotemporal dementia from Alzheimer's disease? *Journal of Neurology, Neurosurgery and Psychiatry, 69*, 178–186.

Braak, H., Alafuzoff, I., Arzberger, T., Kretzschmar, H., & Del Tredici, K. (2006). Staging of Alzheimer disease-associated neurofibrillary pathology using paraffin sections and immunocytochemistry. *Acta Neuropathologica, 112*, 389–404.

Butters, M. A., Klunk, W. E., Mathis, C. A., Price, J. C., Ziolko, S. K., Hoge, J. A., et al. (2008). Imaging Alzheimer pathology in late-life depression with PET and Pittsburgh Compound-B. *Alzheimer Disease and Associated Disorders, 22*, 261–268.

Calderon, J., Perry, R. J., Erzinclioglu, S. W., Berrios, G. E., Dening, T. R., & Hodges, J. R. (2001). Perception, attention, and working memory are disproportionately impaired in dementia with Lewy bodies compared with Alzheimer's disease. *Journal of Neurology, Neurosurgery and Psychiatry, 70*, 157–164.

Callahan, C. M., Boustani, M. A., Unverzagt, F. W., Austrom, M. G., Damush, T. M., Perkins, A. J., et al. (2006). Effectiveness of collaborative care for older adults with Alzheimer disease in primary care: A randomized controlled trial. *JAMA, 295*, 2148–2157.

Chan, D. C., Kasper, J. D., Black, B. S., & Rabins, P. V. (2003). Presence of behavioral and psychological symptoms predicts nursing home placement in community-dwelling elders with cognitive impairment in univariate but not multivariate analysis. *Journals of Gerontology. Series A: Biological Sciences and Medical Sciences, 58*, 548–554.

Chemerinski, E., Petracca, G., Sabe, L., Kremer, J., & Starkstein, S. E. (2001). The specificity of depressive symptoms in patients with Alzheimer's disease. *American Journal of Psychiatry, 158*, 68–72.

Chen, S. T., Sultzer, D. L., Hinkin, C. H., Mahler, M. E., & Cummings, J. L. (1998). Executive dysfunction in Alzheimer's disease: Association with neuropsychiatric symptoms and functional impairment. *Journal of Neuropsychiatry and Clinical Neurosciences, 10*, 426–432.

Chow, T. W., Binns, M. A., Cummings, J. L., Lam, I., Black, S. E., Miller, B. L., et al. (2009). Apathy symptom profile and behavioral associations in frontotemporal dementia vs dementia of Alzheimer type. *Archives of Neurology*, 66, 888–893.

Cohen-Mansfield, J. (1986). Agitated behaviors in the elderly: II. Preliminary results in the cognitively deteriorated. *Journal of the American Geriatrics Society, 34*, 722–727.

Dickson, D. W. (2001). Neuropathology of Pick's disease. *Neurology, 56*, S16–S20.

D'Onofrio, G., Sancarlo, D., Panza, F., Copetti, M., Cascavilla, L., Paris, F., et al. (2012). Neuropsychiatric symptoms and functional status in Alzheimer's disease and vascular dementia patients. *Current Alzheimer Research, 9*, 759–771.

Dubois, B., Feldman, H. H., Jacova, C., Cummings, J. L., Dekosky, S. T., Barberger-Gateau, P., et al. (2010). Revising the definition of Alzheimer's disease: A new lexicon. *Lancet Neurology, 9*, 1118–1127.

Emre, M., Aarsland, D., Brown, R., Burn, D. J., Duyckaerts, C., Mizuno, Y., et al. (2007). Clinical diagnostic criteria for dementia associated with Parkinson's disease. *Movement Disorders, 22*, 1689–1707.

Eslinger, P. J., Dennis, K., Moore, P., Antani, S., Hauck, R., & Grossman, M. (2005). Metacognitive deficits in frontotemporal dementia. *Journal of Neurology, Neurosurgery and Psychiatry, 76*, 1630–1635.

Ferman, T. J., Smith, G. E., Boeve, B. F., Ivnik, R. J., Petersen, R. C., Knopman, D., et al. (2004). DLB fluctuations: Specific features that reliably differentiate DLB from AD and normal aging. *Neurology, 62*, 181–187.

Flynn, F. G., Cummings, J. L., & Gornbein, J. (1991). Delusions in dementia syndromes: Investigation of behavioral and neuropsychological correlates. *Journal of Neuropsychiatry and Clinical Neurosciences, 3*, 364–370.

Gorno-Tempini, M. L., Hillis, A. E., Weintraub, S., Kertesz, A., Mendez, M., Cappa, S. F., et al. (2011). Classification of primary progressive aphasia and its variants. *Neurology, 76*, 1006–1014.

Hamilton, M. (1980). Rating depressive patients. *Journal of Clinical Psychiatry, 41*, 21–24.

Hansen, L., Salmon, D., Galasko, D., Masliah, E., Katzman, R., DeTeresa, R., et al. (1990). The Lewy body variant of Alzheimer's disease: A clinical and pathologic entity. *Neurology, 40*, 1–8.

Harding, A. J., Broe, G. A., & Halliday, G. M. (2002). Visual hallucinations in Lewy body disease relate to Lewy bodies in the temporal lobe. *Brain, 125*, 391–403.

Hirono, N., Mega, M. S., Dinov, I. D., Mishkin, F., & Cummings, J. L. (2000). Left frontotemporal hypoperfusion is associated with aggression in patients with dementia. *Archives of Neurology, 57*, 861–866.

Hof, P. R., Bouras, C., Perl, D. P., & Morrison, J. H. (1994). Quantitative neuropathologic analysis of Pick's disease cases: Cortical distribution of Pick bodies and coexistence with Alzheimer's disease. *Acta Neuropathologica, 87*, 115–124.

Hulette, C., Mirra, S., Wilkinson, W., Heyman, A., Fillenbaum, G., & Clark, C. (1995). The Consortium to Establish a Registry for Alzheimer's Disease (CERAD): Part IX. A prospective cliniconeuropathologic study of Parkinson's features in Alzheimer's disease. *Neurology, 45*, 1991–1995.

Hyman, B. T., Phelps, C. H., Beach, T. G., Bigio, E. H., Cairns, N. J., Carrillo, M. C., et al. (2012). National Institute on Aging–Alzheimer's Association guidelines for the neuropathologic assessment of Alzheimer's disease. *Alzheimer's and Dementia, 8*, 1–13.

Insel, T., Cuthbert, B., Garvey, M., Heinssen, R., Pine, D. S., Quinn, K., et al. (2010). Research domain criteria (RDoC): Toward a new classification framework for research on mental disorders. *American Journal of Psychiatry, 167*, 748–751.

Jack, C., Knopman, D., Jagust, W., Shaw, L. M., Aisen, P. S., Weiner, M., et al. (2010). Hypothetical model of dynamic biomarkers of the Alzheimer's pathological cascade. *Lancet, 9*, 119–128.

Jellinger, K. A., & Bancher, C. (1998). Neuropathology of Alzheimer's disease: A critical update. *Journal of Neural Transmission, 54*, 77–95.

Johnson, J. K., Head, E., Kim, R., Starr, A., & Cotman, C. W. (1999). Clinical and pathological evidence for a frontal variant of Alzheimer disease. *Archives of Neurology, 56*, 1233–1239.

Kaufer, D. I., Cummings, J. L., Christine, D., Bray, T., Castellon, S., Masterman, D., et al. (1998). Assessing the impact of neuropsychiatric symptoms in Alzheimer's disease: The Neuropsychiatric Inventory Caregiver Distress Scale. *Journal of the American Geriatrics Society, 46*, 210–215.

Landes, A. M., Sperry, S. D., & Strauss, M. E. (2005). Prevalence of apathy, dysphoria, and depression in relation to dementia severity in Alzheimer's disease. *Journal of Neuropsychiatry and Clinical Neurosciences, 17*, 342–349.

Lechowski, L., Benoit, M., Chassagne, P., Vedel, I., Tortrat, D., Teillet, L., et al. (2009). Persistent apathy in Alzheimer's disease as an independent factor of rapid functional decline: The REAL Longitudinal Cohort Study. *International Journal of Geriatric Psychiatry, 24*, 341–346.

Levy, M. L., Cummings, J. L., Fairbanks, L. A., Masterman, D., Miller, B. L., Craig, A. H., et al. (1998). Apathy is not depression. *Journal of Neuropsychiatry and Clinical Neurosciences, 10*, 314–319.

Lim, A., Tsuang, D., Kukull, W., Nochlin, D., Leverenz, J., McCormick, W., et al. (1999). Clinico-neuropathological correlation of Alzheimer's disease in a community-based case series. *Journal of the American Geriatrics Society, 47*, 564–569.

Lough, S., Kipps, C. M., Treise, C., Watson, P., Blair, J. R., & Hodges, J. R. (2006). Social reasoning, emotion and empathy in frontotemporal dementia. *Neuropsychologia, 44*, 950–958.

Lyketsos, C. G., Lopez, O., Jones, B., Fitzpatrick, A. L., Breitner, J., & DeKosky, S. (2002). Prevalence of neuropsychiatric symptoms in dementia and mild cognitive impairment: Results from the cardiovascular health study. *JAMA, 288*, 1475–1483.

Mackenzie, I. R., Rademakers, R., & Neumann, M. (2010). TDP-43 and FUS in amyotrophic lateral sclerosis and frontotemporal dementia. *Lancet Neurology, 9*, 995–1007.

Marin, D. B., Green, C. R., Schmeidler, J., Harvey, P. D., Lawlor, B. A., Ryan, T. M., et al. (1997). Noncognitive disturbances in Alzheimer's disease: Frequency, longitudinal course, and relationship to cognitive symptoms. *Journal of the American Geriatrics Society, 45*, 1331–1338.

Marin, R. S. (1990). Differential diagnosis and classification of apathy. *American Journal of Psychiatry, 147*, 22–30.

Massimo, L., Powers, C., Moore, P., Vesely, L., Avants, B., Gee, J., et al. (2009). Neuroanatomy of apathy and disinhibition in frontotemporal lobar degeneration. *Dementia and Geriatric Cognitive Disorders, 27*, 96–104.

McKeith, I. G., Dickson, D. W., Lowe, J., Emre, M., O'Brien, J. T., Feldman, H., et al. (2005). Diagnosis and management of dementia with Lewy bodies: Third report of the DLB Consortium. *Neurology, 65*, 1863–1872.

McKeith, I. G., Perry, E. K., & Perry, R. H. (1999). Report of the second dementia with Lewy body international workshop: Diagnosis and treatment. Consortium on Dementia with Lewy Bodies. *Neurology, 53*, 902–905.

McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B. T., Jack, C. R., Jr., Kawas, C. H., et al. (2011). The diagnosis of dementia due to Alzheimer's disease: Recommendations from the National Institute on Aging and the Alzheimer's Association workgroup. *Alzheimer's and Dementia, 7*(3), 263–269.

Mega, M. S., Cummings, J. L., Fiorello, T., & Gornbein, J. (1996). The spectrum of behavioral changes in Alzheimer's disease. *Neurology, 46*, 130–135.

Mendez, M. F., Lauterbach, E. C., Sampson, S. M., & Research, A. C. O. (2008). An evidence-based review of the psychopathology of frontotemporal dementia: A report of the ANPA Committee on Research. *Journal of Neuropsychiatry and Clinical Neurosciences, 20*, 130–149.

Mendez, M. F., & Perryman, K. M. (2003). Disrupted facial empathy in drawings from artists with frontotemporal dementia. *Neurocase, 9*, 44–50.

Mendez, M. F., Perryman, K. M., Miller, B. L., Swartz, J. R., & Cummings, J. L. (1997). Compulsive behaviors as presenting symptoms of frontotemporal dementia. *Journal of Geriatric Psychiatry and Neurology, 10*, 154–157.

Miller, B. L., Cummings, J. L., Villanueva-Meyer, J., Boone, K., Mehringer, C. M., Lesser, I. M., et al. (1991). Frontal lobe degeneration: Clinical, neuropsychological, and SPECT characteristics. *Neurology, 41*, 1374–1382.

Miller, B. L., Darby, A., Benson, D. F., Cummings, J. L., & Miller, M. H. (1997). Aggressive, socially disruptive and antisocial behaviour associated with fronto-temporal dementia. *British Journal of Psychiatry, 170*, 150–154.

Miller, B. L., Darby, A. L., Swartz, J. R., Yener, G. G., & Mena, I. (1995). Dietary changes, compulsions and sexual behavior in frontotemporal degeneration. *Dementia, 6*, 195–199.

Modirrousta, M., Price, B. H., & Dickerson, B. C. (2013). Neuropsychiatric symptoms in primary progressive aphasia: Phenomenology, pathophysiology, and approach to assessment and treatment. *Neurodegenerative Disease Management, 3*, 133–146.

Mosimann, U. P., Rowan, E. N., Partington, C. E., Collerton, D., Littlewood, E., O'Brien, J. T., et al. (2006). Characteristics of visual hallucinations in Parkinson disease dementia and dementia with Lewy bodies. *American Journal of Geriatric Psychiatry, 14*, 153–160.

Nagahama, Y., Okina, T., Suzuki, N., & Matsuda, M. (2010). Neural correlates of psychotic symptoms in dementia with Lewy bodies. *Brain, 133*, 557–567.

Neary, D., Snowden, J. S., Gustafson, L., Passant, U., Stuss, D., Black, S., et al. (1998). Frontotemporal lobar degeneration: A consensus on clinical diagnostic criteria. *Neurology, 51*, 1546–1554.

Neumann, M., Sampathu, D. M., Kwong, L. K., Truax, A. C., Micsenyi, M. C., Chou, T. T., et al. (2006). Ubiquitinated TDP-43 in frontotemporal lobar degeneration and amyotrophic lateral sclerosis. *Science, 314*, 130–133.

Nyatsanza, S., Shetty, T., Gregory, C., Lough, S., Dawson, K., & Hodges, J. R. (2003). A study of stereotypic behaviours in Alzheimer's disease and frontal and temporal variant frontotemporal dementia. *Journal of Neurology, Neurosurgery and Psychiatry, 74*, 1398–1402.

O'Callaghan, C., Hodges, J. R., & Hornberger, M. (2013). Inhibitory dysfunction in frontotemporal dementia: A review. *Alzheimer Disease and Associated Disorders, 27*, 102–108.

Okazaki, H., Lipkin, L. E., & Aronson, S. M. (1961). Diffuse intracytoplasmic ganglionic inclusions (Lewy type) associated with progressive dementia and quadriparesis in flexion. *Journal of Neuropathology and Experimental Neurology, 20*, 237–244.

Onari, K., & Spatz, H. (1926). Anatomische Beiträge zur Lehre von der Pickschen umschriebenen Grosshirnrinden-Atrophie ("Picksche Krankheit"). *Journal of Neurology, 101*, 470–511.

Ott, B. R., Noto, R. B., & Fogel, B. S. (1996). Apathy and loss of insight in Alzheimer's disease: A SPECT imaging study. *Journal of Neuropsychiatry and Clinical Neurosciences, 8*, 41–46.

Parvizi, J., Van Hoesen, G. W., & Damasio, A. (2001). The selective vulnerability of brainstem nuclei to Alzheimer's disease. *Annals of Neurology, 49*, 53–66.

Perry, E. K., Marshall, E., Kerwin, J., Smith, C. J., Jabeen, S., Cheng, A. V., et al. (1990). Evidence of a monoaminergic–cholinergic imbalance related to visual hallucinations in Lewy body dementia. *Journal of Neurochemistry, 55*, 1454–1456.

Perry, R. J., Rosen, H. R., Kramer, J. H., Beer, J. S., Levenson, R. L., & Miller, B. L. (2001). Hemispheric dominance for emotions, empathy and social behaviour: Evidence from right and left handers with frontotemporal dementia. *Neurocase, 7*, 145–160.

Pick, A., Girling, D. M., & Berrios, G. E. (1997). On the symptomatology of left-sided temporal lobe atrophy. Classic Text No. 29. (Translated and annotated by D. M. Girling & G. E. Berrios.). *History of Psychiatry, 8*, 149–159.

Poulin, S. P., Dautoff, R., Morris, J. C., Barrett, L. F., Dickerson, B. C., & Alzheimer's Disease Neuroimaging, I. (2011). Amygdala atrophy is prominent in early Alzheimer's disease and relates to symptom severity. *Psychiatry Research, 194*, 7–13.

Rankin, K. P., Baldwin, E., Pace-Savitsky, C., Kramer, J. H., & Miller, B. L. (2005). Self awareness and personality change in dementia. *Journal of Neurology, Neurosurgery and Psychiatry, 76*, 632–639.

Rankin, K. P., Gorno-Tempini, M. L., Allison, S. C., Stanley, C. M., Glenn, S., Weiner, M. W., et al. (2006). Structural anatomy of empathy in neurodegenerative disease. *Brain, 129*, 2945–2956.

Rankin, K. P., Kramer, J. H., & Miller, B. L. (2005). Patterns of cognitive and emotional empathy in frontotemporal lobar degeneration. *Cognitive and Behavioral Neurology, 18*, 28–36.

Robert, P., Onyike, C. U., Leentjens, A. F., Dujardin, K., Aalten, P., Starkstein, S., et al. (2009). Proposed diagnostic criteria for apathy in Alzheimer's disease and other neuropsychiatric disorders. *European Psychiatry, 24*, 98–104.

Rosen, H. J., Allison, S. C., Schauer, G. F., Gorno-Tempini, M. L., Weiner, M. W., & Miller, B. L. (2005). Neuroanatomical correlates of behavioural disorders in dementia. *Brain, 128*, 2612–2625.

Samuel, W., Alford, M., Hofstetter, C. R., & Hansen, L. (1997). Dementia with Lewy bodies versus pure Alzheimer disease: Differences in cognition, neuropathology, cholinergic dysfunction, and synapse density. *Journal of Neuropathology and Experimental Neurology, 56*, 499–508.

Saxena, S. (2012). *Dementia: A public health priority*. Geneva: World Health Organization.

Seeley, W. W., Carlin, D. A., Allman, J. M., Macedo, M. N., Bush, C., Miller, B. L., et al. (2006). Early frontotemporal dementia targets neurons unique to apes and humans. *Annals of Neurology, 60*, 660–667.

Shinagawa, S., Ikeda, M., Fukuhara, R., & Tanabe, H. (2006). Initial symptoms in frontotemporal dementia and semantic dementia compared with Alzheimer's disease. *Dementia and Geriatric Cognitive Disorders, 21*, 74–80.

Simard, M., van Reekum, R., & Cohen, T. (2000). A review of the cognitive and behavioral symptoms in dementia with Lewy bodies. *Journal of Neuropsychiatry and Clinical Neurosciences, 12*, 425–450.

Snowden, J. S., Bathgate, D., Varma, A., Blackshaw, A., Gibbons, Z. C., & Neary, D. (2001). Distinct behavioural profiles in frontotemporal dementia and semantic dementia. *Journal of Neurology, Neurosurgery and Psychiatry, 70*, 323–332.

Spillantini, M. G., Crowther, R. A., Jakes, R., Hasegawa, M., & Goedert, M. (1998). Alpha-synuclein in filamentous inclusions of Lewy bodies from Parkinson's disease and dementia with Lewy bodies. *Proceedings of the National Academy of Sciences USA, 95*, 6469–6473.

Starkstein, S. E., Chemerinski, E., Sabe, L., Kuzis, G., Petracca, G., Teson, A., et al. (1997). Prospective longitudinal study of depression and anosognosia in Alzheimer's disease. *British Journal of Psychiatry, 171*, 47–52.

Steele, C., Rovner, B., Chase, G. A., & Folstein, M. (1990). Psychiatric symptoms and nursing home placement of patients with Alzheimer's disease. *American Journal of Psychiatry, 147*, 1049–1051.

Tekin, S., Mega, M. S., Masterman, D. M., Chow, T., Garakian, J., Vinters, H. V., et al. (2001). Orbitofrontal and anterior cingulate cortex neurofibrillary tangle burden is associated with agitation in Alzheimer disease. *Annals of Neurology, 49*, 355–361.

Trojanowski, J. Q. (2004). Protein mis-folding emerges as a "drugable" target for discovery of novel therapies for neuropsychiatric diseases of aging. *American Journal of Geriatric Psychiatry, 12*, 134–135.

Twelftree, H., & Qazi, A. (2006). Relationship between anxiety and agitation in dementia. *Aging and Mental Health, 10*, 362–367.

Walker, Z., Allen, R. L., Shergill, S., & Katona, C. L. (1997). Neuropsychological performance in Lewy body dementia and Alzheimer's disease. *British Journal of Psychiatry, 170*, 156–158.

Williamson, C., Alcantar, O., Rothlind, J., Cahn-Weiner, D., Miller, B. L., & Rosen, H. J. (2009). Standardised measurement of self-awareness deficits in FTD and AD. *Journal of Neurology, Neurosurgery and Psychiatry, 81*, 140–145.

Wimo, A., & Prince, M. (2010). The world Alzheimer report 2010: "The global impact of dementia." In *ADI world report*: London: Alzheimer's Disease International (ADI).

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., et al. (1982). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research, 17*(1), 37–49.

Yoshimura, N. (1989). Topography of Pick body distribution in Pick's disease: A contribution to understanding the relationship between Pick's and Alzheimer's diseases. *Clinical Neuropathology, 8*, 1–6.

Zhukareva, V., Mann, D., Pickering-Brown, S., Uryu, K., Shuck, T., Shah, K., et al. (2002). Sporadic Pick's disease: A tauopathy characterized by a spectrum of pathological tau isoforms in gray and white matter. *Annals of Neurology, 51*, 730–739.

PART VII

SPECIFIC EMOTIONS

CHAPTER 43

Fear and Anxiety

Kevin S. LaBar

What are you afraid of? What bodily symptoms accompany this sense of fear? Do specific cues or environmental contexts trigger your fear? Why are threatening experiences so memorable? These kinds of questions motivate the study of fear and its close relative, anxiety. Although scientists have yet to fully solve the mystery of fear, there has been much progress in understanding this ubiquitous emotion. Fear is an ideal emotion for scientific inquiry because it has a long evolutionary basis and thus can be studied in a variety of nonhuman animals; moreover, it is relatively straightforward to elicit and measure in a laboratory. However, ethical issues limit the kinds of threatening experiences that can be adapted to scientific investigation. Because the literature on fear and anxiety is vast, this chapter limits its scope to an affective neuroscience perspective that considers how fear signals are processed in the brain, with an emphasis on fear learning paradigms in healthy humans.

Defining Fear and Anxiety

Fear is a negatively valenced emotion elicited in response to an impending threat that motivates a defensive reaction to protect the organism. In humans, fear is accompanied by a subjective sense of apprehension or, in more intense situations, dread. Fear is typically associated with a specific elicitor. Although fear responses evolved in situations of imminent physical harm, such as predator–prey interactions, fear triggers in humans are often more psychological in nature. Regardless of the source of fear, a final common neural pathway is engaged to mobilize bodily resources in the face of threat (see the section "Defensive Motivational Systems"). Due to the high energy demands of defensive encounters, chronic fear states have profound deleterious effects on various systems of the body. Generally, fear responses subside relatively quickly upon termination of the threatening stimulus to allow the body to achieve a homeostatic state.

Anxiety is a state of unease about a distal, potentially negative outcome that is uncertain or unpredictable (Lake & LaBar, 2011). In contrast to fear, anxiety is longer lasting, is more future than present oriented, often has a less specific elicitor or terminator (Lang, Davis, & Ohman, 2000), and functionally prepares the organism to confront a threat—albeit reluctantly—rather than withdrawing from it (McNaughton & Corr, 2004). Fear can become anxiety if active coping mechanisms fail and the fear remains unresolved (e.g., when a specific source of threat in the environment is not identified). Nonetheless, fear is not a necessary antecedent to anxiety. Anxious states are maintained by a host of cognitive processes, including rumination, abstraction, risk assessment, mental time travel, and mental projection/simulation. In clinical studies, anxiety is quantified both as a dispositional trait measure and as an acute state measure.

Although fear and anxiety have different linguistic labels, the boundary between fear and anxiety is not clear-cut, as both emotions are elicited in the context of defensive motivation. Different theories abound regarding the relationship between these constructs and the varieties of their expression. Some anxiety theorists emphasize the role of appraisals (Beck, Emery, & Greenberg, 1985), whereas others emphasize information processing biases (Williams, Watts, MacLeod, & Mathews, 1997), biological factors (McNaughton & Corr, 2004), or motivational systems (Woody & Szechtman, 2011). The muddling of fear-related concepts has hampered progress in scientific understanding of the neural mechanisms of fear and anxiety and their clinical manifestation. For instance, in the development of anxiolytic drugs, divergent effects are often observed across different threat-related behavioral paradigms, complicating the interpretation of their efficacy (Blanchard, Yudko, Rodgers, & Blanchard, 1993; Panksepp, 1998). Blanchard and Blanchard (1988) have argued that rodent experimental approaches should converge with ethological approaches to more carefully delineate how emotions like fear and anxiety emerge from naturalistic situations that elicit various offensive and defensive behaviors. For the first time, the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed. [DSM-5]; American Psychiatric Association, 2013) has separated obsessive–compulsive disorder and posttraumatic stress disorder from other anxiety disorders based on conceptual, neurobiological, and symptomatic differences. Yet, the remaining grouping of disorders within the anxiety disorder umbrella, such as specific phobias and generalized anxiety disorder, may further benefit from teasing apart the relative contributions of fear versus anxiety. More theoretical work is needed to clarify the distinctions among these constructs and to guide empirical and clinical investigation.

Operationalizing Fear for Scientific Investigation

From a functional perspective, the emotion fear serves to mobilize bodily resources to protect the organism from an imminent threat. Threat anticipation spurs the reorganization of metabolic priorities such that digestive, sexual, and parasympathetic autonomic functions are temporarily suppressed while sympathetic arousal, muscular blood flow, and stress hormone release (via the hypothalamic–pituitary–adrenal axis) are increased. This diversion of resources facilitates action planning, defensive response execution, and reinforcement learning in the face of threat. Researchers quantify components of these physiological changes, such as the potentiation of the startle reflex, as dependent measures of fear reactivity. An advantage to this approach is that the measurements are relatively conserved across species, facilitating the development of animal models of fear.

Physiological responses constitute only one class of dependent measures of emotion; it is important to consider these responses relative to other facets, including subjective experience (in humans) and behavioral changes. Some clinical evidence suggests that physiological responses to trauma-related cues predict symptoms of posttraumatic stress disorder better than subjective distress measures or more general emotional reactivity indices (Pineles et al., 2013). However, physiologic measures often correlate only moderately with experiential ratings of fear in humans (Busscher, van Gerwen, Spinhoven, & de Geus, 2010), and other emotions besides fear elicit changes in the same dependent measures. Thus the sensitivity and specificity of these measures has been questioned by some researchers (Quigley & Barrett, 2014). Consequently, multiple dependent measures are important to collect, and it is always important to interpret the results from a given measure with respect to the task context.

Because fear evolved to help organisms manage physical threats, there are obvious ethical limitations to studying fear in the laboratory. In nonhuman animal studies, predator exposure tasks are typically arranged to maintain a distance where direct physical confrontation is prohibitive. In humans, threat paradigms that use noxious stimuli are adjusted in intensity so as to minimize physical pain (e.g., setting electric shock delivery to the tolerance of each participant). These modifications are necessary to conduct research ethically but limit the translation of results to real-world scenarios involving high-intense fear reactions. Other innate threat paradigms that do not involve punishers can circumvent some of these ethical issues, such as predator odor exposure, but these tasks are less translatable to human investigation. Virtual reality technologies are currently being explored as a methodological advance to simulate more realistic fearful experiences. For instance, virtual reality has proven effective in simulating fear of heights for evaluating treatment outcomes in acrophobic patients (Ressler et al., 2004) and as a basic research tool to study fear and avoidance learning using dynamic virtual predators (Huff et al., 2011; Mobbs et al., 2009).

Operationalizing Anxiety for Scientific Investigation

In contrast to fear paradigms, which use phasic threats to provoke a transient fear response, anxiety paradigms manipulate the unpredictability or uncertainty of aversive events to elicit a more sustained state of apprehensive anticipation. Because anxiety is more temporally oriented to the future than the present, anticipatory anxiety paradigms typically cue the participant to the relative likelihood or certainty that a future unpleasant event will occur. For example, participants in a threat-of-shock paradigm might receive a "threat" cue that a future shock is likely to occur in the immediate future, whereas a "safe" cue indicates that shock will not occur. In other tasks, participants see a clock that counts down to the time at which an unpleasant stimulus is likely to be delivered. Across these situations, anxiety is exacerbated by providing participants with no control over the delivery of the aversive stimulus (e.g., avoidance or escape behaviors cannot be executed). Other paradigms elicit anxiety incidentally by contextual manipulations that organisms find innately anxiety provoking. For rodents and other species, placement in an open field elicits anxiety because of the potential for exposure to dangers, such as predators, without safe havens for protection. In a similar vein, humans experience more anxiety in the dark than in the light due to compromises in visual system function that hinder the identification of potential sources of threat or escape routes (the reverse is true for nocturnal organisms, which exhibit more fear in the light). Thus, experimenters can move participants from light to dark locations or from exposed to protected environments to capitalize on innate contextual triggers of anxiety.

Dependent measures of anxiety are similar to those elicited by fear but they differ in a few respects. Due to its future time orientation, anxiety engages precautionary and risk-assessment behaviors, such as repetitive visual scanning for potential threats, more so than a full-blown fight-or-flight response. In addition, dependent measures of anxiety have more protracted time courses because they are less temporally linked to the presence of a threat. For example, researchers use spontaneous fluctuations in skin conductance during threat anticipation intervals as a dependent measure of anxiety, whereas they time-lock phasic skin conductance responses to conditioned or unconditioned threat cues as a dependent measure of fear. Waiting periods during threat anticipation yield additional measures of anxiety, such as habitual or periodic motor behaviors (pacing, nail-biting, jaw clenching). Finally, anxiety is sometimes accompanied by thoughts that mull over potential sources of action to cope with or prepare for a future threat; these cognitive processes can promote defensive approach behaviors toward a future threat rather than defensive withdrawal responses away from it, as in the case of fear. These differences between fear and anxiety measures are best understood as lying along a continuum of defensive response repertoires, as described in the section "Defensive Motivational Systems."

Defensive Motivational Systems

Both fear and anxiety emerged within the evolutionary context of defensive encounters to promote survival. Thus, understanding how defensive motivation circuits are organized, even in less advanced organisms, can lead to important insights into these emotions (LeDoux, 2012). An interplay of aggression and fear manifests during defensive battles that creates opposing tendencies to fight or flee the situation. Activation of fear in these contexts confers several benefits, including (1) it promotes threat detection by motivating perceptual vigilance; (2) it promotes more flexibility in species-typical response repertoires by assessing routes for action and weighing response options given the details of the eliciting context (e.g., flight if danger is avoidable vs. freezing if unavoidable); (3) it promotes action preparation—particularly those related to withdrawal, avoidance, or escape—by redistributing metabolic resources; and (4) it promotes learning by engaging reinforcement circuits and memory consolidation for the episode. For more remote threats, anxiety serves similar functions, although anxious states prepare energy supply mechanisms but do not fully engage them as they are not immediately needed (Woody & Szechtman, 2011), and anxiety nudges the organism defensively toward approaching threats (as when test anxiety prompts studying behavior; McNaughton & Corr, 2004).

The neural organization of the defensive motivational system is organized in a hierarchical series of cortico–limbic–brainstem structures with strong connections to the autonomic nervous system (Figure 43.1). This system is organized primarily according to defensive distance (threat imminence), shifting from parasympathetic to sym-

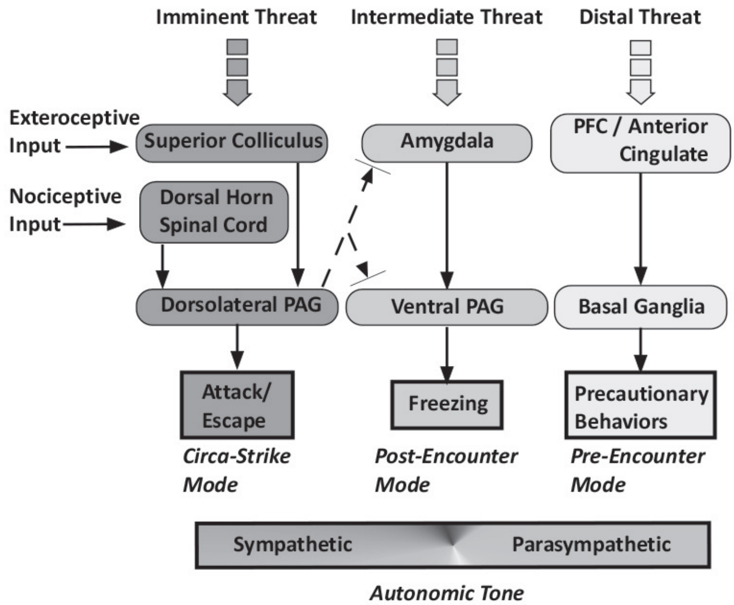

FIGURE 43.1. Motivational systems for defensive avoidance. Defensive motivation is organized according to threat imminence. For distal threats (preencounter mode), prefrontal cortex (PFC) and anterior cingulate control systems engage motor regions to execute precautionary behaviors. Once a threat is detected (postencounter mode), the amygdala evaluates sensory input and engages freezing or flight behavior according to contextual factors. For unavoidable threats (circa-strike mode), physical contact and nociceptive inputs are integrated in the dorsolateral periaqueductal gray (PAG) to coordinate behavioral attack or escape and to inhibit freezing (dashed lines). With increasing threat imminence, autonomic activity shifts from parasympathetic to sympathetic control.

pathetic autonomic tone as the threat encroaches closer in time and space. In addition, there are some specializations according to defensive direction (defensive avoidance vs. defensive approach; McNaughton & Corr, 2004) and defensive experience (for innate vs. learned threats; LeDoux, 2012). According to the tripartite model of Fanselow (1994), distal threats, such as entering an area where a potential predator lurks, prompt a *preencounter defensive mode* that reorganizes routine behaviors like meal patterns and promotes precautionary behaviors and appraisals. The neural structures enacting these effects are not well understood but likely include ventral frontal and anterior cingulate regions that monitor conflict, represent goals, and control limbic and hypothalamic-mediated autonomic functions (McNaughton & Corr, 2004).

After a predator is detected in the current environment, the organism enters a *postencounter defensive mode* that promotes freezing and potentiates startle reflexes, along with a host of autonomic changes. The amygdala coordinates these responses by targeting specific downstream structures: freezing responses in the ventral periaqueductal gray; startle reflex potentiation in the nucleus reticularis pontis caudalis; and autonomic functions in hypothalamic and dorsal medullary nuclei, such as the parabrachial nucleus for respiratory panting and the lateral hypothalamus for sympathetic activation (increased skin conductance, blood pressure, pupillary dilation, etc.). In addition, the amygdala targets basal forebrain and brainstem sites for widespread neuromodulation of arousal and vigilance (e.g., ventral tegmental area for dopamine release, locus coeruleus for norepinephrine release, and the mesopontine tegmentum and nucleus basalis of Meynert for acetylcholine release). Imminent threats, as when predator contact is inevitable, prompt a *circa-strike defensive mode* that involves threat displays, attack, and escape behaviors mediated by subcortical structures, most prominently the dorsal periaqueductal gray.

Unlike defensive avoidance, defensive approach is less well studied but is more associated with anxiety than with fear. McNaughton (Gray & McNaughton, 2000; McNaughton & Corr, 2004) hypothesizes that defensive approach involves a dorsal corticolimbic stream that links the dorsal prefrontal cortex and posterior cingulate with the septo-hippocampal system and cortico–striatal–thalamic loops for response execution. This system mediates behavioral inhibition in response to conflicting response tendencies. As with defensive avoidance, this network is organized according to defensive distance such that remote threats engage prefrontal and cingulate regions for conflict resolution mechanisms, with intermediate levels of threat engaging the septo-hippocampal system for cognitive aspects of anxiety, including negatively valenced information processing biases and exploratory risk-assessment behaviors, and the amygdala for the coordination of arousal responses. Finally, immediate threats engage circuitry in the medial hypothalamus and periaqueductal gray to generate simple behavioral reactions such as defensive quiescence. (See Davis, Walker, Miles, & Grillon, 2010, for details on neuropharmacologic research methods in fear and anxiety across humans and rodents.)

Perceptual and Attentional Processing of Threats and Fear Indicators

The failure to identify sources of threat in the environment has dire behavioral consequences. Because of the high cost of false negatives to the individual or group, brain mechanisms evolved to monitor for and react to potential threats in the environment, communicate the existence of threat to others, engage coping strategies, and learn from threatening experiences. The first step in this defensive cascade is to assess exteroceptive input for the presence of threats. Numerous behavioral studies show that threatening stimuli achieve prioritization in perception and attention. For instance, threatening stimuli exhibit faster reaction times in target detection tasks, as when a snake or spider is present among an array of fruits or plants (Flykt, 2005; Flykt & Caldara, 2006; Ohman, Flykt, & Esteves, 2001), when an angry face is present among a crowd of happy or neutral faces (Mather & Knight, 2006; Ohman, Lundqvist, & Esteves, 2001), or when a target is embedded in a fear-conditioned stimulus (Notebaert, Crombez, Van Damme, De Houwer, & Theeuwes, 2011). In some cases, these effects are stronger for threat stimuli than for those that elicit or symbolize other emotions—for example, detecting an angry face among a crowd of neutral faces has more advantages than detecting a sad or happy face (Mather & Knight, 2006). Moreover, when task-irrelevant threat stimuli are included among distractors during a neutral visual search task, reaction times are slowed, implicating a reflexive attentional effect that hinders goal-directed attentional processing (Miltner, Kriechel, Hecht, Trippe, & Weiss, 2004). Similar effects of incidental anxiety have been reported, with performance on a dual-target search task being negatively impacted by anticipatory anxiety induced by a threat-of-shock manipulation (Cain, Dunsmoor, LaBar, & Mitroff, 2011).

Both subcortical and cortical pathways contribute to threat-detection processes, with relative specializations for preattentive versus attentive modes of stimulus processing. Preattentive modes include both situations of *sensory unawareness*, when a stimulus is not consciously perceived due to its brevity or weak energy—and *attentional unawareness*, when a stimulus is readily available for conscious perception but is not selected for attentional resources (Tamietto & De Gelder, 2010). Sensory unawareness is tested using subliminal presentations of stimuli via backward masking or binocular rivalry paradigms. Backward masking involves presenting a stimulus near the threshold for perceptual awareness (for visual stimuli in humans, typically around 17 milliseconds), followed immediately by another image that masks lingering stimulus processing. Binocular rivalry achieves similar effects by presenting different stimuli to each eye simultaneously, with only one image reaching conscious perception at any point in time. Attentional unawareness is tested using various paradigms that present multiple stimuli across space or time with sufficient duration and stimulus energy to allow each one to be registered by the sensory system. In this case, attentional allocation operates to select only a subset of these stimuli to enter into conscious awareness due to attentional capacity limitations and/or task demands. Across all preattentive mode tasks, the threat potential of the stimulus is manipulated to determine whether threatening stimuli receive preferential prioritization of resources over neutral stimuli (or other kinds of emotional stimuli) in the unaware condition.

Subcortical routes of sensory input to the limbic forebrain regions, particularly the amygdala, are thought to be critical for preattentive threat detection (see Pessoa & Adolphs, 2010, for an alternative view). The lateral amygdala serves as the primary sensory gateway to the amygdala, with the exception of olfaction, which targets the cortical and medial nuclei of the amygdala via evolutionarily older pathways (Aggleton & Mishkin, 1986). Auditory input from the medial geniculate and posterior intralaminar nuclei of the thalamus projects to the lateral and central nuclei of the amygdala. Visual input from the pulvinar and lateral geniculate nuclei of the thalamus also project to the lateral nucleus of the amygdala. Interestingly, a portion of this visual input to the amygdala arises via a secondary visual pathway from the retina to the superior colliculus that does not terminate in the primary visual cortex of the occipital lobe. This magnocellular, or extrageniculate, pathway derives primarily from retinal ganglion cells that have large, nonfoveal receptive fields and high motion sensitivity but low visual acuity and color sensitivity. This pathway may have evolved principally for the detection of moving predators in peripheral vision and functioned to reflexively orient attention to the spatial location of possible threats (Tomalski, Johnson, & Csibra, 2009). Later in evolution the functional role of this circuit likely expanded to include other aspects of visual and socioemotional processing beyond threat assessment (Garrido, Barnes, Sahani, & Dolan, 2012).

Functional imaging studies in humans have provided some evidence for a role of these subcortical structures in preattentive threat detection. Subliminally presented facial expressions of fear elicit activity in the amygdala, pulvinar, and superior colliculus (Liddell et al., 2005; Morris, Ohman, & Dolan, 1999), and the functional connectivity among these structures is more positively correlated during subliminal than supraliminal presentations (Williams et al., 2006). Although functional connectivity does not necessarily imply direct anatomical connectivity, recent diffusion tensor imaging studies have validated the existence of this subcortical circuit to the amygdala in the human brain (Tamietto, Pullens, De Gelder, Weiskrantz, & Goebel, 2012). Subliminal images of the eye region of fearful faces alone are sufficient to engage amygdala responses (Whalen et al., 2004). The expression of fear widens the eye aperture, revealing a larger sclera and exposed iris. These physiognomic changes have important perceptual effects, as they increase visual acuity and make the direction of eye gaze more visible to others, thereby facilitating the social communication of threat (Lee, Susskind, & Anderson, 2013). Amygdala activation extends to unseen fearful facial expressions in binocular rivalry studies (Williams, Morris, McGlone, Abbott, & Mattingley, 2004), as well as other subliminal threat signals, including images of snakes and spiders (Carlsson et al., 2004), which also evoke autonomic responses (Ohman & Soares, 1994). Although fear is the most widely studied emotion in these tasks, there is evidence that the amygdala also responds to subliminal facial expressions of some other emotions (Killgore & Yurgelun-Todd, 2004).

Studies of patients who are cortically blind with damage to the primary visual pathways provide a unique opportunity to examine nonconscious aspects of fear perception. When faces or body gestures are presented in the blind portion of their visual field (called the "scotoma"), the patients do not consciously perceive anything but can accurately guess (better than chance) whether the stimulus expresses fear or other emotions, and these stimuli elicit rapid, appropriate changes in pupillary reflexes and facial expression (Tamietto et al., 2009). Moreover, visual stimuli presented in the scotoma elicit fear-potentiated startle responses following Pavlovian conditioning, despite not being consciously seen (Hamm et al., 2003). Such reports of *affective blindsight* are associated with activation in the subcortical circuits described above (Morris, de Gelder, Weiskrantz, & Dolan, 2001; Pegna, Khateb, Lazeyras, & Seghier, 2005).

Attentional unawareness in threat detection has been studied using numerous paradigms that present fearful stimuli as task-irrelevant distractors superimposed onto other tasks. Despite being unattended, fearful faces nonetheless enhance processing along the ventral visual pathway, including the fusiform gyrus and amygdala (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Vuilleumier, Armony, Driver, & Dolan, 2001), and these effects are stronger in trait-anxious individuals (Bishop, Duncan, & Lawrence, 2004). In an important finding, Vuilleumier and colleagues (Vuilleumier, Richardson, Armony, Driver, & Dolan, 2004) showed that the fusiform modulation of both unattended and attended fearful faces was reduced in patients with amygdala damage due to epilepsy, implicating an amygdala-dependent visual feedback pathway. This pathway, which aligns with amygdala feedback projections described in the nonhuman primate (Amaral & Price, 1984), was subsequently identified using diffusion tensor imaging in humans (Gschwind, Pourtois, Schwartz, Van de Ville, & Vuilleumier, 2012). It may function to bias processing in relevant portions of the visual cortex for extracting perceptual details of emotionally salient stimuli, including high-frequency information important for categorizing fearful facial expressions (Smith & Schyns, 2009).

Studies of patients with neglect syndrome also show some ability of threatening and other affective stimuli to reflexively grab attention in the neglected (contralateral) hemifield. These patients typically have damage to components of the attentional control system in the frontal and/or parietal cortex in the right hemisphere. Under competitive conditions in which sensory stimuli are presented to both hemispheres, the patients tend to neglect items presented to the left (contralesional) field. However, if the stimuli presented in the neglected field contain spiders, fearful body gestures, fear-conditioned stimuli, or emotional facial expressions, their detection is facilitated relative to neutral control stimuli (Dominguez-Borras, Saj, Armony, & Vuilleumier, 2012). Functional magnetic resonance imaging (fMRI) studies of these patients indicate that emotional stimuli detected in the contralesional field are processed in the superior colliculus–pulvinar–amygdala circuit described above (Morris et al., 2001; Pegna et al., 2005). A similar circuit was activated in an experimental model of blindsight in which visual cortex function was transiently disrupted using transcranial magnetic stimulation (Ro, Shelton, Lee, & Chang, 2004).

Collectively, these results implicate a dissociation between the frontoparietal attentional control system that provides a general means for selecting sensory input to guide goal-directed behavior and an amygdala-based system that prioritizes the attentional processing of emotional (Vuilleumier, 2005) and/or motivational (Lang & Bradley, 2010) stimuli. In some cases, these streams of processing act iteratively in a flexible way to shuttle processing resources between task-relevant goals and processing of irrelevant but emotionally salient stimuli (Yamasaki, LaBar, & McCarthy, 2002). At other times, the influence of these two streams is additive, and information is integrated across them (Fichtenholtz et al., 2004; Vuilleumier et al., 2001). These attentional–emotional interactions are mediated by hubs in the anterior cingulate cortex, orbitofrontal cortex, and insula that are bidirectionally connected to the two processing streams (Fichtenholtz & LaBar, 2012). The hubs are hypothesized to maintain a balance between motivational/affective processing and executive/attentional control functions to support healthy mood regulation (Mayberg, 1997). Of course, the amygdala itself can even become a target of attentional control, as demonstrated by studies of emotion regulation (Ochsner, Silvers, & Buhle, 2012), including the regulation of threat (Schiller & Delgado, 2010; see the section "Fear Regulation").

The Social Communication of Threat

Once a threat is detected in the environment, defensive vocalizations provide important signaling information regarding its presence, location, and quality. During defensive encounters, alarm cries serve dual roles: as part of a defensive display to ward off an approaching predator and to alert conspecifics to the nature or intensity of the threat (it is debated whether such cries might also signal the state of distress of the communicator). These functions can be disentangled by analyzing the spectral frequency and behavioral context of the alarm calls in ethological studies. Both wild black rats and laboratory rats emit sonic vocalizations in the presence of a predator, such as a cat, that increase with defensive proximity (Litvin, Blanchard, & Blanchard, 2007). These vocalizations do not depend on the presence of conspecifics and thus function solely as part of the circa-strike defensive display. By contrast, defensive ultrasonic cries in the 22-kHz range are emitted only in the presence of conspecifics. These cries elicit behavioral quiescence in observer rats (Brudzynski & Chiu, 1995) and they alter the frequency of response calls in rat pups (Brudzynski, Kehoe, & Callahan, 1999). Such calls serve as effective conditioned cues in fear-conditioning studies (Lindquist, Jarrard, & Brown, 2004), and central amygdala lesions block the expression of these calls during fear conditioning (Choi & Brown, 2003).

Naturalistic observations indicate that the signaling properties of defensive calls can take different forms. African elephants emit different vocal rumbles to signal the presence of local tribesmen versus a swarm of bees (Soltis, King, Douglas-Hamilton, Vollrath, & Savage, 2014). Recorder playback of these vocalizations elicit different behaviors in listener elephants, with bee rumbles selectively provoking head shaking, an adaptive deterrent to invading swarms. Across both call types, threat intensity increases the fundamental frequency of the vocalization, which results in accelerated vigilance and flight behavior in listener elephants. Thus, information about both the quality and intensity of the threat can be discerned from acoustic analysis of some (but not all) calls, and variations in the calls can yield behavioral differences in the defensive responses of the listener, implicating communicative value to the social group. Many other species exhibit similar effects. For instance, vervet monkey defensive calls indicate the presence of different predators and yield appropriate defensive behaviors in listeners: downward glances to snake calls, upward glances to eagle calls, and running to leopard calls (Seyfarth, Cheney, & Marler, 1980). In blue monkeys, not only does the defensive call discriminate the nature of the predator (eagles vs. leopards) but in some cases it also takes into consideration the level of danger to the social group; response calls to eagle shrieks grow more frequent if the social group is closer to the source of the shriek than farther away, regardless of the position of the sentinel (calling) monkey (Papworth, Bose, Barker, Schel, & Zuberbuhler, 2008).

Mammalian vocalizations are mediated by dual motor pathways (Jurgens, 2009). A limbic pathway originates from the motor sector of the anterior cingulate gyrus to the periaqueductal gray to the reticular formation in the pons and medulla, where phonatory motorneurons are targeted. The anterior cingulate cortex initiates voluntary vocalizations, and stimulation of brainstem components of this circuit is sufficient for the production of innate vocalizations. Some populations of neurons in this circuit, as well as the amygdala and auditory cortex, are tuned to the frequency of defense calls (Fanselow, 1994; Peterson & Wenstrup, 2012). A parallel, primary motor pathway produces fine, articulatory movements of the mouth and tongue, and integrates the motor cortex with feedback circuits in the basal ganglia and cerebellum for learned vocalization patterns. These pathways converge in the reticular formation. Damage to the primary motor pathway will leave affective gutteral utterances intact, a dissociation also observed for motor pathways controlling facial expression (Borod, 1993).

In humans, the social communication of threats via facial expression cues has been better studied than vocal expression cues. However, facial signals of fear and anger only operate over relatively short distances (Smith & Schyns, 2009), and thus vocal affect extends the range of defensive communication. Nonverbal defensive displays take the form of shrieks, cries, and yelps. These and other gutteral vocalizations evoke responses in the amygdala, insula, and belt regions of the auditory cortex in listeners (De Lucia, Clarke, & Murray, 2010; Fruhholz & Grandjean, 2013; Sander & Scheich, 2005). Of course, human language provides a more flexible, symbolic route for the communication of threat. These threat warnings can be quite abstract, as evidenced by the announcement of "color codes" to warn air travelers of terrorist threat levels in U.S. airports following September 11, 2001.

In order for facial or vocal expression cues to be maximally effective, they must be combined with each other, along with other forms of nonverbal communication, such as eye gaze and body gesture, to indicate the source of the threat. Vocal and facial indicators of fear are integrated in the amygdala, fusiform gyrus, and superior/middle temporal gyrus (Dolan, Morris, & de Gelder, 2001; Ethofer et al., 2006; Phillips et al., 1998). Responses in the amygdala and fusiform are stronger when fear signals are congruent between sensory channels, which enhances the overall perception of fear. Similar effects have been reported for gaze–expression combinations—when the combinations of eye-gaze direction and facial expression signal a clear threat, amygdala responses are enhanced for short stimulus durations that emphasize reflexive processing; however, with longer durations these effects reverse, which may relate to a separate role for the amygdala in resolving ambiguity (Adams et al., 2012; Graham & LaBar, 2012).

Experiential Fear and Anxiety

Whereas the neural substrates underlying perceptual and expressive components of fear are becoming better characterized, the central representation of subjective fear and anxiety states remain poorly understood. Initial insights into limbic contributions to experiential fear states come from intracranial stimulation studies of neurological patients with implanted electrodes for the surgical monitoring of epilepsy. Early studies using small numbers of patients showed that fear and anxiety were commonly felt upon initiation of amygdala stimulation (Chapman et al., 1954). Later, more controlled studies using larger numbers of patients confirmed these findings; fear was the most commonly reported emotion in response to amygdala stimulation, often accompanied by changes in autonomic function, visceral reactivity, perceptual hallucinations, memory retrieval, and/or a feeling of déjà vu (Gloor, Olivier, Quesney, Andermann,

& Horowitz, 1982; Halgren, Walter, Cherlow, & Crandall, 1978). Interpretation of these studies, however, is complicated by the anecdotal nature of the reports and the presence of epilepsy in the patients (although some results were obtained in healthy tissue that did not encompass the epileptic focus or seizure after-discharges).

Studies of emotional experience in patients with amygdala-lesions due to epilepsy or other congenital diseases have yielded mixed results. Anderson and Phelps (2002) reported intact subjective emotions, as assessed through self-report measures and a daily diary study, in postsurgical patients with medial temporal lobe epilepsy, including a patient with bilateral amygdala damage. However, Feinstein and colleagues (Feinstein, Adolphs, Damasio, & Tranel, 2011) found a selective, impoverished experience and expression of fear in a case study of a patient (S. M.) with bilateral amygdala damage. These effects were noted in S. M.'s self-report questionnaires and field sampling of life experiences, including exposure to several fear-inducing situations such as holding live snakes and spiders, viewing horror films, and going to a haunted house. By contrast, S. M. and two other patients with bilateral amygdala damage exhibited panic attacks and escape responses to carbon dioxide inhalation, which was accompanied by a subjective feeling of panic and fear (Feinstein et al., 2013). The latter finding is consistent with evolutionary models of a panic-distress system that is partially separable from fear and triggered more by interoceptive sources of sensory input (Panksepp, 1998).

Neuroimaging studies have yielded similarly mixed findings regarding central representations of fear. Several meta-analyses of emotional fMRI studies have been conducted, with the most consistent finding linking the amygdala with fear (Murphy, Nimmo-Smith, & Lawrence, 2003; Phan, Wager, Taylor, & Liberzon, 2002; but see K. A. Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012). However, a direct comparison of perceptual versus experiential emotion tasks showed that amygdala activity is predominantly driven by tasks emphasizing perception rather than changes in subjective experience (Wager et al., 2008). Researchers are beginning to take a new look into this question by applying multivariate statistical methods to discern how information in various brain regions and autonomic indices contributes to the classification of different emotional states (Kragel & LaBar, 2014).

Conditioning Models of Fear Learning

In order for fear to be maximally adaptive as an emotion, it must operate not only in the moment of immediate threat to prepare defensive reactions, but it must also facilitate learning from experience so that harbingers of future threats are avoided. Pavlovian fear conditioning paradigms provide an exemplary model system for characterizing how sensory cues and environmental contexts gain access to defensive networks through their association to threatening events. In a typical fear conditioning experiment, an innocuous cue, such as a tone or light (the *conditioned stimulus* [CS]), is established as a reliable predictor of a subsequent aversive event, such as a shock (the *unconditioned stimulus* [US]), that innately provokes defensive reactions. Fear learning is demonstrated by a change in the behavioral or physiological response to the CS that is indicative of fear, such as potentiated startle reflexes (see the section "Operationalizing Fear for Scientific Investigation"). This form of learning can be quite rapid, with a highly intense US yielding fear conditioning in a single training trial. A variant of cued fear conditioning called *trace conditioning* involves separating the offset of the CS and onset of the US by a brief temporal interval (a memory "trace"). Trace conditioning places additional demands on timing, attentional, and working-memory mechanisms and is mediated by partially distinct systems in the brain (Knight, Cheng, Smith, Stein, & Helmstetter, 2004). Conditioned cues, in turn, can be used to condition fear associations to other novel cues (second-order conditioning), creating a hierarchy of fear associations. These associations can even be learned vicariously, by observing others undergo fear conditioning procedures, or through social instruction, by verbally telling others about the threat value of a CS (Olsson & Phelps, 2004). Therefore, conditioned fear learning ranges from quite simple, nonconscious reflex potentiation to higher-order forms that involve complex cognitive processes or social modeling.

The spatial context in which conditioning occurs is also associated with aversive reinforcers. A return to the context, even without the CS being present, yields similar fear responses ("contextual fear"). Because phasic CSs are the most reliable predictor of the US in these studies, contextual fear is typically weaker than cued fear, and it develops later in time (LaBar & LeDoux, 1996). However, a variant of fear conditioning involves random presentation of shocks in a context with no phasic CS at all. In this case, the context is the most reliable predictor of the shock and yields robust responses (Ameli, Ip, & Grillon, 2001). This form of contextual fear is often used as a model of anxiety, as it places the organism in a state of anticipation of uncued and unpredictable aversive events (see the section "Operationalizing Anxiety for Scientific Investigation"). Because this state is driven by a specific environment in the experimental paradigms, it is most applicable to certain anxiety disorders that are exacerbated in particular situational contexts (as in some cases of social anxiety, test anxiety, or performance anxiety). Contextual fear is commonly reported in individuals who were robbed or assaulted. These aversive experiences often lead to subsequent avoidance of the location of the incident, or a return of fear and perceptual vigilance when reentering the location.

Although nearly any kind of stimulus can serve as a CS, which indicates the broad flexibility of fear learning, some stimuli and CS–US combinations are relatively more effective than others. Biological preparedness theory provides an evolutionary explanation for some of these effects (Ohman & Mineka, 2001). In particular, threat stimuli that are evolutionarily ingrained, such as snakes and spiders, may have special meaning in defensive contexts. Snakes and spiders are among the most common sources of specific phobias. Snakes and spiders can be fear conditioned subliminally, along with other biologically prepared stimuli, such as threatening or fearful faces (Ohman & Soares, 1993, 1994). These stimuli have prioritized routes of access to fear-learning systems, and the fear responses to them are harder to extinguish once they are acquired. Whether these evolutionary pressures have led to a dedicated fear module in the brain remains debated. As discussed below, cognitive processes can modulate fear learning, which invalidates the impenetrability criterion for such a module (Ohman & Mineka, 2001), at least for conscious aspects of fear processing.

Medial Temporal Lobe Contributions to Conditioned Fear Learning

Across species, the amygdala has emerged as a critical structure for both the acquisition and expression of conditioned fear learning (LaBar & LeDoux, 2002). Sensory information representing the CS and US reach the lateral amygdala through parallel afferent pathways: a subcortical route via direct thalamic connections (see the section "Perceptual and Attentional Processing of Threats and Fear Indicators") and cortical routes via each primary sensory pathway (Romanski & LeDoux, 1992; Figure 43.2). CS and US information converge onto common neurons in the lateral amygdala, providing a cellular means for integration of sensory information and synaptic plasticity underlying associative learning (Romanski, Clugnet, Bordi, & LeDoux, 1993). For simple CS–US associations, electrophysiological changes in the lateral amygdala occur quickly (within tens of milliseconds of CS onset), implicating a role for rapid processing of conditioned threats along the subcortical processing route (Quirk, Repa, & LeDoux, 1995). However, for more complex associations, the cortical pathway provides a necessary input. Conditioned-induced changes in amygdala signaling, in turn, modulate synaptic plasticity in other regions, such as the thalamus, anterior cingulate cortex, and sensory cortex (Quirk, Armony, & LeDoux, 1997; Talk, Kashef, & Gabriel, 2004). One function of these changes is to alter the profile of sensory tuning curves to favor features of the CS, such as the pitch of an auditory CS; neurons that weakly responded to the frequency of the CS respond more vigorously to it after a fear learning experience (Edeline & Weinberger, 1992). In this way, fear conditioning mechanisms retune sensory input to facilitate detection of similar threat warnings in the future.

Once processed by the lateral amygdala, information about conditioned cues feeds forward through direct and indirect projections to the central nucleus. The central nucleus also undergoes conditioning-induced plasticity and orchestrates the engagement of appropriate defensive responses (Wilensky, Schafe, Kristensen, & LeDoux, 2006). Disconnection of a specific central nucleus efferent target yields selective deficits in the expression of fear conditioning while leaving other dependent measures intact. For instance, disrupting the connections to the ventral periaqueductal gray area eliminate freezing (conditioned immobility) but do not impact changes in fear-induced autonomic outflow or startle reflex potentiation. Because lateral or central nucleus lesions yield global deficits, these regions are thought to provide the minimum core circuitry necessary for fear conditioning to occur (Nader, Majidishad, Amorapanth, & LeDoux, 2001).

Information about environmental contexts associated with fear conditioning experiences enters the basal and accessory basal amygdala from the

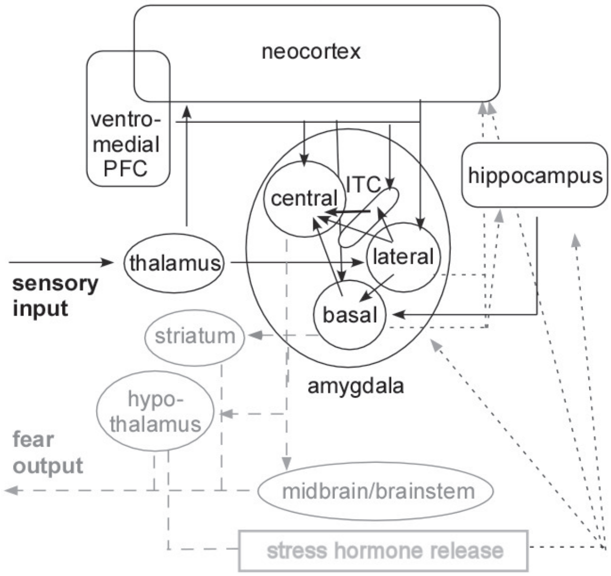

FIGURE 43.2. Processing pathways for fear conditioning. Sensory information arising from subcortical and cortical inputs into the amygdala (solid black lines) are integrated for conditioned fear learning. Within the amygdala, threat cues are processed from the lateral nucleus to the central nucleus directly and indirectly via the basal and intercalated nuclear cells (ITC). Contextual cue information arising from hippocampal input enters the circuit primarily via the basal nucleus. The central nucleus coordinates defensive reactions (light gray dashed lines) by targeting various brainstem structures responsible for engaging specific somatomotor and autonomic functions, such as reflex startle potentiation, breathing and heart rate changes, and sweat gland activity. Central nucleus outputs also activate the hypothalamic–pituitary–adrenal stress axis, and basal nucleus outputs to the striatum initiate coping strategies. Feedback pathways (dark gray dotted lines) from the basolateral nuclei to the hippocampus and neocortex, as well as more diffuse stress hormone release, serve to consolidate the fear memory and tune sensory representations to features of the threatening cues. Consolidation and recall of fear extinction involves regulatory input from the ventromedial prefrontal cortex (PFC).

hippocampus and is projected forward to the central nucleus. The hippocampal–amygdala pathway is another site of synaptic plasticity that is important for contextual, but not cued, fear conditioning (Maren & Fanselow, 1995). Therefore, parallel pathways to the amygdala are involved in different aspects of fear learning, and these routes merge in the central nucleus as a final common pathway for coordinating defensive reactions. In contrast to the central nucleus efferent projections, the basolateral nuclear complex sends widespread projections to the neocortex and basal ganglia, which are thought to be important for initiating coping strategies, for balancing threat processing with other behavioral priorities, and for consolidating the memory for the fear learning episode.

The role of the amygdala in fear conditioning has been validated and extended in human fear conditioning investigations. Neurological patients with amygdala lesions are consistently impaired in acquiring conditioned fear (Bechara et al., 1995; Glascher & Adolphs, 2003; LaBar, LeDoux, Spencer, & Phelps, 1995; Phelps et al., 1998; Weike et al., 2005). These deficits occur despite intact awareness of the CS–US contingency (but see Coppens, Spruyt, Vandenbulcke, Van Paesschen, & Vansteenwegen, 2009) and intact defensive reactions to innate, unconditioned threats. The impairments in these patients span from simple subliminal and supraliminal forms of fear conditioning to more complex paradigms involving discrimination among multiple cues.

The lesions in these patients often encompass surrounding tissue in the medial temporal lobe, which can complicate interpretation of results (Ahs, Frans, Tibblin, Kumlien, & Fredrikson, 2010). Therefore, it is important that neuroimaging studies with finer anatomic resolution have corroborated a link between amygdala activation and conditioned fear learning in healthy subjects (reviewed in Sehlmeyer et al., 2009). Amygdala activation tends to be stronger at the beginning of acquisition training when the emotional contingencies are initially being learned (Buchel, Morris, Dolan, & Friston, 1998; LaBar, Gatenby, Gore, LeDoux, & Phelps, 1998), although pattern classification of high-resolution fMRI reveals conditioning effects in the basolateral and centromedial amygdala that are maintained or even increased over training trials (Bach, Weiskopf, & Dolan, 2011). Amygdala activation is tightly coupled with the expression of conditioned fear, as measured either as an individual difference variable or as within-subjects correlations with concurrent startle (van Well, Visser, Scholte, & Kindt, 2012) or skin conductance responses (SCRs; Buchel et al., 1998; Cheng, Knight, Smith, Stein, & Helmstetter, 2003; Furmark, Fischer, Wik, Larsson, & Fredrikson, 1997; LaBar et al., 1998). Compared with supraliminal forms of conditioning, subliminal fear conditioning evokes tighter functional coupling between the amygdala and subcortical processing circuits (Morris et al., 1999) and may rely on interoceptive information processing to a greater extent (Katkin, Wiens, & Ohman, 2001). As with the patient studies, neuroimaging results have extended the amygdala's role to more complex forms of fear conditioning, including trace fear conditioning (Knight et al., 2004), contextual fear conditioning (Alvarez, Biggs, Chen, Pine, & Grillon, 2008), and socially instructed fear learning (Phelps et al., 2001).

The hippocampus, by contrast, contributes selectively to human fear conditioning tasks that place demands on spatial and temporal processing, such as trace conditioning (Knight et al., 2004) and contextual conditioning (Alvarez et al., 2008) paradigms. As with the amygdala findings, these results are consistent with the nonhuman animal literature, implicating a conservation of function across species. Interestingly, patients with selective hippocampal lesions show the opposite pattern to patients with amygdala lesions with regard to implicit and explicit measures of fear learning. Whereas bilateral amygdala damage manifests as impaired fear conditioning (measured physiologically) but intact explicit knowledge of the stimulus contingencies, bilateral hippocampal damage manifests as intact fear conditioning but poor explicit memory for the conditioning episode (Bechara et al., 1995; LaBar & Phelps, 2005). In a famous early anecdote, the Swiss neurologist Claperède (1911/1995) noted that a patient with Korsakoff's amnesia, whom he had previously pricked with a pin hidden in his hand, subsequently avoided shaking hands with him, despite having no recollection of the prior threatening episode. These kinds of dissociations have provided further support for the idea of multiple memory systems in the brain. However, in healthy subjects explicit knowledge and conditioning processes likely interact, given the extensive connectivity between the amygdala and adjacent sectors of the medial temporal lobe, and thus the two kinds of learning mechanisms may normally operate iteratively or interactively (LaBar & Disterhoft, 1998; Lovibond & Shanks, 2002).

Fear Generalization

In his seminal discoveries, Pavlov (1927) originally noticed that the conditioned value of a stimulus can transfer to other stimuli that resemble the CS but have never been paired with a reinforcer. The most famous historic example of fear generalization in humans is the study of Little Albert. John Watson and Rosalie Rayner (1920) conditioned an 11-month-old infant to the sight of a white rat by pairing it with the delivery of a loud-noise US. After a few training trials, Little Albert displayed distress and avoidance responses to the rat, which generalized to include other furry objects, including other animals, fur coats, and a Santa Claus beard. The generalized responses lasted up until the last time Little Albert was tested 30 days later. Although this study was fraught with ethical and scientific integrity issues, it ignited an interest in fear generalization and conditioning-based accounts of affective disorders.

Fear generalization can occur across perceptual and conceptual attributes of cues, as well as across environmental contexts. Perceptual forms of cue generalization include mechanisms based on feature similarity, physical intensity, and emotional intensity. These different forms of perceptual generalization can be distinguished by the shape of the generalization gradient when a perceptual attribute of the CS is varied along a continuum, such as brightness or hue. Whereas feature-based generalization exhibits symmetric generalization functions, with fear indices peaking near the CS value and decreasing on opposite sides of the continuum, physical and emotional intensity gradients exhibit asymmetric generalization functions, with fear indices selectively increasing toward the end of the continuum with the most intense values (Dunsmoor & LaBar, 2013; Dunsmoor, Mitroff, & LaBar, 2009; Vervliet, Baeyens, Van den Bergh, & Hermans, 2013). For example, when a 1,000 Hz tone is used as a CS, conditioned fear responses generalize in a symmetric gradient to tones that are both higher and lower in frequency than 1,000 Hz (e.g., moderate fear to 800 and 1,200 Hz tones and low fear to 400 and 1,600 Hz tones). By contrast, fear selectively generalizes to tones that are louder but not softer than the CS (an asymmetric physical intensity gradient). Fear generalization may also be guided by conceptual knowledge, even when the generalized stimuli bear little physical resemblance to the CS. For instance, conditioned fear transfers more readily to items that are semantically related to a CS than those that are not (Dunsmoor, White, & LaBar, 2011), or to other exemplars from the same superordinate category as the CS, as in natural object categories (Dunsmoor, Martin, & LaBar, 2012). These generalization mechanisms extend beyond classical fear conditioning to include operant forms of conditioning and reward learning.

Despite the long history of generalization in behaviorist traditions, only recently have researchers begun to unravel the brain mechanisms mediating fear generalization. Initial neuroimaging results indicate that brain regions that contribute to the acquisition of conditioned fear also mediate the generalization of conditioned fear responses. Generalization to faces that vary along a continuum of fearful expression intensity engages the amygdala and insula, whose hemodynamic response amplitude correlates with physiological indices of fear to the generalized face stimuli, as well as the thalamus and brainstem (Dunsmoor, Prince, Murty, Kragel, & LaBar, 2011). Generalization to these fearful expressions also induces enhanced functional coupling between the amygdala and face-processing regions of the fusiform gyrus. The dorsal frontoparietal and cingulate regions are activated to the offset of the generalized faces at the point where the US appeared during the initial learning. This pattern is suggestive of an omission response due to the violation of a cognitive expectancy that an aversive event should occur following the presentation of the generalized fear stimuli (Dunsmoor & LaBar, 2012). Finally, generalization to safety cues presented during conditioned learning (e.g., to a cue that is never paired with a US) involves the subgenual anterior cingulate and ventromedial prefrontal cortex, which counteract the spread of fear and limit the breadth of the generalization gradients.

Fear generalization on the basis of shared conceptual features among object category exemplars elicits activity in the amygdala, dorsal anterior cingulate gyrus, insula, thalamus, and occipitotemporal cortical regions that process the conditioned object category (Dunsmoor, Kragel, Martin, & LaBar, 2014). In this case, the amygdala becomes more functionally coupled to the cortical representations of the aversively reinforced object category; but, as predicted by biological preparedness theory, this effect has only been observed thus far with animate object categories whose cortical representations are anatomically connected with the amygdala. Multivariate pattern analysis shows that fear conditioning experiences alter the representation of the CS object category in the amygdala and occipitotemporal cortex, such that exemplars of the category are signaled more similarly when the category is reinforced with an aversive US than when it is not. This shared signal may contribute to the generalized fear responses to the items across the category.

The extent of fear generalization to cues that resemble a CS is often predicted by individual differences in anxiety, with the strongest generalization occurring in individuals high in anxious or obsessive–compulsive traits (Dunsmoor, Prince, et al., 2011; Dunsmoor, White, et al., 2011; Kaczkurkin & Lissek, 2013). These effects are even more pronounced in anxiety disorders, for which fear responses can broadly overgeneralize (Lissek et al., 2009, 2014). In generalized anxiety disorder, fear generalization on the basis of perceptual information is associated with alterations in the integrity of the ventromedial prefrontal cortex and its functional and structural connections with corticolimbic structures, including the amygdala (Cha et al., 2014). An important question for future research is how the forces of generalization can be thwarted or reversed to improve functioning in these disorders.

Consolidation and Reconsolidation of Fear Memories

Once a learning episode takes place, numerous processes contribute to consolidating the learning into a long-term memory trace. Over a period of several hours, local synaptic processes, including long-term potentiation, strengthen the connections that represent the constituent parts of the learning experience. Further replay and consolidation of the memory trace occurs during sleep the night after the event occurred. Finally, over an extended period of weeks to years, the storage of memories can shift across different systems in the brain. At each of these stages of memory consolidation, neuromodulatory influences alter the nature of the representations to either strengthen or weaken the integrity of the memory trace. For instance, engagement of the hypothalamic–pituitary–adrenal stress axis around the time of a fear conditioning episode enhances long-term retention of fear memories across species (Rodrigues, LeDoux, & Sapolsky, 2009; Zorawski, Blanding, Kuhn, & LaBar, 2006).

In recent years, it has come to be appreciated that memories undergo a period of reconsolidation upon their retrieval, which provides an opportunity for further modification of the memory trace. For cued fear conditioning, this period of postretrieval memory lability lasts up to a few hours of the reactivation of the fear memory (usually triggered by presenting the CS alone) and requires protein synthesis and engagement of calcium-dependent second messenger systems in the amygdala (Finnie & Nader, 2012). If these molecular cascades are blocked or down-regulated pharmacologically, the fear memory becomes unstable, perhaps even "erased." For instance, administering the protein synthesis inhibitor anisomycin into the basolateral amygdala within 6 hours of presenting a CS that had already undergone fear conditioning blocks the retention of fear to the CS (Nader, Schafe, & LeDoux, 2000). However, older memories are more resistant to reconsolidation effects (Suzuki et al., 2004), perhaps because they are already stored across multiple memory systems.

While these animal investigations have raised considerable clinical interest for remediation of anxiety disorders, the translation of these paradigms into human investigations are complicated by ethical and methodological challenges. Drugs that block protein synthesis are toxic to humans, and other drugs that have modulatory influences on emotional memory processes, such as propranolol—a beta-adrenergic blocker—have yielded mixed results in the human reconsolidation studies conducted to date (reviewed in Schiller & Phelps, 2011). These initial findings have led researchers to consider using behavioral manipulations that may update the value of fear memory representations during the reconsolidation window as a novel intervention. In particular, presenting the fear-conditioned CS without reinforcement within 6 hours of reactivating the conditioned fear memory (through a CS-reminder trial) attenuates conditioned fear responses up to a year later (Schiller et al., 2010). Presentations of the CS that had undergone reconsolidation of this sort reduce conditioned fear responses and concomitant amygdala activity (Agren et al., 2012). While this translational work remains in its infancy, it is opening up avenues for novel intervention strategies by capitalizing on the temporary lability of fear memories. Yet, it is not clear whether a permanent reduction of fear to a potentially threatening stimulus is adaptive, and ethical dilemmas surround the "erasing" of unwanted fear memories in the context of clinical treatment.

Fear Regulation

As a form of protection from threats, learned fear behaviors are enduring. However, given its high metabolic cost, fear is important to relinquish as warranted by situational indicators of relative safety. Voluntary and involuntary forms of emotion regulation are recruited to inhibit fear when and where it is no longer appropriate to express. These regulatory controls establish new memories of safety value for the formerly fearful cues or contexts that compete with the original fear memory for behavioral expression. To decide how to respond to recurrent themes of threat, an organism must balance the expression of these opposing memory traces to guide defensive behaviors. Because the latent fear memory is almost always available for later retrieval, the return of fear plagues long-term treatment outcomes in anxiety disorders.

Involuntary aspects of fear regulation include brain mechanisms sensitive to temporal cues and spatial contexts that indicate that the threat is no longer present. These mechanisms have been detailed in animal models of extinction learning and the contextual control of conditioned fear. *Extinction learning* occurs when the contingency between the CS and US is removed by repeatedly presenting the CS without reinforcement. Over time, the organism learns that the CS no longer predicts an aversive event, following which conditioned fear responses subside. Repeating extinction training over intervals of days is beneficial, as a period of memory consolidation solidifies the extinction memory trace. A recent study even showed that presenting olfactory reminders of extinction training during slow-wave sleep facilitates the extinction process in humans (Hauner, Howard, Zelano, & Gottfried, 2013). The long-term consolidation and recall of extinction learning is mediated by the infralimbic cortex (ventromedial prefrontal cortex in primates), which inhibits fear processing in the amygdala, most prominently by engaging the intercalated nuclei of the amygdala to block central nucleus signaling (reviewed in Milad & Quirk, 2012). In humans, the ventromedial prefrontal cortex, including the subgenual portion of the anterior cingulate gyrus, plays a similar role in extinction recall, as revealed by both functional and structural imaging studies (Milad et al., 2005, 2007; Phelps, Delgado, Nearing, & LeDoux, 2004). Engaging this inhibitory neural circuitry is thought to be critical for successful exposure therapy treatment in anxiety disorders, as these therapies are based on extinction learning principles. Initial clinical studies indicate that in posttraumatic stress disorder, there is an imbalance in prefrontal–amygdala signaling of extinction, as the amygdala exhibits a prolonged response during initial extinction learning and the ventromedial prefrontal cortex is less activated during extinction recall. Consequently, physiological indices of fear conditioning persist into the extinction training period for these patients, along with activation of the dorsal anterior cingulate gyrus, which enhances fear expression (Milad et al., 2009). Current efforts are under way to identify how to augment extinction learning pharmacologically or behaviorally in order to restore the integrity of these regulatory pathways.

In addition to learning that conditioned fear cues no longer portend danger, it is also important to learn where learned threats are more or less likely to be encountered according to contextual cues of danger and safety. Understanding the contextual regulation of conditioned fear is also relevant to improve treatment outcomes in anxiety disorders (Vervliet, Craske, & Hermans, 2013). When patients leave the safe confines of the therapeutic setting and enter other environments, fear responses tend to recover (*fear renewal*), especially for novel contexts with unknown threat value or those that are associated with prior threat experiences. Fear responses also recover in contexts where patients experience stressors after extinction-based training regimens (*fear reinstatement*). Both of these context-dependent fear recovery phenomena rely on the hippocampus, consistent with its role in acquiring fear to environmental contexts (Corcoran & Maren, 2001; Holland & Bouton, 1999). For the contextual recovery of fear, the hippocampus modifies fear expression in the amygdala through both direct neural interactions with the basal nuclei and indirect effects through the ventromedial and dorsomedial prefrontal cortical interfaces to the amygdala (Orsini, Kim, Knapska, & Maren, 2011; Sotres-Bayon, Bush, & LeDoux, 2004). In humans, hippocampal lesions impair fear reinstatement (LaBar & Phelps, 2005), and hippocampal–ventromedial prefrontal activity that signals extinction retention is attenuated in a stressful context following fear reinstatement (Kalisch et al., 2006). Researchers are currently exploring ways to combat the return of fear by making extinction training less context specific. For instance, by conducting extinction in multiple contexts, it is possible to mitigate the context-dependent return of fear in some circumstances across both rats and humans (Dunsmoor, Ahs, Zielinski, & LaBar, 2014; Laborda & Miller, 2013).

Voluntary forms of fear regulation have rarely been studied in conjunction with conditioned learning, but the mechanisms are likely similar to those involved in effortfully regulating other aspects of emotional processing. For instance, when individuals cognitively reappraise the meaning of aversive stimuli to lessen their emotional impact, negative affect reduction is accompanied by activity increases in the lateral prefrontal, cingulate, and parietal regions, and activity decreases in the limbic areas, such as the amygdala (Ochsner et al., 2012). One study showed similar mechanisms at play in the cognitive reappraisal of conditioned fear stimuli (Delgado, Nearing, LeDoux, & Phelps, 2008). When participants used visual imagery to decrease the aversiveness of the CS, physiological indices of conditioned learning were attenuated, CS-evoked activity in the amygdala was reduced, and CS-evoked activity was enhanced in the prefrontal cortical regions. An additional study indicated that this form of active coping is successful in attenuating conditioned fear responses and subjective fear reports up to 24 hours later (Shurick et al., 2012). More work is clearly needed to evaluate the relative effectiveness of different emotion regulation strategies on reducing negative affect associated with conditioned fear memories.

Role of the Bed Nucleus of the Stria Terminalis in Anxiety

Most of the research discussed in this chapter focuses on phasic aspects of fear processing, such as responses to facial expressions of fear or conditioned fear cues. However, research over the past decade has begun to dissociate the brain regions mediating fear processing from more sustained forms of anxiety. Several paradigms have been developed to model state anxiety, including presentation of long-duration or unpredictable threats, or manipulation of environmental factors that enhance a sense of apprehension, such as open/elevated field exploration tests or presenting startle probes in dark environments for humans (or light environments for rodents). Rodent studies using these kinds of paradigms have shown that fear and anxiety can be partially dissociated with respect to their neurobiological substrates. Whereas fear-potentiated startle relies on the central nucleus of the amygdala, light-enhanced startle relies on the bed nucleus of the stria terminalis (BNST), a region of the "extended amygdala" that protrudes anteriorly into the basal ganglia (reviewed in Davis et al., 2010; Figure 43.3). Rats with lesions of the BNST exhibit nonanxious phenotypes when confronted by an elevated maze and show low contextual fear, but they exhibit normal conditioned fear to a CS (Duvarci, Bauer, & Pare, 2009). In humans, individual differences in anxiety predict BNST activation in response to contextual threat indicators in a threat-of-shock paradigm, with enhanced tracking of anticipated proximal threats as a sign of hypervigilance (Somerville, Whalen, & Kelley, 2010). Pharmacological dissociations also distinguish fear from anxiety in some of these paradigms. Whereas blockade of corticotropin-releasing factor (CRF) receptors, which are especially high in the BNST, attenuate light-enhanced startle and long-duration threats, they have little effect on fear-potentiated startle or short-duration threats (Lee & Davis, 1997; Walker, Miles, & Davis, 2009). Similarly, CRF1 and CRF2 genetic knockout mice exhibit selective impairments on context-potentiated startle but not fear-potentiated startle (Risbrough et al., 2009). These initial findings suggest avenues for disentangling the neuropharmacological mediation of fear and anxiety, and can lead to more refined clinical treatments.

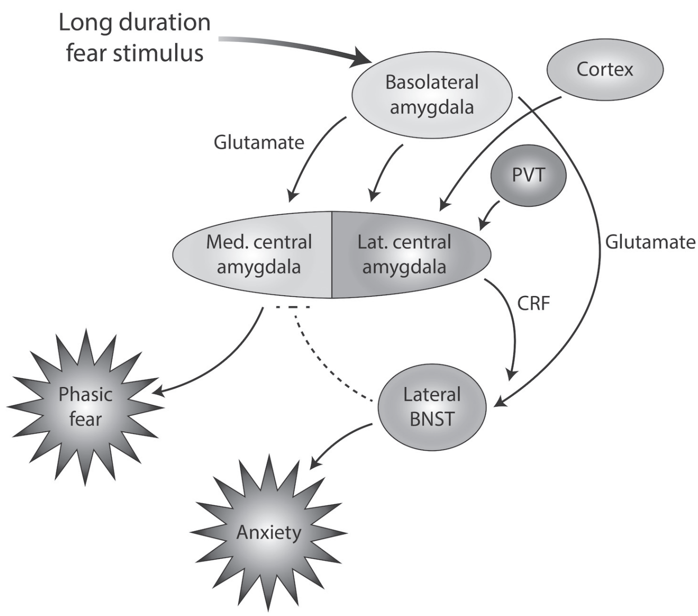

FIGURE 43.3. A proposed neural model for the partial separation of phasic fear and prolonged anxiety. Information about threats is evaluated by the basolateral amygdala. Projections to the medial division of the central nucleus of the amygdala promote phasic fear responses, whereas prolonged anxiety is mediated by projections to the lateral division of the bed nucleus of the stria terminalis (BNST). BNST projections include both direct and indirect pathways via the lateral division of the central nucleus of the amygdala. The BNST is further modulated by stress through release of corticotropin-releasing factor (CRF) and paraventricular thalamic (PVT) inputs via the lateral division of the central nucleus of the amygdala. Dashed lines indicate putative inhibitory projections that help transfer phasic responses to sustained ones. Adapted from Davis, Walker, Miles, and Grillon (2010). Copyright 2010 by Nature Publishing Group.

Conclusions

Defensive motivation systems evolved to optimize the management of physical threats to survival and are organized according to threat imminence. The emotions fear and anxiety serve adaptive functions in defensive encounters by facilitating the detection of threats, reorganizing metabolic processes and behavioral priorities to prepare appropriate defensive action repertoires, and enhancing memory for these experiences. Threatening stimuli gain preferential access to perceptual and attentional systems through both reflexive and endogenous means across subcortical and cortical processing pathways. Clinical disorders such as hemispatial neglect and cortical blindness provide unique opportunities to investigate the preattentive detection of threat. Limbic regions, especially the amygdala, integrate sensorimotor aspects of fear processing and initiate coping strategies. Whether these regions are also central to the experience of fearful and anxious states remains debated. For organisms that live in social groups, defense calls promote the safety of the group through modulations of vocal acoustics that often indicate contextual details of predatory threats and elicit specific behavioral patterns in listeners.

Mechanisms of fear learning allow a broad range of stimuli to gain access to defensive motivation systems, yet these mechanisms exhibit some biases for evolutionarily engrained threats. Because of the high cost of "false positives" in threat analysis, fear learning systems exhibit rapid learning, a resistance to extinction, retuning of sensory experience toward signaling features of prior threats, and stress-enhanced memory consolidation. Corticolimbic structures exhibit a degree of specialization across fear and anxiety paradigms, including the amygdala for the acquisition, expression, and generalization of fear conditioning; the hippocampus for contextual fear acquisition, context-dependent fear recovery, and explicit memory for conditioning experiences; the ventromedial prefrontal cortex for the recall of extinction and the generalization of safety cues; and the BNST for some aspects of anxiety.

In anxiety disorders, fear processing pathways become maladaptive as revealed by greater attentional biases, stronger resistance to extinction, and overgeneralization of fear learning. Treatment efforts for anxiety disorders are focusing on ways to pharmacologically or behaviorally enhance extinction learning, to use voluntary emotion regulation strategies to dampen the experience of fear and anxiety, and to take advantage of memory reconsolidation mechanisms to update stored representations of threatening experiences. Better theoretical delineation of fear and anxiety constructs and their neural substrates will permit more precise targeting of such therapeutic interventions.

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References

Adams, R. B., Jr., Franklin, R. G., Jr., Kveraga, K., Ambady, N., Kleck, R. E., Whalen, P. J., et al. (2012). Amygdala responses to averted vs direct gaze fear vary as a function of presentation speed. *Social Cognitive and Affective Neuroscience, 7*(5), 568–577.

Aggleton, J. P., & Mishkin, M. (1986). The amygdala: Sensory gateway to the emotions. In R. Plutchik & H. Kellerman (Eds.), *Emotion: Theory, research and experience: Vol. 3. Biological foundations of emotion* (pp. 281–298). New York: Academic Press.

Agren, T., Engman, J., Frick, A., Björkstrand, J., Larsson, E.-M., Furmark, T., et al. (2012). Disruption of reconsolidation erases a fear memory trace in the human amygdala. *Science, 337*(6101), 1550–1552.

Ahs, F., Frans, O., Tibblin, B., Kumlien, E., & Fredrikson, M. (2010). The effects of medial temporal lobe resections on verbal threat and fear conditioning. *Biological Psychology, 83*(1), 41–46.

Alvarez, R. P., Biggs, A., Chen, G., Pine, D. S., & Grillon, C. (2008). Contextual fear conditioning in humans: Cortical–hippocampal and amygdala contributions. *Journal of Neuroscience, 28*(24), 6211–6219.

Amaral, D. G., & Price, J. L. (1984). Amygdalo–cortical projections in the monkey (Macaca fascicularis). *Journal of Comparative Neurology, 230*(4), 465–496.

Ameli, R., Ip, C., & Grillon, C. (2001). Contextual fear-potentiated startle conditioning in humans: Replication and extension. *Psychophysiology, 38*(3), 383–390.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: Author.

Anderson, A. K., Christoff, K., Panitz, D., De Rosa, E., & Gabrieli, J. D. (2003). Neural correlates of the automatic processing of threat facial signals. *Journal of Neuroscience, 23*(13), 5627–5633.

Anderson, A. K., & Phelps, E. A. (2002). Is the human amygdala critical for the subjective experience of emotion?: Evidence of intact dispositional affect in patients with amygdala lesions. *Journal of Cognitive Neuroscience, 14*(5), 709–720.

Bach, D. R., Weiskopf, N., & Dolan, R. J. (2011). A stable sparse fear memory trace in human amygdala. *Journal of Neuroscience, 31*(25), 9383–9389.

Bechara, A., Tranel, D., Damasio, H., Adolphs, R., Rockland, C., & Damasio, A. R. (1995). Double dissociation of conditioning and declarative knowledge relative to the amygdala and hippocampus in humans. *Science, 269*(5227), 1115–1118.

Beck, A. T., Emery, G., & Greenberg, R. L. (1985). *Anxiety disorders and phobias*. New York: Basic Books.

Bishop, S. J., Duncan, J., & Lawrence, A. D. (2004). State anxiety modulation of the amygdala response to unattended threat-related stimuli. *Journal of Neuroscience, 24*(46), 10364–10368.

Blanchard, D. C., & Blanchard, R. J. (1988). Ethoexperimental approaches to the biology of emotion. *Annual Review of Psychology, 39*, 43–68.

Blanchard, R. J., Yudko, E. B., Rodgers, R. J., & Blanchard, D. C. (1993). Defense system psychopharmacology: An ethological approach to the pharmacology of fear and anxiety. *Behavioural Brain Research, 58*, 155–165.

Borod, J. C. (1993). Cerebral mechanisms underlying facial, prosodic, and lexical emotional expression: A review of neuropsychological studies and methodological issues. *Neuropsychology, 7*, 445–463.

Brudzynski, S. M., & Chiu, E. M. (1995). Behavioural responses of laboratory rats to playback of 22 khz ultrasonic calls. *Physiology and Behavior, 57*, 1039–1044.

Brudzynski, S. M., Kehoe, P., & Callahan, M. (1999). Sonographic structure of isolation-induced ultrasonic calls of rat pups. *Developmental Psychobiology, 34*, 195–204.

Buchel, C., Morris, J., Dolan, R. J., & Friston, K. J. (1998). Brain systems mediating aversive conditioning: An event-related fMRI study. *Neuron, 20*(5), 947–957.

Busscher, B., van Gerwen, L. J., Spinhoven, P., & de Geus, E. J. (2010). Physiological reactivity to phobic stimuli in people with fear of flying. *Journal of Psychosomatic Research, 69*(3), 309–317.

Cain, M. S., Dunsmoor, J. E., LaBar, K. S., & Mitroff, S. R. (2011). Anticipatory anxiety hinders detection of a second target in dual-target search. *Psychological Science, 22*(7), 866–871.

Carlsson, K., Petersson, K. M., Lundqvist, D., Karlsson, A., Ingvar, M., & Ohman, A. (2004). Fear and the amygdala: Manipulation of awareness generates differential cerebral responses to phobic and fear-relevant (but nonfeared) stimuli. *Emotion, 4*(4), 340–353.

Cha, J., Greenberg, T., Carlson, J. M., Dedora, D. J., Hajcak, G., & Mujica-Parodi, L. R. (2014). Circuit-wide structural and functional measures predict ventromedial prefrontl cortex fear generalization: Implications for generalized anxiety disorder. *Journal of Neuroscience, 34*(11), 4043–4053.

Chapman, W. P., Schroeder, H. R., Geyer, G., Brazier, M. A. B., Fager, C., Poppen, J. L., et al. (1954). Physiological evidence concerning importance of the amygdaloid nuclear region in the integration of ciculatory function and emotion in man. *Science, 120*, 949-–950.

Cheng, D. T., Knight, D. C., Smith, C. N., Stein, E. A., & Helmstetter, F. J. (2003). Functional MRI of human amygdala activity during Pavlovian fear conditioning: Stimulus processing versus response expression. *Behavioral Neuroscience, 117*(1), 3–10.

Choi, J. S., & Brown, T. H. (2003). Central amygdala lesions block ultrasonic vocalization and freezing as conditional but not unconditional responses. *Journal of Neuroscience, 23*(25), 8713–8721.

Claparède, E. (1911/1995). Recognition and selfhood. *Consciousness and Cognition, 4*, 371–378.

Coppens, E., Spruyt, A., Vandenbulcke, M., Van Paesschen, W., & Vansteenwegen, D. (2009). Classically conditioned fear responses are preserved following unilateral temporal lobectomy in humans when concurrent US-expectancy ratings are used. *Neuropsychologia, 47*(12), 2496–2503.

Corcoran, K. A., & Maren, S. (2001). Hippocampal inactivation disrupts contextual retrieval of fear memory after extinction. *Journal of Neuroscience, 21*(5), 1720–1726.

Davis, M., Walker, D. L., Miles, L., & Grillon, C. (2010). Phasic vs sustained fear in rats and humans: Role of the extended amygdala in fear vs anxiety. *Neuropsychopharmacology, 35*, 105–135.

De Lucia, M., Clarke, S., & Murray, M. M. (2010). A temporal hierarchy for conspecific vocalization discrimination in humans. *Journal of Neuroscience, 30*(33), 11210–11221.

Delgado, M. R., Nearing, K. I., LeDoux, J. E., & Phelps, E. A. (2008). Neural circuitry underlying the regulation of conditioned fear and its relation to extinction. *Neuron, 59*(5), 829–838.

Dolan, R. J., Morris, J. S., & de Gelder, B. (2001). Cross-modal binding of fear in voice and face. *Proceedings of the National Academy of Sciences USA, 98*(17), 10006–10010.

Dominguez-Borras, J., Saj, A., Armony, J. L., & Vuilleumier, P. (2012). Emotional processing and its impact on unilateral neglect and extinction. *Neuropsychologia, 50*, 1054–1071.

Dunsmoor, J. E., Ahs, F., Zielinski, D. J., & LaBar, K. S. (2014). Extinction under multiple virtual reality contexts diminishes fear reinstatement in humans. *Neurobiology of Learning and Memory, 113*, 157–164.

Dunsmoor, J. E., Kragel, P. A., Martin, A., & LaBar, K. S. (2014). Aversive learning modulates cortical representations of object catgories. *Cerebral Cortex, 24*(11), 2859–2872.

Dunsmoor, J. E., & LaBar, K. S. (2012). Brain activity associated with omission of an aversive event reveals the effects of fear learning and generalization. *Neurobiology of Learning and Memory, 97*(3), 301–312.

Dunsmoor, J. E., & LaBar, K. S. (2013). Effects of discrimination training on fear generalization gradients and perceptual classification in humans. *Behavioral Neuroscience, 127*, 350–356.

Dunsmoor, J. E., Martin, A., & LaBar, K. S. (2012). Role of conceptual knowledge in learning and retention of conditioned fear. *Biological Psychology, 89*(2), 300–305.

Dunsmoor, J. E., Mitroff, S. R., & LaBar, K. S. (2009). Generalization of conditioned fear along a dimension of increasing fear intensity. *Learning and Memory, 16*(7), 460—469.

Dunsmoor, J. E., Prince, S. E., Murty, V. P., Kragel, P. A., & LaBar, K. S. (2011). Neurobehavioral mechanisms of human fear generalization. *Neuroimage, 55*, 1878–1888.

Dunsmoor, J. E., White, A. J., & LaBar, K. S. (2011). Conceptual similarity promotes generalization of higher order fear learning. *Learning and Memory, 18*(3), 156–160.

Duvarci, S., Bauer, E. P., & Pare, D. (2009). The bed nucleus of the stria terminalis mediates inter-individual variations in anxiety and fear. *Journal of Neuroscience, 29*(33), 10357–10361.

Edeline, J. M., & Weinberger, N. M. (1992). Associative retuning in the thalamic source of input to the amygdala and auditory cortex: Receptive field plasticity in the medial division of the medial geniculate body. *Behavioral Neuroscience, 106*(1), 81–105.

Ethofer, T., Anders, S., Erb, M., Droll, C., Royen, L., Saur, R., et al. (2006). Impact of voice on emotional judgment of faces: An event-related fMRI study. *Human Brain Mapping, 27*, 707–714.

Fanselow, M. S. (1994). Neural organization of the defensive behavior system responsible for fear. *Psychonomic Bulletin and Review, 1*(4), 429–438.

Feinstein, J. S., Adolphs, R., Damasio, A., & Tranel, D. (2011). The human amygdala and the induction and experience of fear. *Current Biology, 21*, 34–38.

Feinstein, J. S., Buzza, C., Hurlemann, R., Follmer, R. L., Dahdaleh, N. S., Coryell, W. H., et al. (2013). Fear and panic in humans with bilateral amygdala damage. *Nature Neuroscience, 16*(3), 270–273.

Fichtenholtz, H. M., Dean, H. L., Dillon, D. G., Yamasaki, H., McCarthy, G., & LaBar, K. S. (2004). Emotion-attention network interactions during a visual oddball task. *Brain Research. Cognitive Brain Research, 20*(1), 67–80.

Fichtenholtz, H. M., & LaBar, K. S. (2012). Emotional influences on visuospatial attention. In G. R. Mangun (Ed.), *Neuroscience of attention: Attentional control and selection* (pp. 250–266). New York: Oxford University Press.

Finnie, P. S. B., & Nader, K. (2012). The role of metaplasticity mechanisms in regulating memory reconsolidation. *Neuroscience and Biobehavioral Reviews, 36*, 1667–1707.

Flykt, A. (2005). Visual search with biological threat stimuli: Accuracy, reaction times, and heart rate changes. *Emotion, 5*(3), 349–353.

Flykt, A., & Caldara, R. (2006). Tracking fear in snake and spider fearful participants during visual search: A multi-response domain study. *Cognition and Emotion, 20*(8), 1075–1091.

Fruhholz, S., & Grandjean, D. (2013). Amygdala subregions differentially respond and rapidly adapt to threatening voices. *Cortex, 49*(5), 1394–1403.

Furmark, T., Fischer, H., Wik, G., Larsson, M., & Fredrikson, M. (1997). The amygdala and individual differences in human fear conditioning. *NeuroReport, 8*(18), 3957–3960.

Garrido, M. I., Barnes, G. R., Sahani, M., & Dolan, R. J. (2012). Functional evidence for a dual route to amygdala. *Current Biology, 22*, 129–134.

Glascher, J., & Adolphs, R. (2003). Processing of the arousal of subliminal and supraliminal emotional stimuli by the human amygdala. *Journal of Neuroscience, 23*(32), 10274–10282.

Gloor, P., Olivier, A., Quesney, L. F., Andermann, F., & Horowitz, S. (1982). The role of the limbic system in experiential phenomena of temporal lobe epilepsy. *Annals of Neurology, 12*(2), 129–144.

Graham, R., & LaBar, K. S. (2012). Neurocognitive mechanisms of gaze-expression interactions in face processing and social attention. *Neuropsychologia, 50*(5), 553–566.

Gray, J. A., & McNaughton, N. (2000). *The neuropsychology of anxiety: An enquiry into the functions of the septo-hippocampal system* (2nd ed.). Oxford, UK: Oxford University Press.

Gschwind, M., Pourtois, G., Schwartz, S., Van de Ville, D., & Vuilleumier, P. (2012). White-matter connectivity between face-responsive regions in the human brain. *Cerebral Cortex, 22*(7), 1564–1576.

Halgren, E. E., Walter, R. R. D., Cherlow, D. D. G., & Crandall, P. P. H. (1978). Mental phenomena evoked by electrical stimulation of the human hippocampal formation and amygdala. *Brain, 101*(1), 83.

Hamm, A. O., Weike, A. I., Schupp, H. T., Treig, T., Dressel, A., & Kessler, C. (2003). Affective blindsight: Intact fear conditioning to a visual cue in a cortically blind patient. *Brain, 126*, 267–275.

Hauner, K. K., Howard, J. D., Zelano, C., & Gottfried, J. A. (2013). Stimulus-specific enhancement of fear extinction during slow-wave sleep. *Nature Neuroscience, 16*(11), 1553–1555.

Holland, P. C., & Bouton, M. E. (1999). Hippocampus and context in classical conditioning. *Current Opinion in Neurobiology, 9*(2), 195–202.

Huff, N. C., Hernandez, J. A., Fecteau, M. E., Zielinski, D. J., Brady, R., & Labar, K. S. (2011). Revealing context-specific conditioned fear memories with full immersion virtual reality. *Frontiers in Behavioral Neuroscience, 5*, 75.

Jurgens, U. (2009). The neural control of vocalization in mammals: A review. *Journal of Voice, 23*(1), 1–10.

Kaczkurkin, A. N., & Lissek, S. (2013). Generalization of conditioned fear and obsessive–compulsive traits. *Journal of Psychology and Psychotherapy, 7*, 3.

Kalisch, R., Korenfeld, E., Stephan, K. E., Weiskopf, N., Seymour, B., & Dolan, R. J. (2006). Context-dependent human extinction memory is mediated by a ventromedial prefrontal and hippocampal network. *Journal of Neuroscience, 26*(37), 9503–9511.

Katkin, E. S., Wiens, S., & Ohman, A. (2001). Nonconscious fear conditioning, visceral perception, and the development of gut feelings. *Psychological Science, 12*(5), 366–370.

Killgore, W. D., & Yurgelun-Todd, D. A. (2004). Acitvation of the amygdala and anterior cingulate during nonconscious processing of sad versus happy faces. *NeuroImage, 21*, 1215–1223.

Knight, D. C., Cheng, D. T., Smith, C. N., Stein, E. A., & Helmstetter, F. J. (2004). Neural substrates mediating human delay and trace fear conditioning. *Journal of Neuroscience, 24*(1), 218–228.

Kragel, P. A., & LaBar, K. S. (2014). Advancing emotion theory by multivariate pattern classification. *Emotion Review, 6*, 160–174.

LaBar, K. S., & Disterhoft, J. F. (1998). Conditioning, awareness, and the hippocampus. *Hippocampus, 8*(6), 620–626.

LaBar, K. S., Gatenby, J. C., Gore, J. C., LeDoux, J. E., & Phelps, E. A. (1998). Human amygdala activation during conditioned fear acquisition and extinction: A mixed-trial fMRI study. *Neuron, 20*(5), 937–945.

LaBar, K. S., & LeDoux, J. E. (1996). Partial disruption of fear conditioning in rats with unilateral amygdala damage: Correspondence with unilateral temporal lobectomy in humans. *Behavioral Neuroscience, 110*(5), 991–997.

LaBar, K. S., & LeDoux, J. E. (2002). Emotional learning circuits in animals and humans. In R. J. Davidson, K. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 52–65). New York: Oxford University Press.

LaBar, K. S., LeDoux, J. E., Spencer, D. D., & Phelps, E. A. (1995). Impaired fear conditioning following unilateral temporal lobectomy in humans. *Journal of Neuroscience, 15*(10), 6846.

LaBar, K. S., & Phelps, E. A. (2005). Reinstatement of conditioned fear in humans is context dependent and impaired in amnesia. *Behavioral Neuroscience, 119*(3), 677.

Laborda, M. A., & Miller, R. R. (2013). Preventing return of fear in an animal model of anxiety: Additive effects of massive extinction and extinction in multiple contexts. *Behavior Therapy, 44*, 249–261.

Lake, J. I., & LaBar, K. S. (2011). Unpredictability and uncertainty in anxiety: A new direction for emotional timing research. *Frontiers in Integrative Neuroscience, 5*, 55.

Lang, P. J., & Bradley, M. M. (2010). Emotion and the motivational brain. *Biological Psychology, 84*, 437–450.

Lang, P. J., Davis, M., & Ohman, A. (2000). Fear and anxiety: Animal models and human cognitive psychophysiology. *Journal of Affective Disorders, 61*, 137–159.

LeDoux, J. (2012). Rethinking the emotional brain. *Neuron, 73*(4), 653–676.

Lee, D. H., Susskind, J. M., & Anderson, A. K. (2013). Social transmission of the sensory benefits of eye widening in fear expressions. *Psychological Science, 24*(6), 957–965.

Lee, Y. J., & Davis, M. (1997). Role of the hippocampus, the bed nucleus of the stria terminalis, and the amygdala in the excitatory effect of corticotropin-releasing hormone on the acoustic startle reflex. *Journal of Neuroscience, 17*, 6434–6446.

Liddell, B. J., Brown, K. J., Kemp, A. H., Barton, M. J., Das, P., Peduto, A., et al. (2005). A direct brainstem–amygdala–cortical “alarm” system for subliminal signals of fear. *NeuroImage, 24*(1), 235–243.

Lindquist, D. H., Jarrard, L. E., & Brown, T. H. (2004). Perirhinal cortex supports delay fear conditioning to rat ultrasonic social signals. *Journal of Neuroscience, 24*(14), 3610–3617.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*, 121–202.

Lissek, S., Kaczkurkin, A. N., Rabin, S., Geraci, M., Pine, D. S., & Grillon, C. (2014). Generalized anxiety disorder is associated with overgeneralization of classically conditioned fear. *Biological Psychiatry, 75*(11), 909–915.

Lissek, S., Rabin, S., Heller, R. E., Lukenbaugh, D., Geraci, M., Pine, D. S., et al. (2009). Overgeneralization of conditioned fear as a pathogenic marker of panic disorder. *American Journal of Psychiatry, 167*(1), 47–55.

Litvin, Y., Blanchard, D. C., & Blanchard, R. J. (2007). Rat 22 kHz ultrasonic vocalizations as alarm cries. *Behavioural Brain Research, 182*, 166–172.

Lovibond, P. F., & Shanks, D. R. (2002). The role of awareness in Pavlovian conditioning: Empirical evidence and theoretical implications. *Journal of Experimental Psychology: Animal Behavior, 28*(1), 3–26.

Maren, S., & Fanselow, M. S. (1995). Synaptic plasticity in the basolateral amygdala induced by hippocampal formation stimulation in vivo. *Journal of Neuroscience, 15*(11), 7548–7564.

Mather, M., & Knight, M. R. (2006). Angry faces get noticed quickly: Threat detection is not imparied among older adults. *Journal of Gerentology: B. Psychological Science, 61*, 54–57.

Mayberg, H. S. (1997). Limbic–cortical dysregulation: a proposed model of depression. *Journal of Neuropsychiatry and Clinical Neurosciences, 9*(3), 471–481.

McNaughton, N., & Corr, P. J. (2004a). A two-dimensional neuropsychology of defense: Fear/anxiety and defensive distance. *Neuroscience and Biobehavioral Reviews, 28*, 285–305.

Milad, M. R., Pitman, R. K., Ellis, C. B., Gold, A. L., Shin, L. M., Lasko, N. B., et al. (2009). Neurobiological basis of failure to recall extinction memory in posttraumatic stress disorder. *Biological Psychiatry, 66*(12), 1075–1082.

Milad, M. R., Quinn, B. T., Pitman, R. K., Orr, S. P., Fischl, B., & Rauch, S. L. (2005). Thickness of ventromedial prefrontal cortex in humans is correlated with extinction memory. *Proceedings of the National Academy of Sciences USA, 102*, 10706–10711.

Milad, M. R., & Quirk, G. J. (2012). Fear extinction as a model for translational neuroscience: Ten years of progress. *Annual Review of Psychology, 63*, 129–151.

Milad, M. R., Wright, C. I., Orr, S. P., Pitman, R. K., Quirk, G. J., & Rauch, S. L. (2007). Recall of fear extinction in humans activates the ventromedial prefrontal cortex and hippocampus in concert. *Biological Psychiatry, 62*(5), 446–454.

Miltner, W. H., Kriechel, S., Hecht, H., Trippe, R., & Weiss, T. (2004). Eye movements and behavioral responses to threatening and nonthreatening stimuli during visual search in phobic and nonphobic subjects. *Emotion, 4*, 323–339.

Mobbs, D., Marchant, J. L., Hassabis, D., Seymour, B., Tan, G., Gray, M., et al. (2009). From threat to fear: The neural organization of defensive fear systems in humans. *Journal of Neuroscience, 29*(39), 12236–12243.

Morris, J. S., de Gelder, B., Weiskrantz, L., & Dolan, R. J. (2001). Differential extrageniculostriate and amygdala responses to presentation of emotional faces in a cortically blind field. *Brain, 124*, 1241–1252.

Morris, J. S., Ohman, A., & Dolan, R. J. (1999). A subcortical pathway to the right amygdala mediating "unseen" fear. *Proceedings of the National Academy of Sciences USA, 96*, 1680–1685.

Murphy, F. C., Nimmo-Smith, I., & Lawrence, A. D. (2003). Testing neural models of emotion space: A meta-analysis of human brain mapping data. *Cognitive Affective and Behavioral Neuroscience, 3*(3), 207–233.

Nader, K., Majidishad, P., Amorapanth, P., & LeDoux, J. E. (2001). Damage to the lateral and central, but not other, amygdaloid nuclei prevents the acquisition of auditory fear conditioning. *Learning and Memory, 8*(3), 156–163.

Nader, K., Schafe, G. E., & LeDoux, J. E. (2000). Fear memories require protein synthesis in the amygdala for reconsolidation after retrieval. *Nature, 406*(6797), 722–726.

Notebaert, L., Crombez, G., Van Damme, S., De Houwer, J., & Theeuwes, J. (2011). Signals of threat do not capture, but prioritize, attention: A conditioning approach. *Emotion, 11*(1), 81–89.

Ochsner, K. N., Silvers, J. A., & Buhle, J. T. (2012). Functional imaging studies of emotion regulation: A synthetic review and evolving model of the cognitive control of emotion. *Annals of the New York Academy of Sciences, 1251*, E1–E24.

Ohman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General, 130*, 466–478.

Ohman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: An anger superiority effect with schematic stimuli. *Journal of Personality and Social Psychology, 80*, 381–396.

Ohman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review, 108*(3), 483–522.

Ohman, A., & Soares, J. J. F. (1993). On the automatic nature of phobic fear: Conditioned electrodermal responses to masked fear-relevant stimuli. *Journal of Abnormal Psychology, 102*(1), 121–132.

Ohman, A., & Soares, J. J. F. (1994). "Unconscious anxiety": Phobic responses to masked stimuli. *Journal of Abnormal Psychology, 103*, 231–240.

Olsson, A., & Phelps, E. A. (2004). Learned fear of "unseen" faces after Pavlovian, observational, and instructed fear. *Psychological Science, 15*(12), 822–828.

Orsini, C. A., Kim, J. H., Knapska, E., & Maren, S. (2011). Hippocampal and prefrontal projections to the basal amygdala mediate contextual regulation of fear after extinction. *Journal of Neuroscience, 31*(47), 17269–17277.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions*. Oxford, UK: Oxford University Press.

Papworth, S., Bose, A. S., Barker, J., Schel, A. M., & Zuberbuhler, K. (2008). Male blue monkeys alarm call in response to danger experienced by others. *Biology Letters, 4*(5), 472–475.

Pavlov, I. P. (1927). *Conditioned reflexes*. London: Oxford University Press.

Pegna, A. J., Khateb, A., Lazeyras, F., & Seghier, M. L. (2005). Discriminating emotional faces without primary visual cortices involves the right amygdala. *Nature Reviews Neuroscience, 8*, 24–25.

Pessoa, L., & Adolphs, R. (2010). Emotion processing and the amygdala: from a 'low road' to 'many roads' of evaluating biological significance. *Nature Reviews Neuroscience, 11*(11), 773–783.

Peterson, D. C., & Wenstrup, J. J. (2012). Selectivity and persistent firing responses to social vocalization in the basolateral amygdala. *Neuroscience, 217*, 154–171.

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *Neuroimage, 16*(2), 331–348.

Phelps, E. A., Delgado, M. R., Nearing, K. I., & LeDoux, J. E. (2004). Extinction learning in humans: Role of the amygdala and vmPFC. *Neuron, 43*(6), 897.

Phelps, E. A., LaBar, K. S., Anderson, A. K., O'Connor, K. J., Fulbright, R. K., & Spencer, D. D. (1998). Specifying the contributions of the human amygdala to emotional memory: A case study. *Neurocase, 4*, 527–540.

Phelps, E. A., O'Connor, K. J., Gatenby, J. C., Gore, J. C., Grillon, C., & Davis, M. (2001). Activation of the left amygdala to a cognitive representation of fear. *Nature Reviews Neuroscience, 4*(4), 437–441.

Phillips, M. L., Young, A. W., Scott, S. K., Calder, A. J., Andrew, C., Giampietro, V., et al. (1998). Neural responses to facial and vocal expressions of fear and disgust. *Proceedings of the Royal Society B: Biological Sciences, 265*(1408), 1809–1817.

Pineles, S. L., Suvak, M. K., Liverant, G. I., Gregor, K., Wisco, B. E., Pitman, R. K., et al. (2013). Psychophysiologic reactivity, subjective distress, and their associations with PTSD diagnosis. *Journal of Abnormal Psychology, 122*(3), 635–644.

Quigley, K. S., & Barrett, L. F. (2014). Is there consistency and specificity of autonomic changes during emotional episodes? Guidance from the conceptual act theory and psychophysiology. *Biological Psychology, 98*, 82–94.

Quirk, G. J., Armony, J. L., & LeDoux, J. E. (1997). Fear conditioning enhances different temporal components of tone-evoked spike trains in auditory cortex and lateral amygdala. *Neuron, 19*(3), 613–624.

Quirk, G. J., Repa, C., & LeDoux, J. E. (1995). Fear conditioning enhances short-latency auditory responses of lateral amygdala neurons: Parallel recordings in the freely behaving rat. *Neuron, 15*(5), 1029–1039.

Ressler, K. J., Rothbaum, B. O., Tannenbaum, L., Anderson, P., Graap, K., Zimand, E., et al. (2004). Cognitive enhancers as adjuncts to psychotherapy: Use of D-cycloserine in phobic individuals to facilitate extinction of fear. *Archives of General Psychiatry, 61*(11), 1136–1144.

Risbrough, V. B., Geyer, M. A., Hauger, R. L., Coste, S., Stenzel-Poore, M., Wurst, W., et al. (2009). CRF1 and CRF2 receptors are required for potentiated startle to contextual but not discrete cues. *Neuropsychopharmacology, 34*(6), 1494–1503.

Ro, T., Shelton, D., Lee, O. L., & Chang, E. (2004). Extrageniculate mediation of unconscious vision in transcranial magnetic stimulation-induced blindsight. *Proceedings of the National Academy of Sciences USA, 101*, 9933–9935.

Rodrigues, S. M., LeDoux, J. E., & Sapolsky, R. M. (2009). The influence of stress hormones on fear circuitry. *Annual Review of Neuroscience, 32*, 289–313.

Romanski, L. M., Clugnet, M. C., Bordi, F., & LeDoux, J. E. (1993). Somatosensory and auditory convergence in the lateral nucleus of the amygdala. *Behavioral Neuroscience, 107*, 444–450.

Romanski, L. M., & LeDoux, J. E. (1992). Equipotentiality of thalamo-amygdala and thalamo-cortico-amygdala circuits in auditory fear conditioning. *Journal of Neuroscience, 12*(11), 4501–4509.

Sander, K., & Scheich, H. (2005). Left auditory cortex and amygdala, but right insula dominance for human laughing and crying. *Journal of Cognitive Neuroscience, 17*, 1519–1531.

Schiller, D., & Delgado, M. R. (2010). Overlapping neural systems mediating extinction, reversal and regulation of fear. *Trends in Cognitive Science, 14*(6), 268–276.

Schiller, D., Monfils, M. H., Raio, C. M., Johnson, D. C., Ledoux, J. E., & Phelps, E. A. (2010). Preventing the return of fear in humans using reconsolidation update mechanisms. *Nature, 463*(7277), 49–53.

Schiller, D., & Phelps, E. A. (2011). Does reconsolidation occur in humans? *Frontiers in Behavioral Neuroscience, 5*, 24.

Sehlmeyer, C., Schoning, S., Zwitserlood, P., Pfleiderer, B., Kircher, T., Arolt, V., et al. (2009). Human fear conditioning and extinction in neuroimaging: A systematic review. *PLoS ONE, 4*(6), e5865.

Seyfarth, R. M., Cheney, D. L., & Marler, P. (1980). Vervet monkey alarm calls: Semantic communication in a free-ranging primate. *Animal Behavior, 28*, 1070–1094.

Shurick, A. A., Hamilton, J. R., Harris, L. T., Roy, A. K., Gross, J. J., & Phelps, E. A. (2012). Durable effects of cognitive restructuring on conditioned fear. *Emotion, 12*(6), 1393–1397.

Smith, F. W., & Schyns, P. G. (2009). Smile through your fear and sadness: Transmitting and identifying facial expression signals over a range of viewing distances. *Psychological Science, 20*(10), 1202–1208.

Soltis, J., King, L. E., Douglas-Hamilton, I., Vollrath, V., & Savage, A. (2014). African elephant alarm calls distinguish between threats from humans and bees. *PLoS ONE, 9*(2), e89403.

Somerville, L. H., Whalen, P. J., & Kelley, W. M. (2010). Human bed nucleus of the stria terminalis indexes hypervigilant threat monitoring. *Biological Psychiatry, 68*(5), 416–424.

Sotres-Bayon, F., Bush, D. E., & LeDoux, J. E. (2004). Emotional perseveration: An update on prefrontal-amygdala interactions in fear extinction. *Learning and Memory, 11*(5), 525–535.

Suzuki, A., Josselyn, S. A., Frankland, P. W., Masushige, S., Silva, A. J., & Kida, S. (2004). Memory reconsolidation and extinction have distinct temporal and biochemical signatures. *Journal of Neuroscience, 24*(20), 4787–4795.

Talk, A., Kashef, A., & Gabriel, M. (2004). Effects of conditioning during amygdalar inactivation on training-induced neuronal plasticity in the medial geniculate nucleus and cingulate cortex in rabbits (Oryctolagus cuniculus). *Behavioral Neuroscience, 118*(5), 944–955.

Tamietto, M., Castelli, L., Vighetti, S., Perozzo, P., Geminiani, G., Weiskrantz, L., et al. (2009). Unseen facial and bodily expressions trigger fast emotional reactions. *Proceedings of the National Academy of Sciences USA, 106*(42), 17661–17666.

Tamietto, M., & De Gelder, B. (2010). Neural bases of the non-conscious perception of emotional signals. *Nature Reviews Neuroscience, 11*, 697–709.

Tamietto, M., Pullens, P., De Gelder, B., Weiskrantz, L., & Goebel, R. (2012). Subcortical connections to human amygdala and changes following destruction of the visual cortex. *Current Biology, 22*, 1449–1455.

Tomalski, P., Johnson, M. H., & Csibra, G. (2009). Temporal-nasal asymmetry of rapid orienting to face-like stimuli. *NeuroReport, 20*, 1309–1312.

van Well, S., Visser, R. M., Scholte, H. S., & Kindt, M. (2012). Neural substrates of individual differences in human fear learning: Evidence from concurrent fMRI, fear-potentiated startle, and US-expectancy data. *Cognitive, Affective, and Behavioral Neuroscience 12*(3), 499–512.

Vervliet, B., Baeyens, F., Van den Bergh, O., & Hermans, D. (2013). Extinction, generalization, and return of fear: A critical review of renewal research in humans. *Biological Psychology, 92*(1), 51–58.

Vervliet, B., Craske, M. G., & Hermans, D. (2013). Fear extinction and relapse: State of the art. *Annual Review of Clinical Psychology, 9*, 215–248.

Vuilleumier, P. (2005). How brains beware: Neural mechanisms of emotional attention. *Trends in Cognitive Science, 9*(12), 585–594.

Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2001). Effects of attention and emotion on face processing in the human brain: An event-related fMRI study. *Neuron, 30*, 829–841.

Vuilleumier, P., Richardson, M. P., Armony, J. L., Driver, J., & Dolan, R. J. (2004). Distant influences of amygdala lesion on visual cortical activation during emotional face processing. *Nature Reviews Neuroscience, 7*(11), 1271–1278.

Wager, T. D., Barrett, L. F., Bliss-Moreau, E., Lindquist, K. A., Duncan, S., Kober, H., et al. (2008). The neuroimaging of emotion. In M. Lewis & J. M. Haviland-Jones

(Eds.), *Handbook of emotions* (3rd ed., pp. 249–271). New York: Guilford Press.

Walker, D. L., Miles, L. A., & Davis, M. (2009). Selective participation of the bed nucleus of the stria terminalis and CRF in sustained anxiety-like versus phasic fear-like responses. *Progress in Neuro-Psychopharmacology Biological Psychiatry, 33*(8), 1291–1308.

Watson, J. B., & Rayner, R. (1920). Conditioned emotional reactions. *Journal of Experimental Psychology, 3*(1), 1–14.

Weike, A. I., Hamm, A. O., Schupp, H. T., Runge, U., Schroeder, H. W. S., & Kessler, C. (2005). Fear conditioning following unilateral temporal lobectomy: Dissociation of conditioned startle potentiation and autonomic learning. *Journal of Neuroscience, 25*(48), 11117–11124.

Whalen, P. J., Kagan, J., Cook, R. G., Davis, F. C., Kim, H., Polis, S., et al. (2004). Human amygdala responsivity to masked fearful eye whites. *Science, 306*(5704), 2061.

Wilensky, A. E., Schafe, G. E., Kristensen, M. P., & LeDoux, J. E. (2006). Rethinking the fear circuit: The central nucleus of the amygdala is required for the acquisition, consolidation, and expression of Pavlovian fear conditioning. *Journal of Neuroscience, 26*(48), 12387.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1997). *Cognitive psychology and emotional disorders* (2nd ed.). Chichester, UK: Wiley.

Williams, L. M., Das, P., Liddell, B. J., Kemp, A. H., Rennie, C. J., & Gordon, E. (2006). Mode of functional connectivity in amygdala pathways dissociates level of awareness for signals of fear. *Journal of Neuroscience, 26*(36), 9264.

Williams, M. A., Morris, A. P., McGlone, F., Abbott, D. F., & Mattingley, J. B. (2004). Amygdala responses to fearful and happy facial expressions under conditions of binocular suppression. *Journal of Neuroscience, 24*(12), 2898–2904.

Woody, E. Z., & Szechtman, H. (2011). Adaptation to potential threat: The evolution, neurobiology, and psychopathology of the security motivation system. *Neuroscience and Biobehavioral Reviews, 35*, 1019–1033.

Yamasaki, H., LaBar, K. S., & McCarthy, G. (2002). Dissociable prefrontal brain systems for attention and emotion. *Proceedings of the National Academy of Sciences USA,* 99(17), 11447–11451.

Zorawski, M., Blanding, N. Q., Kuhn, C. M., & LaBar, K. S. (2006). Effects of stress and sex on acquisition and consolidation of human fear conditioning. *Learning and Memory, 13*(4), 441.

CHAPTER 44

Anger

Eddie Harmon-Jones and Cindy Harmon-Jones

Anger likely serves a variety of adaptive functions. It organizes and regulates psychological processes, such as self-defense and mastery. It regulates social and interpersonal processes, and it organizes processes to assist with goal-directed action. However, anger may also be associated with negative intra- and interpersonal consequences, including child maltreatment and violence (Holtzworth-Munroe & Clements, 2007) and coronary heart disease (Niaura et al., 2002). For these reasons, individuals and societies often try to down-regulate anger to attempt to reduce these negative consequences.

Emotions are processes that involve involuntary action readiness (Frijda, 1986; Lewis & Michalson, 1983). Emotions provide organisms with complex and biologically prepared behavioral potentials that assist in coping with challenges to their welfare (Panksepp, 1998). However, these inherited behavioral potentials only imply ways of behaving as organisms evolved to have larger, more complex brains. While we as humans may possess the same emotional instincts as lower animals, we are not as constrained by their dictates and we have more choices (Panksepp, 1998). Consequently, our emotions can be controlled and may not directly influence behavior.

An emotion is a multicomponent process made up of basic processes such as feelings of pleasure or displeasure; facial/bodily expression components; particular appraisals; and motivational components such as particular action plans and activation states (Frijda, 1993; Lewis, 2014). Moreover, these components are not perfectly correlated with one another (Lang, 1995). For example, anger is an unpleasant feeling, described using words like "annoyed," "angry," and "enraged," which, in our view, express differences in intensity of experience (Berkowitz & Harmon-Jones, 2004a, 2004b; cf. Lewis, 1993, who suggested that rage and anger are qualitatively different). Anger is associated with appraisals of other blame, and it often motivates approach and attack behaviors.

When left uncontrolled or uninhibited, the facial expression of anger involves the muscles of the brow moving inward and downward, "creating a frown and a foreboding appearance around the eyes, which seem to be fixed in a hard stare toward the object of anger. The nostrils dilate and the wings of the nose flare out. The lips are opened and drawn back in a rectangle-like shape, revealing clinched teeth. Often the face flushes red" (Izard, 1977, p. 330). However, because most humans are taught to control anger and its expression, the facial expressions of anger vary considerably among people. However, "on the face of an angry person there is almost always one or more of the innate components of the natural expression which signals his or her internal state" (Izard, 1977, p. 330).

In this chapter, we review research and theoretical advances in the study of basic processes involved in (primarily human) anger. We focus our review on the causes of anger, and its subjective feeling and motivational components. We do not review the vast literature on angry facial expressions, as it is beyond the scope of this chapter (see Russell & Fernández-Dols,1997, for a review).

Causes of Anger

Several theorists have proposed that anger results from physical or psychological restraint or from interference with goal-directed activity (Darwin, 1872/1965; Izard, 1977; Lewis, 1993). This perspective on understanding the causes of anger is consistent with proposals made by other major theoretical perspectives on the causes of various emotions.

Reinforcement Approaches

Neo-behaviorists proposed that the actual or signaled arrival or termination of pleasant or unpleasant events, referred to as positive or negative reinforcers, respectively, is the primary cause of emotions (Mowrer, 1960). Gray (1987) extended these early ideas by including stimulus omissions and interactions with individuals' resources, such as ability to cope with events (see also Rolls, 1999). According to these theories, angry emotions—like frustration, anger, and rage—are caused by the omission of positive reinforcers or the termination of positive reinforcers.

Similarly, Lewis (1993) posited that the thwarting of goal-directed action is an unlearned cause of anger. In one experiment testing this idea, 2- to 8-month-old infants were first conditioned to move one of their arms in order to see a picture of another baby's smiling face as well as hear happy music. Then after they had learned this association, they were exposed to an extinction phase in which their arm movement did not result in the happy events. This termination of the positive reinforcer ("frustrating" event) caused the majority of the infants to have anger-like facial expressions (Lewis, Alessandri, & Sullivan, 1990; Lewis, Sullivan, Ramsay, & Alessandri, 1992).

In another model based on neo-behavioristic ideas, Berkowitz (1989) extended the original frustration–aggression model (Dollard, Doob, Miller, Mowrer, & Sears, 1939) in his cognitive neo-associative model of anger and aggression. Berkowitz proposed that any unpleasant event, such as frustration, pain, discomfort, or social stress, causes negative affect. According to Berkowitz (1989), this negative affect is associated with motivations to fight as well as flee; he has referred to this as a *fight-and-flight* motivation. His model goes further to propose that an individual's prior experiences have created associations that provide cues that will influence what happens in any given situation. If these cues are associated primarily with a desire to escape, then the flight system will be activated and the person will experience mostly fear. If, however, these cues are associated primarily with a desire to attack, then the fight system will be activated and the person will experience mostly anger.

Cognitive Appraisal Approach

Another prominent theoretical approach to understanding the causes of anger is the cognitive appraisal approach. Broadly speaking, these theorists posit that emotions are caused by an individual's appraisal or interpretation of a situation. Thus, it is not the situation itself that causes the emotion, but the way in which the person interprets the situation (e.g., Roseman, Spindel, & Jose, 1990). According to these theories, individuals constantly appraise situations in which they find themselves, and these appraisals, which can be conscious or nonconscious, always precede emotions.

According to appraisal theorists, anger is an unpleasant emotion that often occurs in response to an appraisal of a blocked goal. An appraisal of a blocked goal may consist of perception of the absence of a reward or presence of a punishment (Roseman, 1991), or of an obstruction to obtaining a goal (Lazarus, 1991; Scherer, 2001). To define the term "goal," some theorists refer to an outcome that is personally significant (Lazarus, 1991; Scherer, 2001). Other researchers define goals very broadly, such that every desired outcome would qualify, from the fulfillment of basic needs to achieving long-term, self-relevant plans. According to these broad definitions, pain may produce anger because the individual experiences it as blocking his or her goal of being physically comfortable.

Appraisal theories hypothesize that appraising situations as negative produces negative emotions, including, among others, anger, fear, sadness, and disgust. Thus, other appraisals, besides general negativity, are necessary to produce the discrete emotion of anger. The specific appraisal that is proposed to evoke anger, rather than one of the other negative emotions, is "other-blame," that is, a belief that the unpleasant situation was wrongly caused by someone or something (Lazarus, 1991; Ortony, Clore, & Collins, 1988). An appraisal of other-blame suggests a belief that the person who caused the event acted in a manner that was improper or unfair (Shaver, Schwartz, Kirson, & O'Connor, 1987; Frijda, Kuipers, & ter Schure, 1989; Roseman, 1991). Lazarus (1991) additionally proposed that anger only occurs when individuals perceive a threat to their self-esteem.

The appraisal of "high coping potential" has been proposed as another evaluation necessary for anger to occur. High coping potential refers to the individual's perceived likelihood of being able to resolve the negative situation (Lazarus, 1991; Scherer, 2001; Stein & Levine, 1989). In contrast, if an individual believes he or she is unlikely to be able to resolve the negative situation satisfactorily (i.e., low coping potential), sadness, fear, or anxiety will be experienced rather than anger.

Problems with the Appraisal Accounts

Appraisal theories have generated much interest concerning the causes of emotions, and they are intuitively appealing. For instance, the idea that anger results from negative self-esteem threatening situations that are perceived to be caused by others and that one expects to be able to resolve favorably seems to explain many instances of anger. However, these intuitions may be incorrect. Several theorists have criticized the appraisal theories for not providing empirical evidence demonstrating that appraisals cause emotion. These theorists have suggested that the available evidence could be interpreted to indicate that emotions are the cause of appraisals rather than the converse. For instance, Frijda (1993; Frijda & Zeelenberg, 2001) and Parkinson and Manstead (1992) argued that because of the self-report methods used in tests of appraisal theories, it is difficult to determine whether the identified appraisal patterns preceded or followed the emotional experience. Parkinson and Manstead (1992) wrote, "Nothing in the data resists the interpretation that the relevant appraisals were consequences rather than precedents of the emotional reactions" (p. 129).

Are the appraisals mentioned above necessary for anger, specifically? Appraisals may be involved in the experience of anger, but occur later in the emotion process—that is, they may occur simultaneously with anger or may result from anger, rather than being the cause of anger (Berkowitz & Harmon-Jones, 2004a, 2004b). Berkowitz (1989) proposed a model in which anger is triggered through the fight-or-flight system when an aversive event, such as pain, occurs. His model proposes that once the fight system and anger are activated, the individual then makes appraisals and engages in other cognitive processing to determine whether to attack, who or what to attack, and exactly how to attack. In this model, emotions are a more basic response to an unpleasant event, and cognitive processes, such as appraisals, serve to organize actions in service of emotions and their associated motivations. Berkowitz and Harmon-Jones (2004b) also noted that appraisal theorists' definitions of "goals," "cognitions," and "appraisals" are sometimes so broad that they are untestable (e.g., the "goal" of not experiencing discomfort is not normally active prior to the experience of discomfort).

The appraisal commonly proposed to cause anger, other-blame, also may not be necessary to cause anger. Instead, anger may motivate individuals to seek someone or something to blame for the negative situation. Frijda (1993) reviewed a number of cases where angry persons blamed, and aggressed against, inanimate objects. These cases support the idea that appraisals of other-blame may result from, rather than cause, anger.

The idea that self-esteem threats are necessary to evoke anger has also been questioned. Of course, self-esteem threats may evoke anger, but experiments have found that individuals report feeling anger in response to situations that would not threaten self-esteem (e.g., Berkowitz, 1989; Harmon-Jones, Lueck, Fearn, & Harmon-Jones, 2006). For example, simple physical pain increases anger and aggression, even though it is not associated with a failure or other threat to the self (e.g., Berkowitz, 1999, 2000; Berkowitz, Cochran, & Embree, 1981).

Last, the idea that high coping potential is necessary to create anger has been challenged by research that manipulated coping potential and found the manipulated coping potential influenced brain activations related to approach motivation (see below) but not self-reported anger (Harmon-Jones, Sigelman, Bohlig, & Harmon-Jones, 2003).

Subjective Feelings and Anger

We conceive of anger in a relatively broad way, proposing a commonality of anger rather than there being different kinds of anger (cf. Ellsworth & Scherer, 2003, p. 575). Spielberger and colleagues (Spielberger, Jacobs, Russell, & Crane, 1983; Spielberger, Reheiser, & Sydeman, 1995) also posited this view when they proposed that anger encompassed low-intensity feelings such as irritation or annoyance as well as high-intensity feelings such as fury and rage. Their factor analysis of the items in their State Anger Scale (containing items such as "I am furious" and "I feel irritated") produced only a single factor, suggesting that the angry experiences measured by these items were a unitary affective state varying in intensity. Spielberger et al.'s (1983, 1995) distinction between "anger in" and "anger out" refers to differences in the trait of openly expressing the behavioral concomitants of anger rather than qualitative differences in the nature of the angry feelings (Spielberger et al., 1995). Our conception of anger experience is in agreement with the prototype view of emotion concepts of Shaver and colleagues (1987). Shaver et al. (1987) found that the anger prototype includes a variety of feelings such as *irritation, annoyance, exasperation, disgust*, and *hate*. Thus, various "nuances" of anger experience may not be distinctly different affective states.

Compared with moods, emotions are generally held to have a more specific, consciously recognized cause, a shorter duration, and a definite target. Although some emotion theorists consider moods and emotions to be unique entities, others consider the distinction to be "unsharp" (Frijda, 1986, pp. 59–60), a factor of the degree of clarity individuals believe they possess regarding their affective experience. Regarding varieties of anger, the terms "irritation" and "hostility" tend to be used for mood-like states, whereas "anger" and "rage" refer to more emotion-like states. However, these are merely attempts to capture the variety in the specificity, duration, and intensity of angry affects, as it is difficult to draw a firm dividing line in the continuum between mood and emotion.

The Valence of Anger

Although the valence (positivity vs. negativity) of emotion is considered by many theorists to be one of the most important dimensions of affect, theorists do not always clearly define what is meant by valence. When they do, various emotion researchers have defined this concept in three different ways (Lazarus, 1991): (1) according to whether the conditions that brought about the emotion were pleasant or unpleasant, (2) according to whether the consequences of the emotion were adaptive or maladaptive, or (3) according to whether the emotion feels subjectively pleasant or unpleasant.

Anger can be viewed as a negative affect using the first definition of valence. That is, anger is evoked by negative events, as described in the section "Causes of Anger." The second definition of valence is unwieldy, because it is difficult to definitively state whether the consequences of anger are good or bad. For example, a particular incidence of anger may be adaptive in the short run (a person gets his or her way following an angry outburst) but maladaptive in the long run (the target of the angry outburst avoids him or her in the future and he or she loses a friend), or may be beneficial to the individual, but harmful to others. Using the third definition of valence, anger would be categorized as a negative emotion if individuals dislike the experience of anger, and as a positive emotion if individuals enjoy the experience of anger.

Most appraisal theorists focus on the way the stimulus is evaluated in determining the valence of emotion, and thus, they subscribe to the first definition of valence. From this viewpoint, anger is a negative emotion because it occurs when a person appraises a situation as unpleasant. However, other emotion theorists focus on the responses evoked during the emotion, including physiological changes, facial expressions, subjective experiences, and molar behavior. These response-based theories of emotion tend to use the third definition of valence—that is, whether the individual's experience of the subjective feeling is pleasant or unpleasant.

Most individuals evaluate the subjective experience of anger negatively. However, research has found variance among individuals in the degree of negativity with which anger is experienced (Harmon-Jones, 2004; Harmon-Jones, Harmon-Jones, Amodio, & Gable, 2011). Greater trait anger, measured by the Aggression Questionnaire (Buss & Perry, 1992) or by the hostility subscale of the Positive and Negative Affect Schedule—Expanded form (PANAS-X; Watson & Clark, 1994), is correlated with a more positive attitude toward anger (Harmon-Jones, 2004). Attitude toward anger does not relate to affect intensity or social desirability (Harmon-Jones, 2004). Furthermore, liking for anger relates negatively to trait fear (Harmon-Jones, 2004), and positively to interest in viewing anger-evoking stimuli (E. Harmon-Jones et al., 2011). Thus, when evaluated according to the pleasantness to unpleasantness of the subjective state, anger is a negatively valenced emotion. However, individuals vary in the degree to which they evaluate anger negatively.

Blends of Anger and Positive Affects

Anger may be the primary emotion evoked in a given situation, but it also commonly occurs in combination with other negative emotions (Berkowitz, 1989). Less intuitively, anger may also be positively related to the experience of certain positive emotions. Interpersonal insult, a manipulation often used to evoke anger experimentally, produces greater self-reported anger compared with a no-insult condition, but also produces higher ratings of PANAS positive activation (PA; Harmon-Jones, Vaughn-Scott, Mohr, Sigelman, & Harmon-Jones, 2004). The increase in both anger and PANAS PA was replicated following different anger manipulations (Harmon-Jones, Harmon-Jones, Abramson, & Peterson, 2009). In these studies, anger and positive affect were correlated, and both state anger and state positive affect were also related to trait behavioral activation sensitivity (BAS; Carver & White, 1994), a measure of approach motivation.

One possible explanation for these surprising results is that the PANAS items intended to measure positive affect may not actually reflect pleasantness. These items that comprise the PA subscale are "active," "alert," "attentive," "determined," "enthusiastic," "excited," "inspired," "interested," "proud," and "strong." Notably, "happy" is not included, nor are its common synonyms such as "joyful," "cheerful," or "delighted." The perplexing absence of these terms for positive affect from the PA subscale may be due to the methods used to develop the PANAS. The PANAS items were selected from a large set of emotion words using factor analysis. Items on the PA subscale were chosen because they had a large loading on the first factor and a near-zero loading on the second factor, whereas items chosen for the negative affect subscale had the converse loading (Watson, Clark, & Tellegen, 1988). This technique may have led to elimination of items that measure positivity per se (e.g., happy) and retention of items that measure something besides pure positivity. We suspect that that "something" is approach motivation, and the relationship between PANAS PA and anger supports this idea.

A study examined the hypothesis that the relationship of PANAS PA and anger is due to their common relationship with approach motivation (Harmon-Jones, Harmon-Jones, et al., 2009). Participants listened to either an insulting or a neutral radio broadcast, and then reported their anger, sadness, happiness, and PANAS PA. A factor analysis conducted within the insult condition revealed three factors, with PANAS PA and happiness loading on the first factor, all of the sadness-related items loading on the second factor, and all of the anger-related items loading on a third factor. In the neutral condition, only two factors, positive and negative, emerged. Participants in the insult condition reported greater anger, sadness, and greater endorsement of five PA items (active, alert, determined, interested, and strong), compared with the neutral condition. Participants in the insult condition also reported less happiness and less endorsement of one PA item (enthusiastic). Anger was positively correlated with PA, but negatively correlated with happiness. Furthermore, when happiness was controlled for using regression, the strength of the relationship between anger and PA increased. Similar results were found when anger was induced via autobiographical recall (Harmon-Jones, Harmon-Jones, et al., 2009).

Anger has also been found to relate positively to PANAS PA at the trait level (Harmon-Jones & Harmon-Jones, 2010). Participants completed the PANAS, several measures of trait anger, and a measure of trait happiness. At the zero-order level, PA was positively related to happiness, but not consistently correlated with the anger measures. However, when happiness and anger were used to predict PA in a simultaneous regression, PA was positively correlated with anger. These results, like experimental results assessing state emotions, suggest that happiness acts as a suppressor in the relationship of PA and anger.

Pettersson and Turkheimer (2013) have found conceptually similar results. They created a "balanced PANAS" by adding an antonym with the same valence as each of the original words on the PANAS. For example, the balanced PANAS added the similarly valenced antonym "meek" to account for the PANAS word "hostile," and the similarly valenced antonym "laid-back" to account for the PANAS word "excited." Results revealed that participants' endorsements of these items clustered around valence, and not content. In other words, meek and hostile were positively correlated. However, when variance associated with valence was statistically controlled, words assessing anger "(hostile," "irritable") clustered close to words assessing approach-related positive affect ("proud," "excited," "strong"). Moreover, these approach-related words were not clustered near positive and negative words suggesting vigilance, such as "guilty," "ashamed," "alert," and "attentive." These results support the idea that anger is related to approach, but more importantly, suggest that the relationship between anger and some other measures of approach may be obscured because valence is represented more strongly than content in self-report measures.

Although anger was correlated with PA in these studies, the results do not suggest that anger is experienced as pleasant, because self-reported happiness was less in the anger conditions and anger negatively correlated with happiness. Rather, the results suggest that, in the context of an anger-evoking stimulus, certain items on the PA subscale may measure approach motivation rather than, or in addition to, pleasantness. With this in mind, PA more accurately refers to *pounce affect*, as pouncing can reflect anger or desire.

Motivational Components of Anger

The evidence that anger is an approach-motivated emotion comes from diverse fields within psychology, including social, clinical, behavioral, and developmental (Carver & Harmon-Jones, 2009; Lewis, 2010). Although negative emotions are often presumed to be related to withdrawal motivation (e.g., Norris, Gollan, Berntson, & Cacioppo, 2010; Watson, 2000), many sources of evidence suggest that anger violates this expected relationship. Anger is negative, both in terms of the evoking stimulus and the subjective experience, but as hinted by its relationship with the PANAS PA, it is most often associated with the urge to approach rather than to withdraw. In humans, anger is associated with attack and aggression (Berkowitz, 1993). In animals, an analogous behavior is irritable aggression, which arises from the behavioral facilitation system (Depue & Iacono, 1989).

Developmental researchers have found a relationship between anger and approach motivation even in young infants. Infants were taught to pull a string in order to see a rewarding photograph and hear rewarding music. Their emotional expressions were recorded when the reward was withdrawn and when the contingency was subsequently reinstated. The infants who displayed the greatest anger when the reward was withheld demonstrated the strongest arm pull, and greatest interest and joy, when the reward was reinstated (Lewis et al., 1990, 1992). These results suggested that anger increased task engagement and persistence in response to goal blocking.

Psychological reactance, like anger, is a response to blocked goals, suggesting a link between reactance theory (Wortman & Brehm, 1975) and anger. According to the model that integrated reactance theory and learned helplessness theory, how individuals respond to an undesired outcome depends on both the importance of the outcome and the degree to which they expect control. When expectations for control are high and a desired outcome fails to occur, psychological reactance is aroused, producing increased effort to achieve the desired outcome. However, after repeated, uncontrollable undesired outcomes, individuals show decreased motivation (learned helplessness). In support of the idea that psychological reactance is equivalent to anger, research has found that individuals who reported anger in response to an unsolvable puzzle performed better on a subsequent cognitive task compared with participants who exhibited less anger, presumably because the angry participants were more approach motivated (Mikulincer, 1988).

Other research in adult humans suggests that anger is related to approach motivation, at both the state and trait levels. For example, whereas fear is associated with pessimism, state and trait anger are associated with optimism (Lerner & Keltner, 2001). Similarly, traits reflecting approach motivation—including self-assurance, physical strength, and bravery—relate positively to state anger (Izard, 1991).

Research using facial expressions of emotion also suggests similarities between anger and high-approach positive emotions (Harmon-Jones, Schmeichel, Mennitt, & Harmon-Jones, 2011). To select a high-approach positive emotion to compare with anger, approach motivation was evoked by asking participants to write about an important, personal goal and how they intended to achieve it. This "implemental mind-set" has been shown to produce approach motivation in past studies (Harmon-Jones, Harmon-Jones, Fearn, Sigelman, & Johnson, 2008; Taylor & Gollwitzer, 1995). In a low-approach positive comparison condition, participants wrote about a very pleasant event that had happened to them because of someone else's actions. Participants were then asked to name the emotion they experienced most strongly while engaging in this task. In the implemental mind-set condition, the most commonly freely generated word was "determined," whereas in the low-approach positive condition the most common word was "happy" (or a synonym). These results suggested that determination may be the most prototypical high-approach emotion (C. Harmon-Jones et al., 2011).

In subsequent studies within this same article, participants then made voluntary emotional expressions intended to express determination, anger, joy, and other basic emotions (sadness, fear, disgust, and neutral)—that is, the participants were simply instructed to make the facial expression so that anyone would know what they were feeling (i.e., the participants were not given muscle-by-muscle instructions on making facial expressions). Naïve judges then attempted to identify the emotions in the photographs. The photographs of intended determination expressions that were most often correctly identified were more likely to be misidentified as anger, but not more likely to be misidentified as any other emotion, including joy. These results suggest that determination, a high-approach positive emotion, is perceived as similar to anger (C. Harmon-Jones et al., 2011).

In another follow-up study, naïve judges rated the intensity of joy, anger, and determination expressed in photographs (C. Harmon-Jones et al., 2011). For the determination expressions, the intensity of perceived determination was positively correlated with the intensity of perceived anger and was negatively correlated with the intensity of perceived joy. For the anger expressions, the intensity of perceived anger was positively correlated with the intensity of perceived determination and negatively correlated with the intensity of perceived joy. These results support the idea that anger is approach related, by showing the perceptual similarity between anger and determination, a positive, high-approach emotion.

Anger and Individual Differences in Approach Motivation

Research on bipolar disorder suggests that a hyperactive approach system may underlie mania (Depue & Iacono, 1989; Fowles, 1993; Urošević, Abramson, Harmon-Jones, & Alloy, 2008), and interestingly, the emotions anger and euphoria often co-occur during manic episodes (Cassidy, Forest, Murry, & Carroll, 1998; Depue & Iacono, 1989; Tyrer & Shopsin, 1982). Lithium carbonate, used to treat bipolar disorder, reduces aggression, also suggesting that anger and aggression are part of the syndrome of bipolar disorder (Malone, Delaney, Luebbert, Cater, & Campbell, 2000). In addition, approach motivation is associated with activity in the left frontal cortical region of the brain, as research on individuals who have suffered lesions has shown that damage to the right frontal cortex commonly produces mania (see Robinson & Downhill, 1995, for a review), suggesting that mania and hypomania involve increased left frontal brain activity.

Research on BAS suggests that anger is also related to trait approach motivation within the nonclinical population. In two studies, BAS, measured with Carver and White's (1994) scale, correlated positively with trait anger, measured by the Buss and Perry (1992) aggression questionnaire. In one of the studies, anger also related positively to behavioral inhibition sensitivity (BIS), but when general negative affect was controlled statistically, the association between anger and BIS was eliminated, while the association between anger and BAS remained (Harmon-Jones, 2003). Trait BAS has also been found to predict anger in response to experimental provocations (Carver, 2004). In concert with the clinical studies on mania, the relationship between BAS and anger supports the idea that anger is approach motivated.

Anger has also been found to be associated with selective attention toward rewards but not threats. In one experiment, participants were induced to experience an angry, fearful, excited, or neutral state (Ford et al., 2010). Then, their selective attention toward images depicting threats, rewards, or high arousal controls was measured using eye tracking. Results revealed that participants induced to feel angry showed selective attention toward rewarding images when they were paired with threatening or control images. A follow-up study revealed a conceptually similar pattern of results: Trait anger (and aggression) correlated with more selective attention toward rewarding images (Ford, Tamir, Gagnon, Taylor, & Brunyé, 2012).

Animal behavior research also suggests that anger is associated with approach motivation. In one study, mice, which were selected according to being high or low in exploratory temperament, were tested in several behavioral tasks. Compared with mice that were low in exploratory temperament, mice high in exploratory temperament displayed less-anxious behavior in anxiety-evoking situations. Most important, they demonstrated more aggressive behavior in the intruder test (Kazlauckas et al., 2005).

Similarly, research has revealed that in children (4–9 years old) approach/positive anticipation is positively correlated with frustration/anger, and both of these variables are positively correlated with overt aggression (assessed using mothers' reports; Deater-Deckard et al., 2012).

Other evidence suggestive of anger being associated with approach motivation comes from research examining the startle eye-blink reflex. A reduction in the magnitude of the startle eye-blink reflex during the viewing of arousing/pleasant stimuli has been suggested to be due to the increased approach motivation evoked by the arousing/pleasant stimuli. The researchers who discovered this phenomenon, Lang, Bradley, and Cuthbert (1990), wrote, “when a foreground stimulus engages an appetitive response, a negative probe of that foreground should prompt a reflex of lower amplitude” (p. 381). In a study examining the relationship between individual differences in self-reported trait emotions and the emotion-modulated startle-eye-blink reflex (Amodio & Harmon-Jones, 2011), it was found that trait anger, enjoyment, and surprise were each correlated with reduced startle eye-blink reflexes during the viewing of arousing/pleasant pictures but not aversive pictures.

Asymmetrical Frontal Cortical Activity

Much research has focused on examining the relationship of anger with asymmetrical frontal cortical activity. The interest in examining the relationship between these two variables emerged from research that had suggested that relative left frontal cortical activity was associated with positive affect and approach motivation, whereas relative right frontal cortical activity was associated with negative affect and withdrawal motivation (Davidson, 1998; Harmon-Jones & Allen, 1997). For most emotions, the valence of the emotion (positivity/negativity) is related to its motivational direction (approach–withdrawal). Joy is often associated with approach motivation, and fear and disgust are often associated with withdrawal motivation. Thus, interpreting the research on asymmetrical frontal cortical activity and emotion/motivation in the above manner seemed valid. However, valence and motivational direction are not perfectly related as is illustrated with the emotion of anger—that is, anger is a negative emotion but it is often associated with approach motivation. Consequently, research on anger was conducted in part to test whether asymmetrical frontal cortical activity was associated with affective valence, motivational direction, or both.

In this research literature, the difference between activity in the left and right frontal cortical regions has been considered the variable of interest. In the electroencephalographic (EEG) research, the choice to use this difference score as the variable of interest was originally determined by methodological reasons, such as the need to control for individual differences in skull thickness and volume conduction, which could influence the measured EEG signals recorded from the scalp’s surface. However, subsequent research using a variety of methods has suggested that the difference between activity in the left and right frontal cortical regions may in fact be the variable of interest at a psychological/conceptual level of analysis (Schutter & Harmon-Jones, 2013)—that is, it may be the dynamic relationship between the left and right frontal regions that is responsible (in part) for greater approach versus withdrawal motivation. Consequently, when referring to this difference score, we often use terms like “relative left frontal cortical activity” to indicate greater left than right frontal activity.

Trait Anger

The first studies followed the lead of many past frontal asymmetry studies by simply examining the correlation of the affective/motivational trait with resting, baseline EEG activity measured over 4–8 minutes. The first study found that individual differences in anger, as measured by the anger subscale of the Buss and Perry (1992) Aggression Questionnaire, correlated with greater left frontal activity and lesser right frontal activity (Harmon-Jones & Allen, 1998). A follow-up study addressed an alternative explanation for the results of this study (Harmon-Jones, 2004). According to this alternative explanation, individuals who score high in trait anger may experience anger positively, and this positive feeling or attitude toward anger could explain why anger was correlated with greater relative left frontal activity. This study first developed a valid and reliable assessment of attitude toward anger, and then measured resting baseline EEG activity. Results revealed that trait anger correlated positively with attitude toward anger; individuals who scored as more chronically angry also evaluated their anger more positively. More important, however, greater relative left frontal activity correlated with trait anger but not with attitude toward anger. In addition, the relationship between trait anger and relative left frontal activity remained significant even when attitude toward anger was statistically controlled in regression analyses. Subsequent studies have revealed that trait aggression is also associated with greater relative left frontal activity (Rybak, Crayton, Young, Herba, & Konopka, 2006) even among imprisoned violent offenders (Keune et al., 2012).

State Anger

Given these findings, experiments were conducted to address the limitations inherent in correlational studies. In these experiments, anger was manipulated to test the effects of state anger on asymmetrical frontal brain activity. In the first experiment, participants wrote an essay about an issue they regarded as important and then they received (via random assignment) feedback from another person that was insulting or neutral (Harmon-Jones & Sigelman, 2001). Immediately following the participants' reading of the feedback, EEG was collected. As expected, participants who received the insulting feedback had greater relative left frontal activity than individuals who received neutral feedback. Moreover, within the insult condition, self-reported anger and behavioral aggression were positively correlated with relative left frontal cortical activity. Within the neutral condition, neither of these correlations was significant. Thus, left frontal activation was correlated with more subjective anger and behavioral aggression in the insult condition. This experiment provided the first evidence supporting the hypothesis that anger caused greater relative left frontal cortical activation.

Several experiments have directly and conceptually replicated these results (e.g., Jensen-Campbell, Knack, Waldrip, & Campbell, 2007). For example, in one experiment (Harmon-Jones et al., 2004) participants were insulted (or not) in the same manner as used by Harmon-Jones and Sigelman (2001). They were also induced to sympathize (or not) with the person who would insult them prior to receiving the insult. Results revealed that the manipulated increase in sympathy caused a reduction in the effects of insult on relative left frontal activity. These results suggest that experiencing sympathy for another person may reduce aggressive behaviors (e.g., see Miller & Eisenberg, 1988, for a review) by decreasing the relative left frontal activity associated with anger.

Ostracism from others has been found to evoke anger in a number of experiments (Williams, 2007). EEG experiments have replicated these results and also found that the degree of relative left frontal cortical activity that occurs in response to ostracism correlates with self-reported anger in a standard ostracism paradigm (Cyberball; Peterson, Gravens, & Harmon-Jones, 2011). Moreover, the degree of relative left frontal cortical activity that occurs in response to ostracism correlates with self-reported jealousy in a "romantic/sexual partner" ostracism paradigm (Harmon-Jones, Peterson, & Harris, 2009). In another experiment, Verona, Sadeh, and Curtin (2009) found that an impersonal stressor (high-pressure air blasts assigned by a computer) also evokes greater relative left frontal activity, and this increased left frontal activity correlated with more aggression in an "employee–supervisor" lab task.

Independent Manipulation of Approach Motivation within Anger

The experiments presented so far were designed so that the anger evoked was approach oriented. Although most experiences of anger involve approach motivation, not every experience of anger involves approach motivation. For example, situational variables such as threats of punishment and personality variables such as punishment sensitivity may reduce the approach motivation that occurs with anger (and cause anger to be mixed with anxiety and fear). Variables that cause a lower approach motivational response may also cause sadness to be mixed with anger. However, if anger is associated with greater left frontal cortical activity because of anger's association with approach motivation, then variables that influence the level of approach motivation of anger should influence relative left frontal activity. Several experiments have tested this idea by manipulating approach motivation independently of anger.

Past research and theory has suggested that coping potential influences motivational intensity (Brehm & Self, 1989; Wright, Tunstall, Williams, Goodwin, & Harmon-Jones, 1995). In other words, when individuals expect to be able to act to resolve a particular problem, they should experience more motivation, particularly if it is moderately difficult to act. Consequently, we predicted that expecting to be able to act to resolve an anger-producing situation will increase approach motivational intensity as compared with expecting to be unable to take action. Thus, because relative left frontal activity is associated with approach motivational intensity, the expectation of high coping potential within an anger-inducing situation should cause greater relative left frontal activity. Three experiments have found evidence consistent with this prediction (Harmon-Jones et al., 2003, 2006).

In the Harmon-Jones et al. (2003) experiment, participants were led to believe that they could or could not act to attempt to change an upcoming event that angered them (i.e., a tuition increase at their university). Participants in both conditions reported significant increases in anger over baseline, and the two conditions did not significantly differ from each other. More importantly, participants who believed they could engage in approach-related action to resolve the anger-producing event had greater left frontal activity than participants who expected to be unable to engage in such action. In addition, within this action-possible condition, participants who had greater left frontal activity to the angering situation also reported more anger; this correlational result suggests that their angry experience was approach motivated. In the condition where action was impossible, relative left frontal activity was not correlated with self-reported anger. Taken together with the high level of anger reported in this condition, this correlational result suggests that even though anger is usually associated with approach motivation, when approach-related action is not possible, approach motivation is low, even though angry feelings can be high. Last, within the action-possible condition, participants who had greater left frontal activity to the angering event were more likely to act in ways that would decrease the possibility of the angering event from occurring (i.e., they were more likely to sign a petition and take petitions with them for others to sign to try to eliminate a possible tuition increase at their university). This latter correlational result implies that greater approach motivation, as suggested by greater relative left frontal cortical activity, was associated with more overt behaviors aimed at resolving the angering negative situation.

This finding of greater left frontal cortical activation occurring when individuals are angered and expect to engage in approach-related action has been replicated (Harmon-Jones et al., 2006). In these two experiments, participants who scored low in racial prejudice were presented photographs depicting racist events as well as standard positive, negative (fear/disgust), and neutral photographs from the International Affective Picture System (Lang, Bradley, & Cuthbert, 1997). As expected, these racist photographs evoked self-reported anger. Prior to viewing all of the photographs, participants were assigned (or not) to expect an opportunity to act on their anger immediately after the viewing—that is, they were told that they would write essays discussing how racism was unjust, unfair, and immoral, and these essays would be used in prejudice-reduction studies in the future. In addition to that manipulation, the personal relevance of the photographs was manipulated by having participants either complete a self-report measure of racial prejudice or a comparable questionnaire about a neutral topic. As predicted, the greatest left frontal cortical activity occurred in response to the anger-inducing photographs when the photographs were made more personally relevant and when participants expected to act on their anger. These results conceptually replicate the results of the previous experiment and suggest that increasing the approach motivational character of anger increases relative left frontal cortical activity. The second experiment revealed that this effect was indeed strongest among those participants who scored lowest in racial prejudice.

We believe that these results do not indicate that heavy-handed, explicit manipulations of action possibility are necessary to cause greater relative left frontal activity. These manipulations of action possibility probably only increase the effects of the emotion manipulations on relative left frontal cortical activity. In line with this interpretation, a follow-up study revealed that the anger-inducing pictures evoked a nonsignificant effect on relative left frontal activity when participants were given no manipulations to influence action expectations or personal relevance. However, individuals who scored high on trait anger did show greater relative left frontal activity to the anger-inducing pictures—that is, individual differences in trait anger correlated with greater left frontal activity to anger-producing pictures (controlling for activity to neutral pictures; Harmon-Jones, 2007).

Further support for the importance of approach motivational intensity in determining the relationship of anger and asymmetrical frontal cortical activity comes from an experiment in which whole body posture was manipulated (Harmon-Jones & Peterson, 2009). This experiment tested the hypothesis that a supine body posture or lying flat on one's back would reduce approach motivation and correspondingly the increase in relative left frontal activity that occurs in response to angering events. The idea that a supine posture would reduce approach motivation was based on the observation that individuals often recline backward after acquiring goals and that the posture itself may prevent one from easily moving toward goals (see Price, Peterson, & Harmon-Jones, 2012, for a review). In the experiment, participants were randomly assigned to sit in an upright or reclined position. Then, they received neutral or insulting interpersonal feedback, as described above (Harmon-Jones & Sigelman, 2001). For participants assigned to the upright body posture, results replicated past research: Those who received insulting feedback had greater relative left frontal activation than those who received neutral feedback. More important, participants assigned to the supine body posture had a level of relative left frontal activation that was similar to those in the upright/neutral feedback condition and significantly less than those in the upright/insulting feedback condition. This whole body posture research illustrates the importance of approach motivation in the anger–relative left frontal activity relationship.

Manipulation of Asymmetrical Frontal Cortical Activity and Anger Processing

In the above research, anger was manipulated and regional brain activation was measured, as is commonly done in affective neuroscience research. Another less commonly used method involves the manipulation of regional brain activity and the measurement of a psychological variable. This method permits stronger causal inferences about the role of a particular brain region in a psychological process than the method of measuring regional brain activity to a psychological manipulation, because with the latter method, the measured variable may only be a correlate of the psychological process and not critically involved in the process.

One of the first experiments to manipulate brain activity and measure anger-related processes was conducted by d'Alfonso, van Honk, Hermans, Postma, and de Haan (2000). They used slow repetitive transcranial magnetic stimulation (rTMS) to inhibit activity in the left or right prefrontal cortex. Slow rTMS has been found to cause inhibition of cortical excitability. When slow rTMS is applied to the right prefrontal cortex, the right prefrontal cortex becomes less active and the left prefrontal cortex becomes more active. When slow rTMS is applied to the left prefrontal cortex, the left prefrontal cortex becomes less active and the right prefrontal cortex becomes more active. d'Alfonso et al. found that rTMS to the right prefrontal cortex caused more attention toward angry faces, whereas rTMS to the left prefrontal cortex caused more attention away from angry faces. These researchers interpreted these results to indicate that the increase in left prefrontal activity caused participants to attentionally engage with angry faces, as in an aggressive or dominance confrontation. On the other hand, the increase in right prefrontal activity caused participants to attentionally avoid angry faces, as in a fearful avoidance or submissiveness. These results are conceptually similar to other research that has found that attention toward angry faces is associated with high levels of self-reported anger and that attention away from angry faces is associated with high levels of fear responses (van Honk, Tuiten, de Haan, van den Hout, & Stam, 2001; van Honk et al., 1998, 1999). These results with rTMS have been replicated using other tasks (Donhauser, Belin, & Grosbras, 2014; van Honk & Schutter, 2006).

This research using rTMS has been extended using a different manipulation of asymmetrical frontal cortical activity and a different outcome variable related to anger. Past research has found that contraction of the left hand increases right frontal cortical activity and contraction of the right hand increases left frontal cortical activity (Harmon-Jones, 2006). These unilateral hand contractions also influence emotive responses (Harmon-Jones, 2006; Schiff & Lamon, 1989, 1994).

To test whether the unilateral contraction of hands would influence asymmetrical frontal cortical activity and angry aggression, participants were randomly assigned to contract their right or left hand. Then, they received insulting feedback from another participant, as in previous research (Harmon-Jones & Sigelman, 2001). Afterward, they performed a reaction time game against this other (ostensible) participant. The reaction time game was based on Buss's (1961) aggression paradigm and it was used so that behavioral aggression could be measured. In the game, participants could deliver blasts of white noise, ranging from 60 to 100 decibels and for any period of time up to 10 seconds if they won the reaction time trial (i.e., fastest to press the shift key when an image appeared). As predicted, participants who contracted their right hands gave louder and longer noise blasts to the other participant than those who contracted their left hands (Peterson, Shackman, & Harmon-Jones, 2008). Moreover, within the right-hand contraction condition, greater relative left frontal activation correlated with more behavioral aggression.

Another brain stimulation technique that has been used in the study of anger and asymmetrical frontal cortical activity is transcranial direct current stimulation (tDCS). This methodology uses two electrodes, an anode and a cathode, to simultaneously modulate activity in opposite directions in the left and right frontal cortices. Anodal tDCS increases excitability, whereas cathodal tDCS decreases cortical excitability in the targeted brain region (Ardolino, Bossi, Barbieri, & Priori, 2005; Nitsche & Paulus, 2000). Thus, this method is perfect for studies of asymmetrical frontal activity and emotive states where the psychophysiological variable of interest—the asymmetry—shows greater activity in one hemisphere and lesser activity in the contralateral hemisphere.

So far, two tDCS experiments on anger have been conducted. In both, participants were randomly assigned to one of three tDCS conditions: anodal to right frontal cortex and cathodal to left frontal cortex; cathodal to right frontal cortex and anodal to left frontal cortex; or sham, which is a condition that gives stimulation for a few seconds at the beginning of the 15-minute stimulation period. In both experiments, participants were unable to correctly guess which condition they had experienced, thus suggesting that the sham stimulation was successful. After 10 minutes of stimulation, participants in both experiments received insulting interpersonal feedback similar to that used in past experiments such as Harmon-Jones and Sigelman (2001). In the first experiment (Hortensius, Schutter, & Harmon-Jones, 2012), at the beginning of the session, participants were led to believe that they might interact with the other person participating in the session (which was ultimately the person who insulted them). After the 15 minutes ended, participants played a competitive reaction time game against the other person, so that behavioral aggression could be measured. Finally, self-reported emotions about the feedback were measured. Results revealed that only within the condition in which left frontal cortical activity was increased did self-reported anger relate to aggression. In other words, when individuals were angry and their left frontal cortex was made more active, they behaved more aggressively. In the other two conditions, this effect did not emerge.

In the second experiment (Kelley, Hortensius, & Harmon-Jones, 2013), at the beginning of the session, participants were *not* led to believe that they might interact with the other person participating in the session. After the 15 minutes ended, participants completed two self-report measures of rumination. Based on past work that had linked rumination with more depression (Nolen-Hoeksema, 2000) and depression with greater relative right frontal activity (Thibodeau, Jorgensen, & Kim, 2006), it was expected that the manipulated increase in right frontal activity might cause more rumination about the angering feedback as compared with the other two tDCS conditions. Indeed, it did. These results are conceptually consistent with earlier results obtained from a study examining how individual differences in depression versus mania relate to asymmetrical frontal cortical activity to angering events (Harmon-Jones et al., 2002). In this study, greater mania related to greater relative left frontal cortical activity and greater depression related to greater relative right frontal cortical activity to the anger-evoking event.

Conceptual Interpretation of the Anger–Approach Relationship

One issue that has arisen in the consideration of anger being an approach-oriented emotion is exactly how it is approach oriented. On one hand, anger is associated with approach motivation because anger occurs when approach-oriented goals are blocked—that is, when an individual is motivated to gain a desired reward and is blocked from progress toward the reward, then anger occurs (Carver & Harmon-Jones, 2009). This interpretation of the anger–approach relationship employs the stimulus (i.e., blocked approach motivation) as the determinant of the relationship.

Because anger occurs when desires are blocked, anger itself may orient individuals toward positive outcomes. Indeed, the reviewed research suggests this to be the case (e.g., Ford et al., 2010). However, does anger always orient individuals toward positive outcomes? We suspect that anger will not always do so, because one of anger's main motivational imperatives is to attack the source of anger (Berkowitz, 2012). In these cases, anger may cause individuals to temporarily abandon the original blocked goal so that the angering stimulus or person can be attacked. This latter case may illustrate the difference between anger and rage (Lewis, 1993).

Another, parallel interpretation, however, employs the response as the determinant of the anger–approach relationship—that is, anger is linked to approach motivation, because anger is tightly linked to approach-related responses. Moreover, anger appears to occur in a wide array of situations that do not appear to result from goal blocking (e.g., Berkowitz & Harmon-Jones, 2004a, 2004b). For example, simply adopting physical expressions of anger, even when individuals are not aware that they are creating angry expressions, causes physiological and cognitive responses that are approach oriented (Coan, Allen, & Harmon-Jones, 2001; Keltner, Ellsworth, & Edwards, 1993). Also, angry moods and trait anger appear to be linked to approach motivation, and it seems that these characteristics are at least occasionally linked with approach motivation that did not result from blocked goals. Thus, we suggest that anger may evoke approach motivation even in situations that do not contain an obstacle to a desired outcome.

Anger and Withdrawal Motivation

The research reviewed so far suggests that anger is associated with greater relative left frontal activation because anger is often associated with approach motivation. This conclusion is supported by the experiments that manipulated approach motivation independently of anger and found that it was the approach motivational intensity of anger that determined relative left frontal activation.

Could anger ever be associated with withdrawal motivation and increased relative right frontal activation? Based on past research, we suspect that anger may be evolutionarily prepared to be associated with approach motivation. In support, research with infants (Lewis et al., 1992) and nonhuman animals (Blanchard & Blanchard, 1984) suggests that anger is predominantly associated with approach motivational tendencies.

However, anger may become associated with other response tendencies in addition to approach ones over the lifetime. Moreover, although the blocking of approach motivation may be the primary elicitor of anger, the situations that block approach may also contain threats of punishment that elicit other emotional states. Thus, some situations may cause and/or persons may experience some withdrawal tendencies and increased relative right frontal cortical activity during the experience of anger. As we review below, a few studies have tested these ideas.

One of the first experiments designed to test this idea had soccer players *imagine* that their coach unfairly prevented them from playing a soccer game (Wacker, Heldmann, & Stemmler, 2003). In the anger–approach condition, the players imagined approaching the coach and protesting, whereas in the anger–withdrawal condition, they imagined backing out of the locker room and silently swearing at the coach. In both conditions, the players reported feeling angry; however, the two conditions did not differ from each other in relative left frontal activation, even though both anger conditions evoked greater relative left frontal activation than the neutral comparison condition.

Another study (Hewig, Hagemann, Seifert, Naumann, & Bartussek, 2004) examined the relationship between resting baseline frontal asymmetry and trait anger out, trait anger in, and trait anger control, measured with the State–Trait Anger Expression Questionnaire (Spielberger, 1988). These three measures of anger traits are designed to measure how individuals express anger. Anger out is defined as "expressing angry feelings in aggressive verbal or motor behavior directed toward other people or objects in the environment" (e.g., "When angry or furious, I lose my temper"; Spielberger et al., 1995, p. 57). Therefore, anger out appears to be assessing an approach-related response of anger. Anger in is defined as the degree to which individuals suppress anger and/or direct it at themselves (e.g., "When angry or furious, I keep things in"). Anger control is defined as the degree to which individuals monitor and prevent the expression of anger (e.g., "When angry or furious, I control my angry feelings"). Hewig and colleagues (2004) found that trait anger out correlated with greater relative left frontal activity at resting baseline, but that trait anger control correlated with greater relative right frontal activity. Trait anger in was not correlated with resting frontal asymmetry. Hewig and colleagues (2004) interpreted the results with anger control as suggesting that individuals who score high in anger control may be particularly high in withdrawal motivation. This latter correlation may be due to individuals who score higher in anger control being higher in anxiety or sadness, as these emotions may reduce approach motivation (Lewis & Ramsay, 2005).

As revealed above, the evidence in support of the idea that anger can be associated with withdrawal motivational tendencies is mixed. Anger may be associated with withdrawal motivation but this may occur only when the angering situation also arouses punishment concerns. Thus, these types of situations may evoke feelings of anger as well as anxiety.

A study designed to test these ideas created a situation in which anger was considered particularly socially inappropriate (Zinner, Brodish, Devine, & Harmon-Jones, 2008). This study built on past research suggesting that norms exist that encourage political correctness and discourage expressions of racial prejudice, but that some individuals are angered by the pressures to behave in accord with these norms (Plant & Devine, 1998). These individuals, rather than outwardly expressing their anger, may withdraw when they experience anger in response to situations that emphasize these norms. Indeed, other research has found that some individuals reporting being angry when socially pressured to respond without racial prejudice (Plant & Devine, 2001). In the EEG study, white participants (university students in the United States) were led to believe they were about to interact with a black person. To increase the possibility of anger among some participants, the experimenter mentioned that the study concerned the importance of harmonious interracial interactions. The participants were then instructed to "mentally prepare" for the interaction, and EEG was recorded. Then, prior to the (ostensible) interaction, participants completed a self-report affect measure that asked them to indicate how they felt about the upcoming interaction. In this particular situation, self-reported anger correlated with greater relative right frontal cortical activity as well as increased skin conductance levels and more spontaneous eye blinking. Taken together, these results suggest that the individuals who felt the most anger may have been motivated to withdraw (as suggested by relative right frontal activity), were aroused (skin conductance), and were attempting to suppress their anger (eye blinking; Gross & Levenson, 1993). These individuals may have been motivated to withdraw and suppress their anger because they did not want to appear socially inappropriate. Importantly, the self-reported anger was correlated with anxiety; these results suggest that this social context may have evoked punishment concerns among those who were angry.

Much evidence supports the idea that anger is associated with approach motivational tendencies. Less evidence supports the idea that anger is associated with withdrawal motivational tendencies. In the studies that have examined this latter idea, the results have revealed that state anger may be associated with relative right frontal cortical activity (and possibly withdrawal motivation) when individuals also experience anxiety and are perhaps concerned about punishment (Zinner et al., 2008). In addition, individuals who score high in the trait of anger control tend to have greater relative right frontal activity at rest, suggesting that they may be motivated to withdraw when angry (Hewig et al., 2004).

Conclusion

In this chapter, we have reviewed theories and research related to understanding the causes of anger, the subjective feeling of anger, and the motivational components of anger. In doing so, we also reviewed research relating anger to asymmetrical frontal cortical activity, which led to a better understanding of the role of asymmetrical frontal cortical activity in emotive processes but also suggested new insights into understanding anger.

In addition to increasing our understanding of anger, the reviewed research has pointed to the importance of delineating emotional experience from emotional expression and emotional valence from motivational direction. The reviewed research contributes to a better understanding of the conceptualization of emotional space. Previously, much research and theory emphasized emotional valence and arousal as primary dimensions underlying emotions (Lang, 1995; Watson, 2000). These perspectives have also suggested that valence relates directly to motivational direction, such that positivity is approach oriented and negativity is withdrawal oriented (e.g., Norris et al., 2010). However, research on anger suggests that the valence of an emotion is independent of the motivational direction of an emotion. Negative emotions such as anger may be associated with approach motivation.

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References

Amodio, D. M., & Harmon-Jones, E. (2011). Trait emotions and startle eyeblink responses to affective pictures: On the unique relationship of trait anger. *Emotion, 11*, 47–51.

Ardolino, G., Bossi, B., Barbieri, S., & Priori, A. (2005). Non-synaptic mechanisms underlie the after-effects of cathodal transcutaneous direct current stimulation of the human brain. *Journal of Physiology, 568*, 653–663.

Berkowitz, L. (1989). Frustration–aggression hypothesis: Examination and reformulation. *Psychological Bulletin, 106*, 59–73.

Berkowitz, L. (1993). *Aggression: Its causes, consequences, and control*. New York: McGraw-Hill.

Berkowitz, L. (1999). Anger. In T. Dalgleish & M. Power (Eds.), *Handbook of cognition and emotion* (pp. 411–428). Chichester, UK: Wiley.

Berkowitz, L. (2000). *Causes and consequences of feelings*. Cambridge, UK: Cambridge University Press.

Berkowitz, L. (2012). A different view of anger: The cognitive-neoassociation conception of the relation of anger to aggression. *Aggressive Behavior, 38*, 322–333.

Berkowitz, L., Cochran, S., & Embree, M. (1981). Physical pain and the goal of aversively stimulated aggression. *Journal of Personality and Social Psychology, 40*, 687–700.

Berkowitz, L., & Harmon-Jones, E. (2004a). More thoughts about anger determinants. *Emotion, 4*, 151–155.

Berkowitz, L., & Harmon-Jones, E. (2004b). Toward an understanding of the determinants of anger. *Emotion, 4*, 107–130.

Blanchard, D. C., & Blanchard, R. J. (1984). Affect and aggression: An animal model applied to human behavior. *Advances in the Study of Aggression, 1*, 1–62.

Brehm, J. W., & Self, E. (1989). The intensity of motivation. In M. R. Rosenzweig & L. W. Porter (Eds.), *Annual review of psychology* (Vol. 40, pp. 109–131). Palo Alto, CA: Annual Reviews.

Buss, A. H. (1961). *The psychology of aggression*. New York: Wiley.

Buss, A. H., & Perry, M. (1992). The Aggression Questionnaire. *Journal of Personality and Social Psychology, 63*, 452–459.

Carver, C. S. (2004). Negative affects deriving from the Behavioral Approach System. *Emotion, 4*, 3–22.

Carver, C. S., & Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological Bulletin, 135*, 183–204.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology, 67*, 319–333.

Cassidy, F., Forest, K., Murry, E., & Carroll, B. J. (1998). A factor analysis of the signs and symptoms of mania. *Archives of General Psychiatry, 55*, 27–32.

Coan, J. A., Allen, J. J. B., & Harmon-Jones, E. (2001). Voluntary facial expression and hemispheric asymmetry over the frontal cortex. *Psychophysiology, 38*, 912–925.

d'Alfonso, A. A. L., van Honk, J., Hermans, E., Postma, A., & de Haan, E. H. F. (2000). Laterality effects in selective attention to threat after repetitive transcranial magnetic stimulation at the prefrontal cortex in female subjects. *Neuroscience Letters, 280*, 195–198.

Darwin, C. (1965). *The expression of the emotions in man and animals*. Chicago: University of Chicago Press. (Original work published 1872)

Davidson, R. J. (1998). Anterior electrophysiological asymmetries, emotion, and depression: Conceptual and methodological conundrums. *Psychophysiology, 35*, 607–614.

Deater-Deckard, K., Beekman, C., Wang, Z., Kim, J., Petrill, S., Thompson, L., et al. (2012). Approach/positive anticipation, frustration/anger, and overt aggression in childhood. *Journal of Personality, 78*, 991–1010.

Depue, R. A., & Iacono, W. G. (1989). Neurobehavioral aspects of affective disorders. *Annual Review of Psychology, 40*, 457–492.

Dollard, J., Doob, L., Miller, N., Mowrer, O., & Sears, R. (1939). *Frustration and aggression*. New Haven, CT: Yale University Press.

Donhauser, P. W., Belin, P., & Grosbras, M.-H. (2014). Biasing the perception of ambiguous vocal affect: A TMS study on frontal asymmetry. *Social Cognitive Affective Neuroscience, 9*, 1046–1051.

Ellsworth, P. C., & Scherer, K. R. (2003). Appraisal processes in emotion. In R. J. Davidson, H. Goldsmith, & K. R. Scherer (Eds.), *Handbook of the affective sciences* (pp. 592–595). New York: Oxford University Press.

Ford, B. Q., Tamir, M., Brunyé, T. T., Shirer, W. R., Mahoney, C. R., & Taylor, H. A. (2010). Keeping your eyes on the prize: Anger and visual attention to threats and rewards. *Psychological Science, 21*, 1098–1105.

Ford, B. Q., Tamir, M., Gagnon, S. A., Taylor, H. A., & Brunyé, T. T. (2012). The angry spotlight: Trait anger and selective visual attention to rewards. *European Journal of Personality, 26*, 90–98.

Fowles, D. C. (1993). Behavioral variables in psychopathology: A psychobiological perspective. In P. B. Sutker & H. E. Adams (Eds.), *Comprehensive handbook of psychopathology* (2nd ed., pp. 57–82). New York: Plenum Press.

Frijda, N. H. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.

Frijda, N. H. (1993). The place of appraisal in emotion. *Cognition and Emotion, 7*, 357–387.

Frijda, N. H., Kuipers, P., & ter Schure, E. (1989). Relations among emotion, appraisal, and emotional action readiness. *Journal of Personality and Social Psychology, 57*, 212–228.

Frijda, N. H., & Zeelenberg, M. (2001). Appraisal: What is the dependent? In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion*. Oxford, UK: Oxford University Press.

Gray, J. A. (1987). *The psychology of fear and stress*. London: Cambridge University Press.

Gross, J. J., & Levenson, R. W. (1993). Emotional suppression: Physiology, self-report, and expressive behavior. *Journal of Personality and Social Psychology, 64*, 970–986.

Harmon-Jones, C., Schmeichel, B. J., Mennitt, E., & Harmon-Jones, E. (2011). The expression of determination: Similarities between anger and approach-related positive affect. *Journal of Personality and Social Psychology, 100*, 172–181.

Harmon-Jones, E. (2003). Anger and the behavioural approach system. *Personality and Individual Differences, 35*, 995–1005.

Harmon-Jones, E. (2004). On the relationship of anterior brain activity and anger: Examining the role of attitude toward anger. *Cognition and Emotion, 18*, 337–361.

Harmon-Jones, E. (2006). Unilateral right-hand contractions cause contralateral alpha power suppression and approach motivational affective experience. *Psychophysiology, 43*, 598–603.

Harmon-Jones, E. (2007). Trait anger predicts relative left frontal cortical activation to anger-inducing stimuli. *International Journal of Psychophysiology, 66*, 154–160.

Harmon-Jones, E., Abramson, L. Y., Sigelman, J., Bohlig, A., Hogan, M. E., & Harmon-Jones, C. (2002). Proneness to hypomania/mania or depression and asymmetrical frontal cortical responses to an anger-evoking event. *Journal of Personality and Social Psychology, 82*, 610–618.

Harmon-Jones, E., & Allen, J. J. B. (1997). Behavioral activation sensitivity and resting frontal EEG asymmetry: Covariation of putative indicators related to risk for mood disorders. *Journal of Abnormal Psychology, 106*, 159–163.

Harmon-Jones, E., & Allen, J. J. B. (1998). Anger and prefrontal brain activity: EEG asymmetry consistent with approach motivation despite negative affective valence. *Journal of Personality and Social Psychology, 74*, 1310–1316.

Harmon-Jones, E., & Harmon-Jones, C. (2010). On the relationship of trait PANAS positive activation and trait anger: Evidence of a suppressor relationship. *Journal of Research in Personality, 44*, 120–123.

Harmon-Jones, E., Harmon-Jones, C., Abramson, L. Y., & Peterson, C. K. (2009). PANAS positive activation is associated with anger. *Emotion, 9*, 183–196.

Harmon-Jones, E., Harmon-Jones, C., Amodio, D. M., & Gable, P. A. (2011). Attitudes toward emotions. *Journal of Personality and Social Psychology, 101*, 1332–1350.

Harmon-Jones, E., Harmon-Jones, C., Fearn, M., Sigelman, J. D., & Johnson, P. (2008). Action orientation, relative left frontal cortical activation, and spreading of alternatives: A test of the action-based model of dissonance. *Journal of Personality and Social Psychology, 94*, 1–15.

Harmon-Jones, E., Lueck, L., Fearn, M., & Harmon-Jones, C. (2006). The effect of personal relevance and approach-related action expectation on relative left frontal cortical activity. *Psychological Science, 17*, 434–440.

Harmon-Jones, E., & Peterson, C. K. (2009). Supine body position reduces neural response to anger evocation. *Psychological Science, 20*, 1209–1210.

Harmon-Jones, E., Peterson, C. K., & Harris, C. R. (2009). Jealousy: Novel methods and neural correlates. *Emotion, 9*, 113–117.

Harmon-Jones, E., & Sigelman, J. (2001). State anger and prefrontal brain activity: Evidence that insult-related relative left prefrontal activation is associated with experienced anger and aggression. *Journal of Personality and Social Psychology, 80*, 797–803.

Harmon-Jones, E., Sigelman, J. D., Bohlig, A., & Harmon-Jones, C. (2003). Anger, coping, and frontal cortical activity: The effect of coping potential on anger-induced left frontal activity. *Cognition and Emotion, 17*, 1–24.

Harmon-Jones, E., Vaughn-Scott, K., Mohr, S., Sigelman, J., & Harmon-Jones, C. (2004). The effect of manipulated sympathy and anger on left and right frontal cortical activity. *Emotion, 4*, 95–101.

Hewig, J., Hagemann, D., Seifert, J., Naumann, E., & Bartussek, D. (2004). On the sele
ctive relation of frontal cortical asymmetry and anger-out versus anger-control. *Journal of Personality and Social Psychology, 87*, 926–939.

Holtzworth-Munroe, A., & Clements, K. (2007). The association between anger and male perpetration of intimate partner violence. In T. A. Cavell & K. T. Malcolm (Eds.), *Anger, aggression, and interventions for interpersonal violence* (pp. 313–348). Mahwah, NJ: Erlbaum.

Hortensius, R., Schutter, D. J. L. G., & Harmon-Jones, E. (2012). When anger leads to aggression: Induction of relative left frontal cortical activity with transcranial direct current stimulation increases the anger–aggression relationship. *Social Cognitive Affective Neuroscience, 7*, 342–347.

Izard, C. E. (1977). *Human emotions*. New York: Plenum Press.

Izard, C. E. (1991). *The psychology of emotions*. New York: Plenum Press.

Jensen-Campbell, L. A., Knack, J. M., Waldrip, A. M., & Campbell, S. D. (2007). Do Big Five personality traits associated with self-control influence the regulation of anger and aggression? *Journal of Research in Personality, 41*, 403–424.

Kazlauckas, V., Schuh, J., Dall'Igna, O. P., Pereira, G. S., Bonan, C. D., & Lara, D. R. (2005). Behavioral and cognitive profile of mice with high and low exploratory phenotypes. *Behavioural Brain Research, 162*, 272–278.

Kelley, N. J., Hortensius, R., & Harmon-Jones, E. (2013). When anger leads to rumination: Induction of relative right frontal cortical activity with transcranial direct current stimulation increases anger-related rumination. *Psychological Science, 24*, 475–481.

Keltner, D., Ellsworth, P. C., & Edwards, K. (1993). Beyond simple pessimism: Effects of sadness and anger on social perception. *Journal of Personality and Social Psychology, 64*, 740–752.

Keune, P. M., van der Heiden, L., Várkuti, B., Konicar, L., Veit, R., & Birbaumer, N. (2012). Prefrontal brain asymmetry and aggression in imprisoned violent offenders. *Neuroscience Letters, 515*, 191–195.

Lang, P. J. (1995). The emotion probe. *American Psychologist, 50*, 372–385.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1990). Emotion, attention, and the startle reflex. *Psychological Review, 97*, 377–398.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). *International Affective Picture System (IAPS): Technical manual and affective ratings*. Gainesville, FL: NIMH Center for the Study of Emotion and Attention.

Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

Lerner, J. S., & Keltner, D. (2001). Fear, anger, and risk. *Journal of Personality and Social Psychology, 81*, 146–159.

Lewis, M. (1993). The development of anger and rage. In R. A. Glick & S. P. Roose (Eds.), *Rage, power, and aggression* (pp. 148–168). New Haven, CT: Yale University Press.

Lewis, M. (2010). The development of anger. In M. Potegal, G. Stemmler, & C. Spielberger (Eds.), *International handbook of anger: Constituent and concomitant biological, psychological, and social processes* (pp. 177–191). New York: Springer.

Lewis, M. (2014). *The rise of consciousness and the development of emotional life*. New York: Guilford Press.

Lewis, M., Alessandri, S. M., & Sullivan, M. W. (1990). Violation of expectancy, loss of control, and anger expressions in young infants. *Developmental Psychology, 26*, 745–751.

Lewis, M., & Michalson, L. (1983). *Children's emotions and moods: Developmental theory and measurement*. New York: Plenum Press.

Lewis, M., & Ramsay, D. (2005). Infant emotional and cortisol responses to goal blockage. *Child Development, 76*, 518–530.

Lewis, M., Sullivan, M. W., Ramsay, D. S., & Alessandri,

S. M. (1992). Individual differences in anger and sad expressions during extinction: Antecedents and consequences. *Infant Behavior and Development, 15*, 443–452.

Malone, R. P., Delaney, M. A., Luebbert, J. F., Cater, J., & Campbell, M. (2000). A double-blind placebo-controlled study of lithium in hospitalized aggressive children and adolescents with conduct disorder. *Archives of General Psychiatry, 57*, 649–654.

Mikulincer, M. (1988). Reactance and helplessness following exposure to unsolvable problems: The effects of attributional style. *Journal of Personality and Social Psychology, 54*, 679–686.

Miller, P. A., & Eisenberg, N. (1988). The relation of empathy to aggressive and externalizing/antisocial behavior. *Psychological Bulletin, 103*, 324–344.

Mowrer, O. (1960). *Learning theory and behavior.* Hoboken, NJ: Wiley.

Niaura, R., Todaro, J. F., Stroud, L., Spiro, A., III, Ward, K. D., & Weiss, S. (2002). Hostility, the metabolic syndrome, and incident coronary heart disease. *Health Psychology, 21*, 588–593.

Nitsche, M. A., & Paulus, W. (2000). Excitability changes induced in the human motor cortex by weak transcranial direct current stimulation. *Journal of Physiology, 527*, 633–639.

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology, 109*, 504–511.

Norris, C. J., Gollan, J., Berntson, G. G., & Cacioppo, J. T. (2010). The current status of research on the structure of evaluative space. *Biological Psychology, 84*, 422–436.

Ortony, A., Clore, G. L., & Collins, A. (1988). *The cognitive structure of emotions.* New York: Cambridge University Press.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions.* New York: Oxford University Press.

Parkinson, B., & Manstead, A. S. R. (1992). Appraisal as a cause of emotion. In M. S. Clark (Ed.), *Review of personality and social psychology* (Vol. 13, pp. 122–149). Newbury Park, CA: Sage.

Peterson, C. K., Gravens, L., & Harmon-Jones, E. (2011). Asymmetric frontal cortical activity and negative affective responses to ostracism. *Social Cognitive Affective Neuroscience, 6*, 277–285.

Peterson, C. K., Shackman, A. J., & Harmon-Jones, E. (2008). The role of asymmetrical frontal cortical activity in aggression. *Psychophysiology, 45*, 86–92.

Pettersson, E., & Turkheimer, E. (2013). Approach temperament, anger, and evaluation: Resolving a paradox. *Journal of Personality and Social Psychology, 105*, 285–300.

Plant, E. A., & Devine, P. G. (1998). Internal and external motivation to respond without prejudice. *Journal of Personality and Social Psychology, 75*, 811–832.

Plant, E. A., & Devine, P. G. (2001). Responses to other-imposed pro-black pressure: Acceptance or backlash. *Journal of Experimental Social Psychology, 37*, 486–501.

Price, T. F., Peterson, C. K., & Harmon-Jones, E. (2012). The emotive neuroscience of embodiment. *Motivation and Emotion, 36*, 27–37.

Robinson, R. G., & Downhill, J. E. (1995). Lateralization of psychopathology in response to focal brain injury. In R. J. Davidson & K. Hugdahl (Eds.), *Brain asymmetry* (pp. 693–711). Cambridge, MA: MIT Press.

Rolls, E. T. (1999). *The brain and emotion.* Oxford, UK: Oxford University Press.

Roseman, I. J. (1991). Appraisal determinants of discrete emotions. *Cognition and Emotion, 5*, 161–200.

Roseman, I. J., Spindel, M. S., & Jose, P. E. (1990). Appraisals of emotion-eliciting events: Testing a theory of discrete emotions. *Journal of Personality and Social Psychology, 59*, 899–915.

Russell, J. A., & Fernández-Dols, J. M. (1997). *The psychology of facial expression.* Paris: Cambridge University Press.

Rybak, M., Crayton, J. W., Young, I. J., Herba, E., & Konopka, L. M. (2006). Frontal alpha power asymmetry in aggressive children and adolescents with mood and disruptive behavior disorders. *Clinical EEG Neuroscience, 37*, 16–24.

Scherer, K. R. (2001). Appraisal considered as a process of multilevel sequential checking. In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion* (pp. 92–120). Oxford, UK: Oxford University Press.

Schiff, B. B., & Lamon, M. (1989). Inducing emotion by unilateral contraction of facial muscles: A new look at hemispheric specialization in the experience of emotion. *Neuropsychologia, 27*, 923–935.

Schiff, B. B., & Lamon, M. (1994). Inducing emotion by unilateral contraction of hand muscles. *Cortex, 30*, 247–254.

Schutter, D. J. L. G., & Harmon-Jones, E. (2013). The corpus callosum: A commissural road to anger and aggression. *Neuroscience and Biobehavioral Reviews, 37*, 2481–2488.

Shaver, P., Schwartz, J., Kirson, D., & O'Connor, C. (1987). Emotion knowledge: Further exploration of a prototype approach. *Journal of Personality and Social Psychology, 52*, 1061–1086.

Spielberger, C. D. (1988). *Manual for the State–Trait Anger Expression Inventory (STAXI).* Odessa, FL: Psychological Assessment Resources.

Spielberger, C. D., Jacobs, G. A., Russell, S. F., & Crane, R. S. (1983). Assessment of anger: The State–Trait Anger Scale. In J. N. Butcher & C. D. Spielberger (Eds.), *Advances in personality assessment* (Vol. 2, pp. 159–187). Hillsdale, NJ: Erlbaum.

Spielberger, C. D., Reheiser, E. C., & Sydeman, S. J. (1995). Measuring the experience, expression, and control of anger. In H. Kassinove (Ed.), *Anger disorders: Definition, diagnosis, and treatment* (pp. 49–67). Washington, DC: Taylor & Francis.

Stein, N. L., & Levine, L. J. (1989). The causal organization of emotional knowledge: A developmental study. *Cognition and Emotion, 3*, 343–378.

Taylor, S. E., & Gollwitzer, P. M. (1995). Effects of mindset on positive illusions. *Journal of Personality and Social Psychology, 69*, 213–226.

Thibodeau, R., Jorgensen, R. S., & Kim, S. (2006). Depression, anxiety, and resting frontal EEG asymmetry: A meta-analytic review. *Journal of Abnormal Psychology, 115*, 715–729.

Tyrer, S., & Shopsin, B. (1982). Symptoms and assessment of mania. In E. S. Paykel (Ed.), *Handbook of affective disorders* (pp. 12–23). New York: Guilford Press.

Urošević, S. Abramson, L. Y., Harmon-Jones, E., & Alloy, L. B. (2008). Dysregulation of the Behavioral Approach System (BAS) in bipolar spectrum disorders: Review of theory and evidence. *Clinical Psychology Review, 28*, 1188–1205.

van Honk, J., & Schutter, D. J. (2006). From affective valence to motivational direction: The frontal asymmetry of emotion revised. *Psychological Science, 17*, 963–965.

van Honk, J., Tuiten, A., de Haan, E., van den Hout, M., & Stam, H. (2001). Attentional biases for angry faces: Relationships to trait anger and anxiety. *Cognition and Emotion, 15*, 279–297.

van Honk, J., Tuiten, A., van den Hout, M., Koppeschaar, H., Thijssen, J., de Haan, E., et al. (1998). Baseline salivary cortisol levels and preconscious selective attention for threat: A pilot study. *Psychoneuroendocrinology, 23*, 741–747.

van Honk, J., Tuiten, A., Verbaten, R., van den Hout, M., Koppeschaar, H., Thijssen, J., et al. (1999). Correlations among salivary testosterone, mood, and selective attention to threat in humans. *Hormones and Behavior, 36*, 17–24.

Verona, E., Sadeh, N., & Curtin, J. (2009). Stress-induced asymmetric frontal brain activity and aggression risk. *Journal of Abnormal Psychology, 118*, 131–145.

Wacker, J., Heldmann, M., & Stemmler, G. (2003). Separating emotion and motivational direction in fear and anger: Effects on frontal asymmetry. *Emotion, 3*, 167–193.

Watson, D. (2000). *Mood and temperament*. New York: Guilford Press.

Watson, D., & Clark, L. A. (1994). *The PANAS-X: Manual for the Positive and Negative Affect Schedule—Expanded Form*. Iowa City: University of Iowa Press.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063–1070.

Williams, K. D. (2007). Ostracism. *Annual Review of Psychology, 58*, 425–452.

Wortman, C. B., & Brehm, J. W. (1975). Responses to uncontrollable outcomes: An integration of reactance theory and the learned helplessness model. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 8, pp. 278–336). New York: Academic Press.

Wright, R. A., Tunstall, A. M., Williams, B. J., Goodwin, J. S., & Harmon-Jones, E. (1995). Social evaluation and cardiovascular response: An active coping approach. *Journal of Personality and Social Psychology, 69*, 530–543.

Zinner, L., Brodish, A., Devine, P. G., & Harmon-Jones, E. (2008). Anger and asymmetrical frontal cortical activity: Evidence for an anger–withdrawal relationship. *Cognition and Emotion, 22*, 1081–1093.

CHAPTER 45

Self-Conscious Emotions

Embarrassment, Pride, Shame, Guilt, and Hubris

Michael Lewis

Elsewhere (Chapter 15, this volume) I have tried to show that the first major event in emotional development in the human child occurs with the rise of consciousness.[1] The rise of consciousness alters the nature of the early emotional action patterns, present as part of the evolved biological features of the infant. The advent of consciousness also gives rise to a new set of action patterns that serve as the stimulus for the cognitive-attributional system. These new emotions have been called the self-conscious emotions. They are captured by our language as such statements as "I am so proud of winning first prize in the spelling bee."

This sentence captures my view of the self-conscious emotions, and in particular, pride. There are two references to myself, the reference to an experience, "I am so. . . . " and the cause of that state, "my winning." The emergence of consciousness is defined by this self-reflection. It is important to note that the cause of the pride is the success of some behavior. The sentence itself specifies the cause for the pride, which implies that what was done succeeded in meeting some standard, rule, or goal that the speakers had in regard to their behavior.

With the emergence of consciousness, a person's emotional life is transformed. In addition to the early action patterns, elicited by physical properties of the literal world, the child has now acquired added ideas as elicitors of an emotion, in particular, ideas about the self. It is these ideas that now become the elicitors of new emotional action patterns. Make no mistake, these new action patterns are as biologically derived as the original ones; neither the experience of it nor the action patterns associated with it are taught. It should be pointed out that once ideas emerge, these ideas can also be the elicitors of the early emotional action patterns. Sadness at loss of the mother in the literal world now can be sadness caused by the idea of her loss. Because these self-conscious emotions require the emergence of self-reflection, they appear in the middle of the second year of life. And because some of these self-conscious emotions require the development of other ideas, such as ideas about the standards, rules, and goals (SRGs) of the family and culture, as well as ideas about personal responsibility, their development spans the period from the emergence of consciousness, around 15–24 months, to the end of the child's third year, around 30–36 months. We therefore can think of the child's emotional life as consisting of three periods: the period of the early emotions or at least of their action patterns, the period of the emergence of consciousness, and the period of the development of the self-conscious emotions. However, the set of self-conscious emotions itself needs to be divided between the early ones, what I call the "self-conscious exposed emotions," and the later ones, what I call the "self-conscious evaluative emotions." The major difference between these two sets of emotions centers on the development of knowledge about the SRGs of the family and the greater culture, and the incorporation of this knowledge into the child's mental life. The exposed self-conscious emotions appear to be tied directly to the emergence of a mental representation of self and include at least embarrassment, jealousy, and empathy. The evaluative self-conscious emotions also require the mental representation of the self, but in addition to the knowledge of some of the SRGs the child has acquired, there is a need to develop some ideas about responsibility for the child's actions and thoughts. These evaluative emotions include shame, guilt, pride, embarrassment, and hubris. Hubris is used to denote pride that is not focused on actions but on the global self. Because the overall model, the earlier action patterns, and the emergence of consciousness have already been discussed, this chapter focuses on the self-conscious emotions.

The Self-Conscious Emotions

The self-conscious emotions—in particular, shame—can help us distinguish between those who would attribute mental representation involving the self at an early age and those who see it emerge in the middle of the second year of life. While it is the case that shame can be elicited by many causes, the claim that it exists early within the first year is similar to the claim that all emotions exist in the first months of life, for example, jealousy (Masciuch & Kienapple, 1993). Historically, it has been thought that the self-conscious emotions such as shame took time to develop. Freud (1936/1963), for one, believed that the child needed to have developed an ego and a superego in order to experience guilt and shame. Tomkins's (1963) view had as its central theme how children think of others' thoughts about them as the elicitor of shame. Children's thinking about others thinking about them needs time to develop. Darwin (1872/1965) thought that the self-conscious emotions required a developed cognitive system in which a mental representation of "me" is needed. Darwin related the self-conscious emotions to the process of thinking about what others are thinking about oneself. He wrote about the nature of the mental states that induce blushing. For example, he noted that the self-conscious emotions "consist of shyness, shame and modesty; the essential element in all being self-attention." Notice that Darwin's term, "self-attention," is what we have called "consciousness," or the ability to reflect on oneself. Darwin believed that

> many reasons can be assigned for thinking that originally self-attention directed to personal appearance, in relation to the opinion of others, was the exciting cause; the same effect being subsequently produced, through the force of association, by self-attention in relation to moral conduct. It is not the simple act of reflecting on our own appearance, but the thinking what others think of us, which excites a blush. (1965, pp. 326–327)

While various theories have argued for some universal elicitor of self-conscious emotions, such as failure at toilet training, exposure of the backside, or the interruption of an ongoing action, the idea of an automatic noncognitive elicitor of these emotions does not make much sense. Cognitive processes have to be the elicitors of these complex emotions. It is the way we think about ourselves that becomes the elicitor. There may be a one-to-one correspondence between thinking certain thoughts and the occurrence of a particular emotion; however, for these emotions, the elicitor is still a cognitive event. This does not mean that the earlier emotions, those called primary or basic, are elicited by noncognitive events. Cognitive factors play a role in the elicitation of any action pattern; however, the nature of the cognitive events is much less complex in the earlier emotions (Plutchik, 1980).

While the emotions that appear early—such as joy, sadness, fear, and anger—have received considerable attention, the set of emotions that appear later, which are considered here, has received relatively little attention. There are likely to be many reasons for this lack of interest. One reason is that these self-conscious emotions cannot be described solely in terms of a particular set of facial movements; identification of the self-conscious emotions requires the observation of bodily actions as well as facial cues. A second reason for the neglect of the study of these later emotions is the realization that there are no clear specific elicitors of these particular emotions. While happiness can be elicited by seeing a significant other, and fear can be elicited by the approach of a stranger, there are few specific situations that will always elicit shame, pride, guilt, or embarrassment. These self-conscious emotions are likely to require classes of events that can only be identified by the individuals themselves. For these reasons, little research has been conducted on their development.

Darwin (1872/1965) saw these later emotions as involving the self, and emerging around age 3 years, but he was not able to distinguish among the various types. His observation and concern in regard to blushing reveals his interest in appearance and consciousness. Darwin's use of blushing as an example raises particular difficulties in large part because blushing (1) usually occurs around embarrassment rather than shame or guilt; (2) not all children or adults blush; and (3) blushing usually takes place in the presence of others, while shame can be experienced alone.

The Self-Conscious Exposed Emotions

The emergence of consciousness is seen in some children as early as age 15 months, but all normally developing children show self-referential behavior by age 24 months. Whatever the age when self-referential behavior can be observed is the age when the exposed self-conscious emotions appear. If self-recognition is shown by children at age 18 months, they will start to show these self-conscious emotions at age 18 months, and if it is shown at age 21 months by another child, then for those children they will start to be seen at that age. They are temporally tied to the emergence of self-reflection. This association between them has been studied in terms of exposure embarrassment, discussed next. In our studies, we have found that while fearfulness is unrelated to self-recognition, embarrassment is such that children who do not show self-recognition do not show embarrassment (Lewis, Sullivan, Stanger, & Weiss, 1989).

The work on these exposed self-conscious emotions has centered on three emotions: exposure embarrassment, jealousy/envy, and empathy. Let us start with embarrassment because it is one of the early self-conscious exposed emotions for which there is some information.

Embarrassment

Almost all theories speak of embarrassment as an unpleasant feeling having to do with some form of the discrediting of one's own image, either through the loss of self-esteem, the loss of the esteem of others, or both. However, one of the critical issues in the study of embarrassment has to do with terminology usage. The problem concerns the difference between embarrassment and shame, on the one hand, and between embarrassment and shyness, on the other. Historically, the psychoanalytic approach made little distinction between embarrassment and shame; most of the confusion in this approach has been between guilt and shame (see Broucek, 1991; Lewis, 1971; Morrison, 1989, for exceptions). Freud writes mostly of shame and does not employ another word that might be translated as "embarrassment" (Goffman, 1959). If shame is discussed, it is usually discussed in terms of nakedness or in terms of impulses, either sexual or exhibitional, that need to be held in check. Of more interest is the existential approach. In this approach, embarrassment is seen as an alienation of one's own body. Goffman, for example, discusses the act of blushing as occurring when individuals become aware of their own bodies, which is similar to Darwin's (1872/1965) idea about embarrassment. Unfortunately, the term "alienation" suggests some negative attribution as in being separate from one's own body; however, I think that alienation should be viewed as self-awareness or self-reflection.

The interpersonal approach to embarrassment suggests that individuals feel embarrassed when they project an image of themselves incompatible with their own view *in the presence of others*. "Embarrassment . . . reflects a failure to present oneself in the way one would have wished" (Edelmann, 1987, p. 14). Such theories assume the need for three features: the presence of another person, people becoming aware that they are the center of attention, and the people feeling that they are being judged. As we shall see, this last feature is questionable, since the distinction between embarrassment and shame is not well articulated in this approach. One could argue that the same three conditions are necessary for the production of shame, although this view of embarrassment is quite common (see Lewis, 1971; Semin & Manstead, 1981; and earlier, Izard, 1977; Tomkins, 1963).

Embarrassment is often considered to be similar to shyness, especially to the extent to which embarrassment can be viewed as having a fear component. When we think of a shy child, we tend to think of a child who is reluctant to engage in interpersonal interactions. But this factor of sociability may have less to do with evaluation and more to do with dispositional factors (Eysenck, 1956). Kagan argues for what he calls "inhibition," which bears a striking similarity to shyness (Kagan, Snidman, Arcus, & Reznick, 1994). Even when embarrassment is viewed as a form of shyness, it has a negative evaluation component. For example, Zimbardo (1977) argues that people feel most shy at being the center of attention of a large group of people (see also Jones, Cheek, & Briggs, 1986). For him, a person being watched implies being seen in the best light. Being seen as such, in turn, implies an evaluation of the self against some kind of ideal self. Shyness also has been related to aspects of social anxiety, which also implies an evaluative component (Buss, 1980; Cheek & Buss, 1981; Fenigstein, Scheier, & Buss, 1975).

Since Darwin (1872/1965) described all self-conscious emotions as including the phenomenon of blushing, the use of blushing to indicate shame, embarrassment, and guilt means that blushing as a measure of any one emotion is ineffective. By utilizing a combination of the criteria suggested by others, we have come up with an overall measure of embarrassment that is useful in studying young children. This scoring system for embarrassment agrees with those of others who have attempted to find behavioral manifestation of this emotion (Buss, 1980; Geppert, 1986). In general, the behaviors believed to reflect embarrassment are (1) a smiling facial expression; (2) gaze aversion; and (3) movement of the hands to the body such as touching hair, clothing, face, or other body parts. These hand gestures appear to capture the category of nervous movements that previous investigators believed were characteristic of the emotion. Such body touching can accompany smiling/gaze aversion or immediately follow it. All three classes of behavior appear to be associated with embarrassment.

Embarrassment differs from shame or anxiety/fear in a number of critical ways. First, embarrassment seems to be marked by a "sheepish" grin or a "silly" smile as described by others. In both shame and fear, smiling behavior is usually absent. Moreover, the smiling in embarrassment does not appear to be a frozen type of smile; rather, it is an active engagement with the other people present. Perhaps most important in differentiating embarrassment from other emotions is the gaze behavior and bodily action. In embarrassment, people are more apt to tilt their heads and to engage in gaze-avert/look-at behavior. It is not gaze aversion with the head bowed as in an avoidance response and it is not the immobility of action as in removing one's self from the situation. Instead it is a gaze-avert, gaze-return motion toward the other person present. This on/off sequence is typical of embarrassment, whereas in shame it is more a turning away and remaining away. Finally, nervous touching of the body, including hair, clothing, and face, seems to reflect the subject's engagement in self-directive behavior, reflecting an active focus on the self. In shame or shyness, the person is likely to be immobile, and not inclined toward self-directive behavior. The use of such behavioral criteria is in keeping with the idea that embarrassment appears to be related to the self and requires another social object. The active nature of bodily action in embarrassment, unlike that seen in shame, suggests that embarrassment and shame are readily distinguishable. Blushing, which received so much attention in Darwin's (1872/1965) analysis, would be a likely candidate for indexing embarrassment. However, blushing does not always occur; there being large individual differences in the likelihood of this response. Differences may be due, in part, to different physiology; it is certainly related to skin coloration with light-skinned people blushing more visibly than dark-skinned people. In our research on self-conscious emotions, blushing in children is a relatively infrequent event. Even when children above the age of 3 years show embarrassment in terms of other behaviors, it is rare to observe blushing in those children. This should not be surprising since it is relatively unusual to see blushing in adults. Given the self-reports indicating the high incidence of embarrassment, it is interesting to note that the occasions of blushing seem to be disproportionately low (see Leary & Meadows, 1991).

Since embarrassment has been related to shyness, we need a working definition for this term. Shyness for some researchers is itself not an emotion. For example, Izard and Tyson (1986) describe shyness in terms of sheepishness, bashfulness, and the feeling of uneasiness or psychological discomfort in social situations. They suggest that shyness results from a vacillation between fear and interest or between avoidance and approach. They related shyness to fear, not to self-evaluation. Individuals who are considered shy are not too much concerned with the evaluation of their performance vis-à-vis their standards, as they are with being observed. Thus, our own observations, as well as those of others, indicate that shyness is related to a constellation of factors not related to self-evaluation. Moreover, there is some reason to believe that these individual differences have a dispositional or constitutional basis (Eysenck, 1956; Kagan, Reznick, & Snidman, 1988).

For some researchers, embarrassment is closely linked to shame (Izard, 1979; Tomkins, 1963). While shame appears to be an intense and destructive emotion, embarrassment is less intense and not does involve the same degree of disruption of thought and action as in shame. In terms of body posture, people who are embarrassed do not assume the shame posture of body collapse. Their bodies reflect an ambivalent approach–avoidance posture. In shame situations one rarely sees gaze aversion accompanied by smiling behavior. Thus, from a behavioral point of view these two action patterns appear to be different. Phenomenologically, embarrassment is less differentiated from shame, as people often report that "embarrassment" is less intense than "shame." Situations similar to those that invoke shame are found to invoke embarrassment. Even so, the intensity and duration of the disruptive quality of shame is reduced in embarrassment. These different descriptions of behavior appear to be indicating two different types of embarrassment, because, as our studies of toddlers suggest, one type occurs earlier than the other, and different elicitors are involved.

Embarrassment as Exposure, Not as Evaluation

Embarrassment as exposure appears to be more similar to shyness than to shame, and it is the first type of embarrassment to appear. In certain situations in which children are observed, they become embarrassed. This type of embarrassment is not related to negative evaluation. One of the best examples of this kind of exposure embarrassment is being complimented. The phenomenological experience of embarrassment when complimented is well known. The adult public speaker, when introduced with praise, is often embarrassed. While complimenting may elicit the social rule of modesty in adults or older children, it is not typical for infants as young as 15–18 months of age who are unlikely to have learned the rule of modesty, yet show embarrassment when complimented. Another example of this type of exposure embarrassment can be seen in children's reaction to their public display. When young children observe someone looking at them, they are apt to become embarrassed, look away, and touch or adjust their bodies. When the observed person is an adult woman, she will often adjust or touch her hair. An observed man is less likely to touch his hair, but may adjust his clothes or change his body posture. Observed people look pleased or concerned, rarely sad.

To examine the development of embarrassment my colleagues and I conducted a study with 15- to 18-month-olds, about half of whom showed self-recognition. To induce exposure embarrassment during a free-play situation both the experimenter and the mother pointed to the toddler and repeated her name while pointing. Many of the toddlers who showed self-recognition showed clear examples of embarrassment to this event, suggesting that being the object of another's attention can produce a kind of embarrassment that appears to be unrelated to any evaluation of behaviors. Interestingly, in an earlier study (Lewis, Stanger, Sullivan, & Barone, 1991), children 12–33 months old were asked to dance to music, first by their mothers in the presence of a stranger, and then by the experimenter. In another situation they were also overly praised. Those who showed embarrassment also showed self-recognition, although not all children who showed self-reflection showed embarrassment when made the object of another's attention.

In order to explore this individual difference in the display of embarrassment, in another study, measures of temperament as well as measures of reaction to pain caused by inoculation were obtained for infants along with measures of embarrassment to being the object of others' attention (DiBiase, & Lewis, 1997; Lewis & Ramsay, 2002). The results strongly suggest that individual ease of embarrassment once consciousness emerges is a function of temperament, with young children with difficult temperaments as measured by a variety of indexes more likely to show this type of exposure embarrassment. These findings support the idea that exposure embarrassment is not evaluatively related. The elicitor was simply being the object of another's attention. To support this idea we found that several children with a particularly difficult temperament, when pointed to by their mothers and the experimenter, not only showed embarrassment but they became upset and cried. They were reported by their mothers to be very shy.

Further support for exposure embarrassment can be seen in an experiment I often perform in front of large groups of people. In lecturing to audiences, I demonstrate that embarrassment can be elicited just by exposure. To demonstrate this point, I inform the audience that "I am going to *randomly* point to someone." I further inform the audience that "my pointing has no evaluative component and is not related to anything about the person since I will close my eyes before pointing." Following these words, I turn around several times and I point to someone in the room, who, of course, immediately acts embarrassed. Everyone agrees that the person chosen will be embarrassed if pointed at, yet, since it is random, it cannot reflect anything personal.

There are other examples of embarrassment in which an evaluation is evoked, yet it may be that simply being the object of others' attention can be the real elicitor. Take the simple act of walking into a crowded room and having people stare at your entrance. On such an occasion, one is likely to experience embarrassment and this embarrassment turns into a negative self-evaluation, such as "I hope I have worn the correct dress." I believe, however, that the experience of embarrassment may not be caused by the negative self-evaluation, but by simple public exposure. However, rather than believe that it is the exposure that produces the embarrassment, people often look for a negative evaluation. In other words, the negative evaluation follows embarrassment due to exposure as people attempt to explain why they are embarrassed. The reason is that as adults we also possess a second type of embarrassment that occurs around a standard failure.

Embarrassment as a Function of Evaluation

This type of embarrassment is related to negative self-evaluation and to shame, topics that are covered in more detail later when the self-conscious evaluative emotions are discussed. It emerges later in development than the exposure embarrassment. This second type of embarrassment emerges after the incorporation of the SRGs of the family, which does not occur until the end of the third year**.** Although both types are measured in the same way, the elicitors of this type of embarrassment are quite different from those for exposure embarrassment.

Functional Significance of Early Embarrassment

To ask about the functional significance of a certain behavior runs the risk of storytelling since it is always difficult to test such ideas. Nevertheless, I believe that embarrassment emerges at the same time that children obtain consciousness. Why, then, should self-reflection have a negative component? The emergence of consciousness carries both advantages and disadvantages. This emerging capacity allows children to reflect on themselves; to use the self to make comparisons to others; and ultimately to develop evaluative behaviors, desires, and goals that will guide their actions. At the same time, this capacity to reflect on the self can be dangerous. The dangers reside in the child being entrapped in a circular-like reaction: it is possible to think about the self thinking about the self thinking about the self. Such circularity would lead children into a hopeless cycle of thought, preventing them from acting. To prevent such circular reactions, it would seem reasonable to imagine that self-reflection should be accompanied by arousal containing a slight negative tone. If self-reflection is a little uncomfortable, engaging in it becomes costly.

Thus, it is possible to be too self-reflective. Under such conditions people also have difficulty focusing on action. From a clinical perspective, we have reason to believe that much self-consciousness is related to a variety of problems. On this issue, Csikszentmihalyi and Csikszentmihalyi's (1988) analyses of flow may be relevant. For them, flow is a state of mind that is achieved when the adult's capacity matches some environmental challenge. Under such conditions, adults stop making reference to themselves—that is, self-reflection stops. For example, when one is deeply engaged in work, one often "loses track of the time." This phenomenological experience indicates that it is possible to lose self-reflection, at least some of the time (Csikszentmihalyi & Csikszentmihalyi, 1988). The dangers of self-reflection, as well as its advantages, suggest that embarrassment, as related to exposure to others, reflects an emotion likely to occur some of the time to inhibit self-referential behavior when it develops.

This present model proposes a sequence that starts with embarrassment related to exposure and then is captured, in yet unexplained ways, and utilized in the evaluative processes centering on SRGs. Rozin suggests that disgust also has this developmental pattern (Rozin, Haidt, & McCauley, 1993). By the second half of the second year of life, children show embarrassment to exposure; by the age of 3, children show embarrassment both to exposure and to violating a standard. Both types of embarrassment are available as a consequence of the developmental process.

The other two exposed types of self-conscious emotions that have been studied are jealousy and empathy, although empathy is considered by some as both an emotion such as sympathy and as social cognitive action.

Jealousy

Jealousy usually arises from the loss of something valuable to another, and is most often used when talking about children as being jealous about the attention or time their mothers spend with another, not with them. To be sure, jealousy and envy are often confused and used interchangeably; however, envy refers more to wanting something another possesses. In the case of children and their mothers, the child could be both jealous of the time the mother spends with a sibling and envious of the sibling for being the focus of their mother's attention. As can be seen from this example, these two ideas are not at all clear or distinct, which accounts for their mixed usage. Whether we use the term "jealousy" or "envy," implied in these emotions is a self-referent, the I of consciousness that wants something it does not have. Thus, for these emotions to emerge, consciousness is required. Other cognitive capacities may also be needed; however, jealousy over a mother's attention turned elsewhere, say to a sibling, does not require elaborate cognitions since the direction of another's attention is readily discriminable. A recently published handbook on jealousy contains several essays suggesting the existence of jealousy in the very young child, so that a careful analysis is necessary to determine if such a view is reasonable (Hart & Legerstee, 2010).

Hart's work is a good example of the studies exploring this emotion. In one of her studies, infants and their mothers play together and then on signal the mother turns away from her infant and for a few minutes, while ignoring her, attends to and talks to a doll. The 4-month-old infants show such behavior as interest, joy, anger, and sadness, as well as intense negative emotionality to their mother's attention to the doll. Infants showed increases in their emotionality and did so more when their mothers expressed more positive than neutral vocal behaviors toward the doll. Such findings were taken to indicate that infants this young show jealousy. However, whether these behaviors reflect jealousy or protest around the loss of the mother's attention is not clear, although I would think protest the more likely.

In studying infants, a child's protest over loss of the attention of others generally has been considered in two ways, either as the departure of the mother, as in the attachment paradigm in which the mother leaves the child alone in a strange room, or when the mother is present but is separated from her child either by a physical barrier or by her not directly attending toward the child as in the still-face paradigm (Ainsworth & Bell, 1970; Lewis & Ramsay, 2005; Weinberg & Tronick, 1996).

In the attachment paradigm, the loss of the mother most often results in protests of sadness and crying, as well as anger, as actions designed to get the mother back (Weinraub & Lewis, 1977). The same behaviors can be seen in situations where the mother is separated from the infant by a see-through barrier. While the 1- and 2-year-olds in the experiments can see their mothers, they cannot get close to them. The behaviors of crying, looking at the mother, and trying to get over the barrier are exhibited (Feiring & Lewis, 1979; Goldberg & Lewis, 1969; Wasserman & Lewis, 1985). The same can be said for the infant's behavior when the mother turns away from her interaction with the child (Lewis & Ramsay, 2004b Tronick, Als, Adamson, Wise, & Brazelton, 1978). Also, looking at the very young infant's response to the frustration of a blocked goal in its object world also shows these same behaviors. Thus, in situations involving the loss of the mother's attention, measured by her nonavailability as when behind a barrier, or by her complete disappearance as in the attachment paradigm, or by her lack of interaction as in the still-face procedure, there are similar infant responses, namely, protest. To call these behaviors "jealousy" seems premature, unless one wishes to attribute mental status to the infant's behavior. Although many would, there is no reason to do so unless one is caught in anthropomorphizing about how the adult would feel in the context of one's loss of one's mother (Bradley, 2010; Hobson, 2010; Keller & Lamm, 2010; Trevarthen & Aitken, 2001).

As suggested in Chapter 15, this volume, early action patterns, in this case the blockage of a valued object or person, can become the material for a self-conscious emotion once the emergence of the capacity for self-reference appears. Recent work indicating that young children tend to share their toys with others because of a biological disposition and do not show jealousy and possessiveness until the emergence of consciousness around age 2, lends some support for these ideas. It is also at this time that the idea of ownership emerges (Braten, 2009; Friedman, 2011).

Empathy

Whether empathy is considered an emotion like sympathy or a cognitive act, it seems to involve the ability to place oneself in the role of another. What is important about this ability is the idea that empathy allows for knowing about you, your feelings, what you may be thinking, and what the meaning of your behavior has to you. While we discussed this topic earlier, it is necessary now to think about its development since there is the strong belief that children show empathy long before the emergence of consciousness. Consider, for example, Hoffman's demonstration that in the newborn nursery the crying of one infant elicits the crying of others, or Zahn-Waxler's demonstration that toddlers react by comforting their mothers if they show distress (Roth-Hanania, Davidov, & Zahn-Waxler, 2011; Sagi & Hoffman, 1976).

Clearly, if empathy requires taking the perspective of the other, it is difficult to reconcile an infant crying to another infant's cry with this idea. For many of these early matching behaviors the idea of contagion should be considered. It would seem reasonable that all social creatures are by definition affected by the actions of conspecifics and maybe even by the actions of others who resemble them. Contagious behavior is most apparent in the emotional realm, although it can also be seen in other behavior. As we all have experienced, we are likely to feel sad if others around us are crying and to feel happy when others are laughing. The same is true for the emotions of fear, disgust, and anger. The contagious effects of the emotional behavior of others are well known; witness the contagion of yawning or even of the coordination of menstruation of women living together.

Although some claim a form of mentalism for these coordinated emotional action patterns between the baby and the adult, it seems more likely that this coordination reflects contagion as a basic biological necessity of all animals that live with conspecifics. It may even involve the use of motor neurons. It does not involve mentalism, although, as for other action patterns, it may become the material from which mentalism is formed. The simultaneity of action between two people through contagion may be the material out of which adult empathy grows. However, in the mature form of empathy one does not have to be in the presence of the other's distress to feel upset since it is a mental act that does not need the presence of the other's emotional action pattern to produce one's own action pattern.

This, of course, is the problem with much of the research on early empathy. For example, in many studies, the mother pretends that she has pricked her finger on a pin and makes a hurt, sad face and groans in front of the toddler. It is difficult to know whether the toddler's response is caused by contagion or is caused by modeling and learning to comfort another who is showing pain. Indeed, infants often try to comfort their mothers by patting them or hugging them, but at the same time they do not look distressed and may even show a happy-like face. It is necessary to separate out contagion or imitation from empathy around distress in order to see its relation to the emergence of consciousness. Bischof-Kohler (1991) demonstrated that empathy around the distress of another represents neither imitation nor contagion *if* the child's behavior is well organized so that both facial expression and behavior are in accord. She was able to show that this occurs only once the child showed self-recognition behaviors (Bischof-Kohler, 1991). In other words, mentalism is associated with true empathy, whereas its earlier forms are likely to be contagious action patterns. As de Waal has pointed out, elaborate, empathy-like responses certainly can be seen early in the child's life, but the adult human form of the behavior is unlikely to emerge until the development of consciousness (Preston & de Waal, 2002).

From a developmental point of view, we are confronted with the conundrum of the same behavior being supported by very different processes, and need to be careful to make sure that we do not commit the error of assuming that just because behaviors appear similar on the surface, they are supported by the same underlying process. Indeed, one of the difficulties in the study of development is that, on the one hand, the same process may result in very different behaviors during the developmental sequence, while, on the other hand, the same behavior at different points in time may be supported by very different processes. I think it is safe to conclude that any theory of the development of empathy needs to incorporate the emergence of a self-representation. The distress of the newborn to the cries of other newborns, and the generous charitable donations given by people to the victims of the 2012 Japanese earthquake and tsunami disaster or Hurricane Sandy, should not be considered as having similar underlying processes as the yawning of one person producing yawning in another.

Although other early self-conscious emotions need consideration, what appears to be the case is that all of them are dependent at a minimum on the emergence of consciousness. Few other cognitive capacities besides perception and memory are needed for their emergence, unlike the next set of self-conscious emotions, which rest on the development of complex self-attributions, including self-responsibility, which allows for evaluation of the self in regard to the socialization SRGs of family and culture.

The Self-Conscious Evaluative Emotions

Returning to the sentence "I am so proud of winning first prize in the spelling bee," anchors the discussion of the evaluative self-conscious emotions, since this statement requires consideration of the idea of self-evaluation. When the speaker says that she is proud of what she did, it is because some action on her part has met some standard that she holds. It also implies that she accepts responsibility for her actions. Finally, the experience is her own and while the sentence focuses on her verbal behavior, it is she, her whole self, that is at fault. These aspects of her evaluation lead her to feel proud.

Here, now perhaps for the first time in the child's development, the emotional action pattern called pride is elicited by a set of ideas about herself. The behaviors and feeling of pride that make up this action pattern are for the most part not learned, but are part of the biological capacity of our species. However, it is the kind of ideas about the self and how the action pattern is expressed that is acquired as part of the child's learning engagement with the social world. Children learn about the SRGs of their culture in both direct and indirect ways according to the social nexus in which they are raised. This nexus includes parents, grandparents, siblings, and peers, as well as teachers and others.

These self-conscious evaluative emotions are the basis of our moral behavior, and therefore have been called by some the "moral emotions." The eliciting events of these evaluative self-conscious emotions are ideas about self. While there are theories, such as those of psychoanalysis, that have argued for some universal elicitors of these self-conscious emotions, such as failure at toilet training or exposure of the backside, the idea of an automatic noncognitive elicitor of these evaluative emotions does not seem to make much sense. This does not imply that there are no specific elicitors, rather that the elicitors are the ways we think or what we think about, and there is likely some correspondence between thinking certain thoughts and the occurrence of a particular emotion; however, in the case of this class of emotions, the elicitor is always a way of thinking. This does not mean that the earlier emotions, those called primary or basic, are elicited by noncognitive events. Cognitive factors may play a role in the elicitation of any emotion; however, the nature of cognitive events are much less articulated and differentiated in the earlier ones (see Plutchik, 1980).

The idea that these emotions are elicited by ways of thinking was recognized by Darwin (1872/1965). However, because he focused on blushing and did not pursue the implications of his idea about thoughts of others and the sensitivity to the opinion of others, whether good or bad, he was not able to differentiate among the various kinds of evaluative self-conscious emotions. This failure restricted his analysis. An additional reason may be that because Darwin was arguing for a connection between the emotions of animals and humans, he might not have wanted to consider the leap that might exist between what animals and humans think. Therefore, he did not pursue the idea that humans have the capacity, which animals are unlikely to have, to think about themselves and to think about themselves in ways quite different from how the great apes think about themselves. In part, this might explain Darwin's focus on the issue of physical appearance without giving much thought to ideas about standard, rules, and goals (Herrmann, Hernandez-Lloreda, Call, Hare, & Tomasello, 2010; Premack, 2010).

Let us begin our discussion of the self-conscious evaluative emotions by showing the central role of consciousness in the evaluation process. To summarize what is to follow, let us look at the evaluation of the self, which requires consciousness of ourselves. The self-conscious evaluative emotions involve a set of SRGs. These SRGs are inventions of the culture that are transmitted to children and involve their learning of, and willingness to consider, these SRGs as their own. This process of incorporating SRGs appears to take place by age 3 years, at least in part, since SRGs are constantly being learned throughout life (Stipek, Recchia, & McClintic, 1992). Moreover, SRGs imply self-evaluation because children need the capacity to evaluate their actions with respect to them. Having self-evaluative capacity allows for two distinct outcomes: children can evaluate their behavior and hold themselves responsible for the action being evaluated or children can hold themselves not responsible. In attribution theory, these outcomes have been called an "internal" versus an "external" attribution. If children can conclude that they are not responsible, then evaluation of their behavior ceases. However, if children evaluate themselves as responsible, then children can evaluate their behavior as successful or not vis-à-vis their particular SRGs. The determination of success or failure resides within the individual and is based on the nature of the SRGs. For example, if a student believes that receiving only an A on an exam constitutes success, then receiving a B represents a failure for that student; on the other hand, another student may consider a B a great success. Still another type of cognition related to the self has to do with the evaluation of oneself in terms of specific or global attributions. "Global self-attributions" refer to the whole self, whereas "specific self-attributions" refer to specific features or actions of the self (Dweck & Leggett, 1988; Weiner, 1986). It is these types of self-attributions or ideas about the self that give rise to these self-conscious evaluative emotions. Success or failure vis-à-vis SRGs is likely to produce a self-reflection.

The importance of such a view suggests three factors. First, the model does not attempt to specify what constitutes a success or failure, or how the person goes about evaluating success or failure. Second, the model does not specify any particular SRG. In other words, it is not clear whether there are any specific stimuli that uniquely contribute to any of the self-conscious emotions. Third, the model assumes that self-attributions leading to specific emotions are internal events that reside in people themselves, although the SRGs are taught by others. Although this model is based on a phenomenonological and cognitive-attributional model, it does not mean that the self-conscious emotions are epiphenomenological or deserve a different status than the cognitive-attributional processes themselves. These self-conscious emotions are action patterns that are innate and are bodily in nature. They are not action patterns that existed earlier, since it is ideas that serve as elicitors of these specific action patterns in the same way as do other stimuli. The important point here is that specific action patterns and therefore emotions can be elicited through a variety of self-attributions. The idea that cognitions can lead to emotions has been poorly received by some, who believe that this idea implies that cognitions have real status, whereas emotions are epiphenomenological (Schachter & Singer, 1962). I mean to give emotions that same status as cognitions. Just as cognitions can lead to emotions, emotions can lead to cognitions. The theory implies no status difference.

There is very little agreement as to the specific elicitors of shame, guilt, or embarrassment. Many events are capable of eliciting any one of them. No particular stimulus event has been identified as the trigger for shame and guilt. It would be easier to understand these self-conscious emotions if we could specify the class of external events likely to elicit them. If it were true that shame and guilt are similar to anxiety and that they reflect the subject's fear of uncontrollable impulses, then we could consider the causes of shame to be sexual or aggressive impulses (Freud, 1905/1953, 1936/1963). Alternatively, if we could prove that situations having to do with toilet or genital functions are likely to elicit shame, or if we could prove that the way we appear physically, or how we behave in front of others may automatically elicit shame, we could then specify situations that would help us to define these self-conscious emotions and increase our understanding of what causes them. While there are no known literal events that are likely to cause these self-conscious evaluative emotions, certain ideas may have a more universal-like quality of eliciting certain emotions. So, for example, if an attachment figure says to a child, "I do not love you," this statement may well lead to certain negative ideas about the global self, and thus to the emotion of shame, since a global, stable, and negative self-attribution is likely to occur as a consequence of the statement. However, this example has strong cognitive features and is likely therefore to take place after the first year or two of life.

Before we go into the details about the development of these evaluative self-conscious emotions, the formal qualities of the ideas about the self are presented below. This structural model identifies the ideas about the self that serve as the elicitors of each of four self-conscious evaluative emotions. This model is symmetrical with regard to positive and negative self-evaluative emotions in that it accounts not only for shame and guilt in response to failure but also for pride and hubris, sometimes called "alpha" and "beta" pride, in response to success (Heckhausen, 1984; Stipek, 1983; Tangney, 1995; Tracy & Prehn, 2012). The model also proposes that the immediate elicitors of specific self-evaluative emotions are the qualities of self-related attributions. Given the three sets of judgments shown in Figure 45.1, the model accounts for and distinguishes among four self-conscious evaluative emotions. The immediate elicitors of these are the cognitive self-evaluative processes as described.

Cognitive Self-Evaluative Processes

Standards, Rules, and Goals

The first feature of the model has to do with the SRGs that govern our behavior. All of us have beliefs about what is acceptable for others and for ourselves in regard to SRGs having to do with actions, thoughts, and emotions. This set of beliefs,

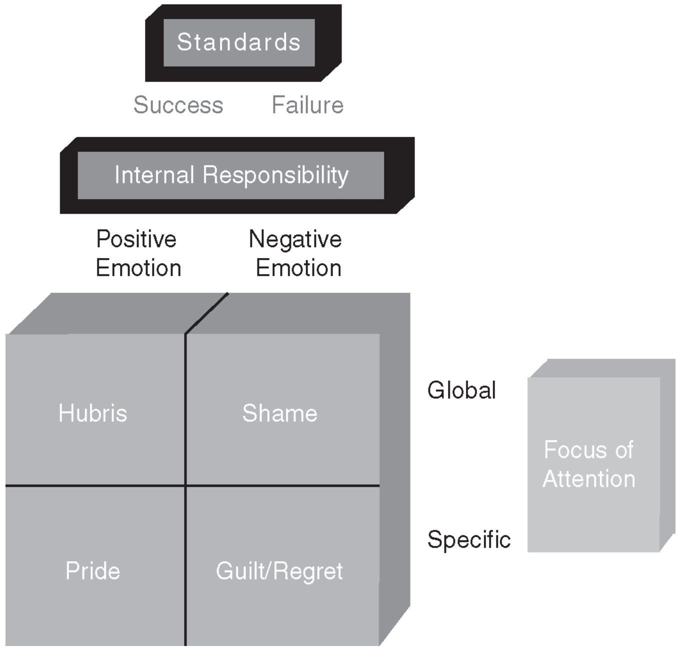

FIGURE 45.1. A model of self-evaluative processes and their relation to four self-evaluative emotions: hubris, shame, pride, and guilt/regret. From Lewis and Sullivan (2005, p. 189). Copyright 2005 by The Guilford Press. Reprinted by permission.

or SRGs, constitutes the information the person acquires through culturalization. SRGs differ across different societies, across groups within societies, across different time epochs, and among individuals of different ages. The standards of our culture are varied and complex, yet each of us knows at least some of them. Moreover, each of us has a unique set. To become a member of any group requires that one must learn that group's SRGs. SRGs are acquired through a variety of processes. They are always associated with human behavior. They are prescribed by the culture, including the culture at large, as well as by the influences of specific groups, such as clan, peers, and family.

While 1-year-olds are learning about some do's and don'ts, their behavior is controlled by the presence of the adult; the specific do's and don'ts are not incorporated into the child's mental life. Instead, they are likely controlled by direct rewards and punishments. By the second year of life, children show some understanding about appropriate and inappropriate behavior, but these nascent SRGs are not yet incorporated and so still require the presence of an adult. Research indicates that by the end of the second and the beginning of the third year of life children have already incorporated some SRGs and seem to show distress when they violate them (Stipek et al., 1992). Another source of support comes from the work on children's understanding of ownership. Kagan (1981) has shown that 2-year-olds can already identify their drawings from others, and Lewis and Ramsay (2004a) have found an association between personal pronouns such as "mine" and the movement of an object toward their own bodies. More recently, Nancekivell, Van de Vondervoort, and Friedman (2013) have reviewed the work on children's understanding of ownership and have also found evidence that it emerges early (see also Noles, Keil, Bloom, & Gelman, 2012). Such findings suggest that 3-year-olds have already begun to incorporate some SRGs, thus do not require the presence of others to make the judgment of success and failure. The acquisition of these SRGs continues across the lifespan.

Evaluation

The evaluation of one's actions, thoughts, and feelings in terms of SRGs is the second cognitive-evaluative process that serves as a stimulus. Two major aspects of this process are considered here; the first has to do with responsibility. For the model to work in describing the process of eliciting emotions, responsibility for the success or failure of an SRG is necessary. Individuals differ in their characteristic evaluative responses. Moreover, situations differ in the likelihood that they will cause a particular evaluative response. The second consideration has to do with how individuals make a determination about success or failure in regard to any specific standard.

Responsibility

Within the study of self-attribution, the problem of internal versus external responsibility has received considerable attention. People violate SRGs but often do not attribute the failure to themselves. They may explain their failure in terms of chance or the actions of others. Responsibility evaluations are functions both of situational factors and individual characteristics. There are people who are likely to blame themselves no matter what happens. Dweck, in studying causes of success and failure, found that many children blamed their success or failure on external forces, not themselves, although there were just as many who were likely to evaluate success and failure in terms of their own actions (see Dweck, 1991; Dweck & Leggett, 1988; Seligman et al., 1984; Weiner, 1986).

Success or Failure

Another feature of the self-evaluation process has to do with the socialization of what constitutes success or failure. Once one has assumed responsibility, exactly how one comes to evaluate an action, thought, or feeling as a success or a failure is not well understood. This aspect of self-evaluation is particularly important because the same SRGs can result in radically different feelings, depending upon whether success or failure is attributed. Many factors are involved in producing inaccurate or unique evaluations of success or failure. These include early failures in the self-system leading to narcissistic disorders, harsh socialization experiences, and high levels of reward for success or punishment for failure (see Alessandri & Lewis, 1996; Morrison, 1989). The evaluation of one's behavior in terms of success and failure is a very important aspect of the emotional response to SRGs, and consequently of the organization of plans and the determination of new goals and plans.

Specific and Global Attributes about the Self

Another attribution in regard to the self has to do with *global* or *specific* self-attribution. "Global" attribution refers to an individual's propensity to focus on the total self. Thus, for any particular behavior violation, some individuals, some of the time, are likely to focus on the totality of the self; they use such self-evaluative phrases as "Because I did this, I am bad or good." Janoff-Bulman's (1979) distinction between "characterological" and "behavioral" self-blame is particularly relevant here (see also Beck, 1979; Dweck, 1991; Lewis, 1971; Weiner, 1986). When a global evaluation is made, the focus is on the self both as an object and as a subject. The self becomes embroiled in the self. It becomes embroiled because the evaluation of the self by the self is total. There is no way out. The focus is not on the individual's behavior, but on the total self. There is little wonder that in using such global attribution one can think of nothing else except the self, and one becomes confused and speechless. Because of this focus on the total self, one is unable to act and is driven from the field of action into hiding or disappearing, or wanting to die.

"Specific" attribution refers to individuals' propensity in some situations, some of the time, to focus on specific actions of the self—that is, their self-evaluation is not global but specific. It is not the total self that has done something good or bad, or right or wrong, but instead some particular specific behavior. Notice that for such occurrences, an individual's focus is not on the totality of the self, but on the specific behavior of the self in a specific situation. The focus here is on the behavior of the self in interaction with objects or persons. Here attention is on the actions of the self or the effect on other selves and on reparation.

Global versus specific self-focus may be a personality style. Global attributions for negative events are generally uncorrelated with global attributions for positive events. It is only when positive or negative events are taken into account that relatively stable and consistent attributional patterns are observed. Some individuals are likely to be stable in their global and specific evaluations; under most conditions of success or failure, these subjects are likely to maintain a global or specific posture with respect to self-attribution. In the attribution literature, such dispositional factors have important consequences upon a variety of fixed personality patterns. So, for example, depressed individuals are likely to make stable global attributions, whereas nondepressed individuals are less likely to be stable in their global attributions. These dispositional factors are likely to arise through both temperament and as socialization factors.

The idea that beliefs and attributions about the self are related to emotions has been proposed by others, although in the past models have been developed primarily for adults and older children, typically with regard to achievement behavior and emotion (see Beck, 1979; Lewis, 1987; Nolen-Hoeksema, Girgus, & Seligman, 1992; Nolen-Hoeksema, Wolfson, Mumme, & Guskin, 1995; Seligman, 1975; Weiner & Graham, 1989). However, Dweck (2006), who worked with school-age children, has offered a similar model. She calls global and specific attributions "orientation toward performance" (global) or "orientation toward the task" (specific). Children who are performance oriented view failure as the result of an incompetent, stable self, while children with a task-orientation focus on "what I did" and tend not to experience their failures as negative, do not blame themselves, and are more confident that they can succeed in similar tasks in the future. They are more likely to believe that ability is "what you learn" with time and experience. Thus, these motivational dispositions appear to capture the responsibility dimension as well as the focus of attention described in my model (Dweck, 1991; Dweck, Chiu, & Hong, 1995; Smiley & Dweck, 1995). In my view, a performance orientation is consistent with, and perhaps an early form of, a stable and global attribution and can lead to shame and thus avoidance. Dweck's (2006) motivational constructs may measure one or more aspects of emerging attribution processes important to the expression of shame, guilt, pride, and hubris. These constructs are particularly relevant since young children who are performance oriented when they fail a task are likely not to want to try again, which would appear to be related to shame.

In addition to the dispositional factors relating to specific or global attributions, there are likely to be situational constraints as well. Some have called these "prototypical situations." That is, although there are dispositional factors, not all people all the time are involved in either global or specific attributions. Unfortunately, these situational factors have not been well studied. It seems reasonable to believe that certain classes of situations should be more likely than others to elicit a particular focus, but exactly what classes of stimuli are likely to elicit global or specific attributions remain unknown.

These attributions—(1) the establishment of one's SRGs; (2) the evaluation of success or failure of one's actions in regard to these SRGs; and (3) the attributions of the self, with responsibility as either internal or external, as well as either global or specific—give rise to the four evaluative self-conscious emotions presented in the model. It is the cognitive evaluative processes of children themselves that elicit these action patterns. Now let us turn to these four self-conscious emotions presented in Figure 45.1.

Shame

Shame is the consequence of a set of complex ideas about the self. First, it is accepting responsibility for a failure in terms of fulfilling SRGs, the consequence of the evaluation of one's actions, thoughts, or feelings. Second, the self-evaluation is global. The phenomenological experience of the person having shame is that of a wish to hide, disappear, or die. It is a highly negative and painful experience and is accompanied by a large increase in the stress hormone cortisol (Gruenewald, Kemeny, Aziz, & Fahey, 2004; Lewis & Ramsay, 2002). This painful experience also results in the disruption of ongoing behavior, confusion in thought, and an inability to speak. The other feature of the action pattern accompanying shame includes a shrinking of the body, as in a collapse of shoulders and head, which is a physical manifestation of the desire to disappear from the eye of the self or the other. Because of the intensity of the action pattern of shame on the whole self, this resulting state is difficult to dissipate. A variety of cognitive strategies—including reinterpretation, forgetting, and conversion—are used to cope with the feeling (H. B. Lewis, 1971; M. Lewis, 1992). Shame is often public, but it is just as likely to be private, unlike embarrassment.

In discussing the early form of embarrassment, the claim was made that two forms of embarrassment are possible: the first having to do with being the object of another's attention, and the second having to do with self-evaluation. Evaluative embarrassment is often classified as shame (Izard, 1979; Tomkins, 1963). The most notable difference between shame and embarrassment is the intensity level. While shame appears to be associated with an intense and disruptive action pattern, embarrassment is less intense and does not appear to invoke disruption of thought and speech as shame does. Moreover, the bodily action does not show a desire to hide, disappear, or die. Phenomenologically, embarrassment is less differentiated from shame than from guilt. The difference of intensity between shame and embarrassment may be due to the nature of the failed SRG. Some SRGs are closely associated with the core of the self, others less so. Failures associated with core self-evaluations are likely to be more intense than those associated with lesser core values. Moreover, while shame can be experienced in private as well as in public, embarrassment is strictly associated with public events.

Guilt

Guilt also occurs in response to accepting responsibility for a failure of an SRG. It is not as intense a negative emotion as shame, since guilt is the consequence of focus on the person's specific actions that result in the failure rather than on the totality of the self. The action pattern of guilt is directed outward toward reparation rather than inward toward withdrawal as seen in shame's collapse of the body and disruption of thought. In fact, the emotion of guilt always seems to have an associated corrective action, something the individual can do to repair the failure (Cole, Barrett, & Zahn-Waxler, 1992).

Guilt can be experienced with different degrees of severity, which are tied to the ease and availability of a corrective action. Should a corrective action not be possible, either in thought, words, or deeds, it is possible that a guilt experience can become one of shame. Here, then, appears another difference between shame and guilt. While it is possible to be ashamed of a guilty action, it is not readily possible to be guilty about being ashamed (Freud's [1936/1963] two types of guilt appear to conform to the differences between shame and guilt).

Pride

Pride is the consequence of a successful evaluation of a specific action. The phenomenological experience is joy over an action, thought, or feeling well done. The focus of pleasure is specific and related to a particular behavior. In pride, the self and the object are separated, as in guilt, and the person focuses attention on the behavior leading to success. Some investigators have likened this state to achievement motivation, an association that seems particularly apt (Heckhausen, 1984; Stipek et al., 1992). This form of pride should be related to achievement constructs, such as "efficacy" or "mastery" feelings and "personal satisfaction." Because positive self-evaluative emotion is associated with a particular action, individuals can identify the means by which they can re-create this rewarding state at a future date.

More recently, Tracy, Robins, and colleagues have studied the emotion pride, and have added to our understanding of the difference between what they call authentic pride and hubris, making the distinction between them (Tracy, Cheng, Robins, & Trzesniewski, 2009; Tracy & Robins, 2014). Tracy and colleagues have found that pride is easily identified within the U.S. culture, as well as cross-culturally, and that there are nonverbal as well as verbal cues (Tracy & Robins, 2008). We have found that pride and/or hubris can be measured by a facial expression of joy and with bodily movements of chest expansion, often with arms raised or out (Lewis, Alessandri, & Sullivan, 1992), a finding more recently found by Tracy and Matsumoto (2008).

Pride can easily be distinguished from joy, as the following example makes clear. When adolescents are asked if they would feel proud if they won a large amount of money from a lottery, their reply is no, since responsibility for winning was chance and not their action. While this distinction is valuable, there have, however, been a few cases where the answer was yes, and upon questioning, they made statements such as "If I used my birthdate (or driver's license number) I might be proud." In other words, it is possible for some to find a way in which their responsibility for the win can be made. It would be of interest to determine whether such responses reflect the other type of pride, which we call hubris.

Hubris

Since the English language does not have two different words for pride (i.e., pride that is associated with a task well done, or pride that is arrogant), the term "hubris" is used for the latter, as it represents the pride "that goeth before the fall." Tracy and Robins (2007) have also described these two types of pride and shown that children can discriminate between them.

When people perceive success and assume responsibility for it, a global or performance focus on the self leads to hubris, or arrogant pridefulness. Hubris is a highly positive and self-rewarding state—that is, people feel extremely good about themselves. When displaying this emotion, children and adults are often described as "puffed up," "full of themselves," or even conceited, insolent, or contemptuous. In extreme cases, hubris is associated with grandiosity or with narcissism (Morrison, 1989). Perhaps the most complete work is that of Tracy and colleagues. In one study, Tracy and Prehn (2012) found that contextual information rather than facial or bodily behavior was utilized to differentiate hubris from pride. In this case, the contextual cues included that the target person was arrogant, and in the other case, there was no evidence that the target worked hard for success. Although hubris is felt as a high reward for the person experiencing it, this emotion is unpleasant for others and therefore socially undesirable. People who are hubristic have difficulty in their interpersonal relations since their hubris is likely to interfere with the wishes, needs, and desires of others, leading to interpersonal conflict and possibly performance deficits. For example, Mueller and Dweck (1998) state that too much praise of children and their resulting overly high self-esteem can lead to their negative performance (see also Baumeister, Campbell, Kreuger, & Vohs, 2003; Kamins & Dweck, 1999). The presumed mechanism in this case might be that excessive pride leads to less effort. Three problems associated with hubris are that (1) it is a transient but addictive emotion; (2) it is unrelated to any specific action, and thus requires continually altering goals or reinterpreting what constitutes success; and (3) it interferes with interpersonal relationships because of its insolent and contemptuous nature (Ashton-James & Tracy, 2012).

Studying Differences in Shame, Embarrassment, and Pride

Individual differences in the self-conscious emotions appear by age 3 years. There seems to be at least two major sources of individual differences: the first is constitutional and has to do with temperament, while the second is in the socialization process.

There is evidence that differences in temperament are related to various self-conscious emotions in children. Recent analyses suggest that temperament involves individual differences in the tendency to express positive as well as negative emotion, as well as differences in reactivity level. These aspects of temperament are likely to be related to the self-conscious evaluative emotions. For example, higher anger and fearfulness are associated with later guilt (Kochanska, 1995; Kochanska, Coy, & Murray, 2001; Kochanska, DeVet, Goldman, Murray, & Putnam, 1994; Ramsay & Lewis, 2001; Rothbart, Ahadi, & Hershey, 1994). Reactivity to stress is an important aspect of temperament that is related to negative self-evaluation, such that higher cortisol responses to stress are associated with greater expression of evaluative embarrassment and shame. Collectively, these findings suggest that greater levels of evaluative embarrassment, and shame in particular, are related to temperament through individual differences in self-focus that may arise, in part, because of a lower threshold for pain and an inability to gate or block internal physiological signals. This results in more attention directed toward the self and thus more self-reference. I have proposed that greater stress reactivity leads to greater attention to the self. Following failure, greater self-attention increases the likelihood that children will attribute negative outcomes globally, rather than specifically, thereby increasing the tendency toward shame and/or evaluative embarrassment. Thus, aspects of temperament influence the tendency toward self-attention, which in turn is likely to promote self-conscious evaluative emotions (Csikszentmihalyi, 1991; Lewis & Ramsay, 1997, 2002).

Socialization can influence individual differences in the self-conscious emotions in many different ways, including influences in the acquisition of the SRGs, an internal focus of responsibility, and global versus specific focus of attention. The methods used to teach SRGs—that is, how children are rewarded and punished—influence children's style of self-evaluation, and therefore their self-conscious evaluative emotions.

As indicated earlier, the self-conscious emotions have been little studied and their development studied even less. Dweck (2006) has studied attributional style, mostly around achievement motivation. Nevertheless, her studies of attribution are one of the essential pieces of data we have. My colleague Sullivan and I have been studying the development of these emotions by using success and failure on tasks we have given toddlers and young children. While we also have been studying achievement, our focus has not been on achievement per se since we construct our own paradigm for studying these emotions by manipulating whether a child fails or passes some task. The child's response to succeeding or failing gives us the opportunity to study our model of the causes of shame, guilt, pride, and embarrassment (Lewis et al., 1992).

Given our work on the self-conscious emotions, the nature of the paradigm for studying them may be of some interest. Children 30 months and older are given at least four tasks, one at a time, to complete. These tasks are either matching colors with animals or solving puzzles and are easy, having few items, or more difficult, having many items. We tell the children that the task they are working on is either easy or difficult. In front of the children is a large clock and children are told that they have to finish each task before the time is up and a loud bell sounds. They are told that if they finish before the bell, they have succeeded, but if they have not finished, they have failed. They are given at least two easy tasks and two difficult tasks.

Because we can manipulate the clock, making it go slower or faster, we can arrange for each child to succeed or fail on each task we give them. By having them fail or succeed by manipulating the clock, we can control their achievement—so their task behavior has nothing to do with their real ability. On half the tasks they succeed and on half they fail. Half of the successes are on easy tasks and half are on difficult ones, while half of the failed tasks are easy and half difficult. We measure their action patterns, which include facial expressions and bodily actions. We also ask them a series of questions about their self-attributions after each task. In our studies, children from 30–72 months have been seen in this experimental situation. Children do not seem to notice the slowing down or speeding up of the clock, especially given that their attention is directed toward solving the tasks (Bennett, Sullivan, & Lewis, 2010; Lewis et al., 1992; Lewis & Sullivan, 2005).

It needs to be kept in mind that this manipulation does not always cause shame, embarrassment, or pride. We would estimate that about 55% of the children show these action patterns to our manipulation. Other methods have been tried: for example, giving the children a doll to play with and after a moment or two of play the arms, legs, and head of the doll fell off. While we could produce failure with this task, we needed another type of task to evaluate the emotional behavior of children when they succeeded. Given that no more children showed shame, guilt, or embarrassment when playing with the dolls than when using our tasks, and since we could produce both success and failure, we have stuck with these tasks.

That not all children show the self-conscious emotions on all the trials again points to the difficulties in studying these emotions. The children's self-conscious emotional responses may or may not be elicited by what we do. For example, if the children did not feel responsible for their success or failure, we do not see these emotions. While there are a few other studies on these emotions in children, my discussion is for the most part organized around our work. Because of the ages of the children studied, we are able to examine such issues as the elicitation of these self-conscious emotions, the attributions children give them, and the differences among children both as a function of their attributions as well as their histories of socialization.

We observe pride as well as happiness when children of any age succeed. The facial and bodily action patterns are quite clear, with some children jumping up and throwing their hands in the air. They are puffed up with their chests extended. They also show some embarrassment, but we are not sure as to why. When we observe Japanese children in the success task situations, we also see embarrassment, which is more than what we see for the American children. This behavior may be related to being the object of the attention of the experimenter. Thus, the best guess is that embarrassment during success means that even in situations of success, being the object of attention is likely to produce exposure embarrassment for some children. A good example is that of school-age children who do well in class, and when the teacher points this out to the other students they become embarrassed. Being the object of attention causes embarrassment, especially for some children (Lewis, Takai-Kawakami, Kawakami, & Sullivan, 2010).

In situations involving failure we see sadness but also shame and embarrassment, and very rarely guilty behavior. We only see guilt when children, on hearing the bell ring in the task described earlier, keep on working even though they know the time is up. Such children seem to show by their body actions that they need just a little more time to finish their task. This appears to be a form of reparation in response to the fact that they did not finish and therefore had failed the task (Alessandri & Lewis, 1993). Shame is indexed by the dropping of the head, hunched-up shoulders, and a sad or blank facial expression. These physical signs occur very quickly and then readily disappear. We also see embarrassment during failure, which is similar in behavior to the embarrassment we see during success. It differs from shame in the way described earlier: there is no bodily collapse but there is a grin.

While in these studies we cannot see the children's physiological behavior, when we do measure their stress hormones, we find differences between shame and some forms of embarrassment. There are significant increases in cortisol stress response when children fail and show shame and evaluative embarrassment. However, when they show embarrassment at being the object of another's attention they usually do not show cortisol increases. Certainly, they do not show stress hormone increases when they succeed. Such findings should alert us to the powerful effects that shame and evaluative embarrassment can produce (Lewis & Ramsay, 2002).

Individual Differences

We find little change when we observe children's behaviors in these situations over the course of their development from age 3 to 6 years—that is, shame and pride are already present by age 3 years and can be elicited by success and failure. However, we do find sex differences, with girls showing more shame and embarrassment across age when they fail than do boys, although there are no sex differences for pride. When we examine these sex differences in shame, we find that girls and boys do not differ in the amount of shame they show when they fail an easy task, but girls show more shame than boys when they fail a difficult task (Lewis et al., 1992). This result may be due to attribution differences, with girls accounting themselves more responsible for the failure, while boys attribute the failure to the difficulty of the task, a similar finding reported for adult women and men.

Sex differences have been widely reported in internal global attribution styles for negative events. In a study of parental response to children's performance on academic tasks, we found that both mothers and fathers make significantly more specific positive attributions to boys than to girls. Specific positive feedback such as "That's a good way of getting the piece of the puzzle into the box" was higher for 3-year-old boys than for 3-year-old girls. Conversely, specific negative feedback such as "You didn't look for the biggest piece first" was higher for girls. Fathers made more specific attributions than mothers. Mothers and fathers both made more specific attributions to boys than to girls. These findings support the notion that a major difference of attribution style observed between boys and girls is related to these different socialization patterns (Levine & Conway, 2010).

The tendency toward a particular attribution style for failure can also be learned or further consolidated at school. During the elementary school years, teachers are likely to exert considerable influence on children's attribution styles, particularly around achievement. How teachers describe and react to children's actions contributes to their emerging styles and likely influences many of the sex differences observed in achievement-related attributions in later childhood. At least in some studies, most of the criticism that teachers direct at elementary school boys refers to specific instances of misbehavior or lack of effort—that is, to task-specific factors, rather than to negative personality traits or lack of ability. Such feedback patterns promote specific and controllable attributions. In girls, the opposite pattern can be observed. Despite the fact that girls, on average, do better in elementary school than boys, girls are more likely to attribute failures to lack of ability, a global factor. Teachers' use of evaluative feedback can be a direct cause of either learned helplessness or mastery orientation in children. Once it appears, teachers' criticisms of girls, in contrast to their criticisms of boys, almost always indicated that the girls lacked general competence or did not understand the work, which are both global attributions. Thus, there is ample reason to expect sex differences in attribution styles based on the consistent pattern of sex differences observed during early socialization and the school years (Lewis, 1976; Witkin, 1965).

Although information on sex differences constitutes much of what we know about the socialization of attribution styles at home and in school, biological factors that covary with sex cannot be completely ruled out in accounting for some of these differences. For example, H. B. Lewis has linked a global attribution style to the perceptual and cognitive style of field dependency, which may be related to biological differences. "Field dependence" refers to the ability to separate a perceived object from the context in which it is embedded, with girls more field dependent than boys (Lewis, 1976; Witkin, 1965)

Learning SRGs

In order for success and failure to elicit self-conscious emotions, the child has to internalize SRGs. Several studies have found that around 3 years of age children seem to have acquired some SRGs that they appear to have incorporated into their knowledge system. Stipek as well as Heckhausen have shown that independent of an adult's praise or punishment, 3-year-old children seem to know about their performance and even make self-judgments about whether they have succeeded or failed at a task. Kagan has also shown that by this age, children can identify which pictures they drew at an earlier time (Heckhausen, 1984; Nolan, Adams, & Kagan, 1980; Stipek et al., 1992). While there is sufficient data to show that children by age 3 years have SRGs, exactly how these are acquired remains relatively unstudied. What is clear, however, is that what constitutes success or failure varies among children. While we talk about this topic in more detail later, our data also indicate that children this age are likely to show more shame when they fail an easy task than when they fail a difficult task. Moreover, they are likely to show more pride when they succeed in a difficult task rather than in an easy task. When I ask adults when they would feel more shame, it is clear that they would feel more shame if they failed an easy rather than a difficult task. Likewise, they would feel more pride if they solved a difficult rather than easy task. It seems clear from a variety of data that children by age 3 years have already incorporated some SRGs into their repertoire. Of course the growth of SRGs as a function of socialization and greater cognitive ability is likely to continue.

Evaluative Style

Individual differences in evaluative style have been observed in young children. Somewhere between 3 and 6 years, differences in perceptions of personal performance emerge and appear consistent over age. Once learned, these early motivational dispositions may become entrenched as a personality or attribution style, especially in response to negative events. Strong negative events occurring early in children's lives seem to push children toward a global attribution style in a kind of one-trial learning—that is, children exposed to such events will more consistently make global attributions under most conditions of failure. Their attributions made in response to success are less likely to be predictable. The intensity and power of negative events acting on a child with still limited coping skills may promote this development. Strong negative emotion swamps any cognitive processing that might override the child's egocentric perceptions about the event. Because children cannot separate themselves from the failure, they focus on the global self. The range of negative life events that lead to global attributions is in need of further investigation. These events may include negative experiences with parents, with others in the immediate social environment, or with general calamities that impact the self, family, or others. However, a reasonable working hypothesis is that the performance or self-attribution style of failure is created in the cauldron of stress. This topic has been discussed in more detail in Lewis (2014).

As we have shown, some attribution can be seen in 3- and 4-year-olds' display of shame and pride as a function of success and failure to easy and difficult tasks. That they behave as we adults do suggests that they evaluate difficult task failures as less their fault than easy task failures, thus exhibiting more shame to the failure of easy tasks. Likewise, success on a difficult task leads to more pride than success on an easy one. In the failure tasks, they attribute the failure of an easy task to themselves, thinking something like "After all, anyone should have passed it," but at the same time attribute their failure at a difficult task to the task parameters. Such data lead us to believe that they are even at this age already able to evaluate as internally or externally their action response to SRGs.

Other individual differences in attributions may affect the child's emotional behavior. While we have shown that particular evaluative patterns have an impact on children's emotional life, it has also been shown that children's beliefs influence their achievement behaviors and motivation even though they may not yet make adult-like attributions. How, then, can individual young children's evaluative attribution styles be assessed? Paper-and-pencil methods developed for older children and adults are not appropriate with young children. However, there are measurement procedures useful in obtaining individual differences in children's focus either as performance- or task oriented, how such differences are related to other kinds of evaluative judgments, and how they affect the display of some self-conscious evaluative emotions.

Dweck has obtained performance or task orientations by asking children to work on both solvable and unsolvable tasks, and afterward to assess their choice to avoid or return to the unsolved task (Elliot & Dweck, 2005). Children who choose to avoid the unsolved task and choose instead a task on which they know they have succeeded are considered to be performance oriented. Their choice of a sure success suggests a motive to avoid a display of incompetence. In order to explore this question further, we have used some of the techniques developed by Dweck (Dweck, 1991; Dweck, Chiu, & Hong, 1995; Smiley & Dweck, 1995) but added several others. After each task we ask the children as young as 3–4 years a series of questions including whether they would like to do the task again and how they feel about how they did, which they answer by matching their feelings to a series of picture faces going from very sad to very happy. We then score the spontaneous negative or positive statements they make after each task. We also have developed a measure of whether they are task- or performance oriented.

After each task, children are asked whether the task was easy or difficult. Our focus was on an easy task that they failed. Their response of "easy" or "hard" in the easy-failed task informs us about whether they are making a performance- or a task-based evaluation. If they state that it was "hard"—even though in reality it was easy—they are focusing on their performance, which was a failure. If they say "easy," they are focusing on the task despite their own performance. Thus, the easy-failed task presents the child with a discrepancy between what the child expects, that is, to do well when it is easy, and the outcome of their behavior, which is a failure. We have found children's responses reveal whether children focus their attention globally on their personal performance, or specifically on the nature of the task. Our hypothesis is that these judgments in response to the failure at an easy task should predict other self-related evaluations as well as the expression of the self-conscious evaluative emotions.

When we compare the questions we asked the children, we find an interesting coherence between them. The task versus performance measures of easy or difficult were related to whether they wanted to try to do another task. The children who were task oriented—that is, those who said the task was easy, were significantly more likely to want to try again than were the children who were performance oriented—that is, those who said the task was hard. These data support the idea that performance and task orientation can be measured in 3- to 4-year-olds (Matthews, Sullivan, & Lewis, 2013).

Certain self-attributions lead to more self-conscious emotions. According to our theory, children who are performance focused should display more shame following failure than children who are task focused, and they should also display more pride following success, although this prediction is more tentative because it is not possible to distinguish between hubris and pride at this age. The effect of performance focus on self-conscious evaluative emotions was observed in two studies. A greater percentage of children who are performance focused as opposed to children who are task focused showed shame and evaluative embarrassment following failure. While the children showed more shame and embarrassment if they were performance oriented, they did not show more sadness than the children who are task oriented. We also looked at anger in response to failure and here found that children who are performance oriented showed more anger than the children who are task oriented. Performance orientation is likely to lead to more shame, which in some cases leads to the outward deflection of shame into blaming others. Finally, performance orientation affects all the self-conscious emotions more than the early emotions of sadness and joy.

This set of studies reveals that children's task and performance focus following failure on an easy task is related to other evaluative judgments about their performance and to the overt display of their self-conscious evaluative emotions. The consistency of children's answers to questions about an easy-failed task can be examined to determine the degree to which they focus on the self when thinking about the failure. A performance focus, as opposed to a task focus following failure, is related to thinking poorly about oneself, to being unwilling to try again, and to being more likely to show shame and evaluative embarrassment following failure. This pattern of negative self-judgments might represent the early precursors of the internal, stable, global attribution styles observed in older children and adults. Such attribution styles for negative events promote shame and thus constitute a risk factor for subsequent maladjustment. While space does not allow us, the relationship between shame and psychopathology has been examined; a brief list of some of the more recent ones include Bennett, Sullivan, and Lewis (2005, 2010); Feiring, Taska, and Lewis (2002); Gold and Lewis (2010); Gold, Sullivan, and Lewis (2011); Stuewig et al. (2015); and Tracy et al. (2009).

More work on the normal and pathological development of the self-conscious emotions is needed. The structural model we have proposed provides the base for the self-conscious emotions. Without a more accurate or agreed-upon taxonomy, the harder it will be to study these emotions. Given the interest in emotional life, and in the relation between emotions and health, it seems increasingly necessary to study these emotions, rather than only the more "primary" or "basic" ones. Given the place of self-evaluation in adult life, it seems clear that the self-conscious evaluative emotions are likely to stand in the center of our emotional and social lives.

Note

1. Portions of this chapter are based on material in Lewis (2014).

References

Ainsworth, M. D. S., & Bell, S. M. (1970). Attachment, exploration, and separation: Illustrated by the behavior of one-year-olds in a strange situation. *Child Development, 41*, 49–67.

Alessandri, S. M., & Lewis, M. (1993). Parental evaluation and its relation to shame and pride in young children. *Sex Roles, 29*(5/6), 335–343.

Alessandri, S. M., & Lewis, M. (1996). Differences in pride and shame in maltreated and nonmaltreated preschoolers. *Child Development, 67*, 1857–1869.

Ashton-James, C. E., & Tracy, J. L. (2012). Pride and prejudice: How feelings about the self influence judgments of others. *Personality and Social Psychology Bulletin, 38*(4), 466–476.

Baumeister, R. F., Campbell, J., Kreuger, J., & Vohs, K. D. (2003). Does high self-esteem cause better performance, interpersonal success, happiness, or healthier lifestyles? *Psychological Science in the Public Interest, 4*(1), 1–44.

Beck, A. T. (1979). *Cognitive therapy and emotional disorders*. New York: Times Mirror.

Bennett, D. S., Sullivan, M. W., & Lewis, M. (2005). Young children's adjustment as a function of maltreatment, shame, and anger. *Child Maltreatment, 10*(4), 311–323.

Bennett, D. S., Sullivan, M. W., & Lewis, M. (2010). Neglected children, shame-proneness and depressive symptoms. *Child Maltreatment, 15*(4), 305–314.

Bischof-Kohler, D. (1991). The development of empathy in infants. In M. E. Lamb & H. Keller (Eds.), *Infant development: Perspectives from German-speaking countries* (pp. 245–273). Hillsdale, NJ: Erlbaum.

Bradley, B. S. (2010). Jealousy in infant-peer trios: From narcissism to culture. In S. L. Hart & M. Legerstee (Eds.), *Handbook of jealousy: Theory, research, and multidisciplinary approaches* (pp. 192–234). Malden, MA: Blackwell/Wiley.

Braten, S. (2009). *The intersubjective mirror in infant learning and evolution of speech*. Amsterdam, The Netherlands: Benjamins.

Broucek, F. J. (1991). *Shame and the self*. New York: Guilford Press.

Buss, A. H. (1980). *Self-consciousness and social anxiety*. San Francisco: Freeman.

Cheek, J. M., & Buss, A. H. (1981). Shyness and sociability. *Journal of Personality and Social Psychology, 41*, 330–339.

Cole, P. M., Barrett, K. C., & Zahn-Waxler, C. (1992). Emotion displays in two-year-olds. *Child Development, 63*, 314–324.

Csikszentmihalyi, M. (1991). *Flow: The psychology of optimal experience*. New York: Harper Collins.

Csikszentmihalyi, M., & Csikszentmihalyi, I. S. (1988). *Optimal experience: Psychological studies of flow in consciousness*. New York: Cambridge University Press.

Darwin, C. R. (1965). *The expression of emotions in man and animals*. Chicago: University of Chicago Press. (Original work published 1872)

DiBiase, R., & Lewis, M. (1997). The relation between temperament and embarrassment. *Cognition and Emotion, 11*, 259–271.

Dweck, C. S. (1991). Self-theories and goals: Their role in motivation, personality and development. In R. Dienstbeir (Ed.), *Nebraska Symposium on Motivation* (Vol. 36, pp. 199–236). Lincoln: University of Nebraska Press.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Random House.

Dweck, C. S., Chiu, C., & Hong, Y. (1995). Implicit theories and their role in judgments and reactions: A world from two perspectives. *Psychological Inquiry, 6*, 267–285.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*, 256–273.

Edelmann, R. J. (1987). *The psychology of embarrassment*. Chichester, UK: Wiley.

Elliot, A. J., & Dweck, C. S. (2005). Competence and motivation: Competence as the core of achievement motivation. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 3–12). New York: Guilford Press.

Eysenck, H. J. (1956). The questionnaire measurement of neuroticism and extraversion. *Revista Psicologia, 50*, 113–140.

Feiring, C., & Lewis, M. (1979). Sex and age differences in young children's reactions to frustration: A further look at the Goldberg and Lewis (1969) subjects. *Child Development, 50*, 848–853.

Feiring, C., Taska, L., & Lewis, M. (2002). Adjustment following sexual abuse discovery: The role of shame and attributional style. *Developmental Psychology, 38*(1), 79–92.

Fenigstein, A., Scheier, M. F., & Buss, A. H. (1975). Public and private self-consciousness: Assessment and theory. *Journal of Consulting and Clinical Psychology, 43*, 522–527.

Freud, S. (1953). Three essays on the theory of sexuality. In J. Strachey (Ed., & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 7, pp. 153–243). London: Hogarth Press. (Original work published 1905)

Freud, S. (1963). *The problem of anxiety* (H. A. Bunker, Trans.). New York: Norton. (Original work published 1936)

Friedman, O. (2011). *Principles guiding young children's reasoning about ownership*. Presentation at the October 11 Colloquium at the Rutgers University Center for Cognitive Science, New Brunswick, NJ.

Geppert, U. (1986). *A coding system for analyzing behavioral expressions of self-evaluative emotions* [Technical manual]. Munich: Max-Planck Institute for Psychological Research.

Goffman, E. (1959). *Presentation of self in everyday life*. Garden City, NY: Doubleday.

Gold, J., & Lewis, M. (2010). The etiology of youth violence: A cognitive-emotional model. In W. F. Arsenio & E. A. Lemerise (Eds.), *Emotions, aggression, and morality in children* (pp. 219–237). Washington, DC: American Psychological Association.

Gold, J., Sullivan, M., & Lewis, M. (2011). The relation between abuse and violent delinquency: The conversion of shame to blame in juvenile offenders. *Child Abuse and Neglect, 35*(7), 459–467.

Goldberg, S., & Lewis, M. (1969). Play behavior in the year-old infant: Early sex differences. *Child Development, 40*, 21–31.

Gruenewald, T. L., Kemeny, M. E., Aziz, N., & Fahey, J. L. (2004). Acute threat to the social self: Shame, social self-esteem, and cortisol activity. *Psychosomatic Medicine, 66*, 915–924.

Hart, S. L., & Legerstee, M. (Eds.). (2010). *Handbook of jealousy: Theory, research, and multidisciplinary approaches*. Malden, MA: Blackwell/Wiley.

Heckhausen, H. (1984). Emergent achievement behavior: Some early developments. In J. Nicholls (Eds.), *The development of achievement motivation* (pp. 1–32). Greenwich, CT: JAI Press.

Herrmann, E., Hernandez-Lloreda, M. V., Call, J., Hare, B., & Tomasello, M. (2010). The structure of individual differences in the cognitive abilities of children and chimpanzees. *Psychological Science, 21*(1), 102–110.

Hobson, R. P. (2010). Is jealousy a complex emotion? In S. L. Hart & M. Legerstee (Eds.), *Handbook of jealousy: Theory, research, and multidisciplinary approaches* (pp. 293–311). Malden, MA: Blackwell/Wiley.

Izard, C. E. (1977). *Human emotions*. New York: Plenum Press.

Izard, C. E. (1979). *The Maximally Discriminative Facial Movement Coding System (MAX)*. Newark, DE: University of Delaware, Instructional Resources Center.

Izard, C. E., & Tyson, M. C. (1986). Shyness as a discrete emotion. In W. H. Jones, J. M. Cheek, & S. R. Briggs (Eds.), *Shyness: Perspectives on research and treatment* (pp. 147–160). New York: Plenum Press.

Janoff-Bulman, R. (1979). Characterological versus behavioral self-blame: Inquiries into depression and rape. *Journal of Personality and Social Psychology, 37*, 1798–1809.

Jones, W. H., Cheek, J. M., & Briggs, S. R. (Eds.). (1986). *Shyness: Perspectives on research and treatment*. New York: Plenum Press.

Kagan, J. (1981). *The second year: The emergence of self-awareness*. Cambridge, MA: Harvard University Press.

Kagan, J., Reznick, J. S., & Snidman, N. (1988). Biological bases of childhood shyness. *Science, 240*, 167–171.

Kagan, J., Snidman, N., Arcus, D., & Reznick, J. S. (1994). *Galen's prophecy: Temperament in human nature*. New York: Basic Books.

Kamins, M. L., & Dweck, C. S. (1999). Person versus process praise and criticism: Implications for contingent self-worth and coping. *Developmental Psychology, 35*, 835–847.

Keller, H., & Lamm, B. (2010). Culture, parenting, and the development of jealousy. In S. L. Hart & M. Legerstee (Eds.), *Handbook of jealousy: Theory, research, and multidisciplinary approaches* (pp. 477–497). Malden, MA: Blackwell/Wiley.

Kochanska, G. (1995). Children's temperament, mothers' discipline, and security of attachment: Multiple pathways to emerging internalization. *Child Development, 66*(3), 597–615.

Kochanska, G., Coy, K. C., & Murray, K. T. (2001). The development of self-regulation in the first 4 years of life. *Child Development, 72*, 1091–1111.

Kochanska, G., DeVet, K., Goldman, M., Murray, K. T., & Putnam, S. P. (1994). Maternal reports of conscience development and temperament in young children. *Child Development, 65*(3), 852–868.

Leary, M. R., & Meadows, S. (1991). Predictors, elicitors and concomitants of social blushing. *Journal of Personality and Social Psychology, 60*(2), 254–262.

Levine, L. E., & Conway, J. M. (2010). Self-other awareness and peer relationships in toddlers: Gender comparisons. *Infant and Child Development, 19*, 455–464.

Lewis, H. B. (1971). *Shame and guilt in neurosis*. New York: International Universities Press.

Lewis, H. B. (1976). *Psychic war in men and women*. New York: New York University Press.

Lewis, H. B. (1987). Shame: The "sleeper" in psychopathology. In H. B. Lewis (Ed.), *The role of shame in symptom formation* (pp. 1–28). Hillsdale, NJ: Erlbaum.

Lewis, M. (1992). *Shame: The exposed self*. New York: Free Press.

Lewis, M. (2014). *The rise of consciousness and the development of emotional life*. New York: Guilford Press.

Lewis, M., Alessandri, S., & Sullivan, M. W. (1992). Differences in shame and pride as a function of children's gender and task difficulty. *Child Development, 63*, 630–638.

Lewis, M., & Ramsay, D. S. (1997). Stress reactivity and self-recognition. *Child Development, 68*, 621–629.

Lewis, M., & Ramsay, D. S. (2002). Cortisol response to embarrassment and shame. *Child Development, 73*(4), 1034–1045.

Lewis, M., & Ramsay, D. S. (2004a). Development of self-recognition, personal pronoun use, and pretend play in the second year. *Child Development, 75*(6), 1821–1831.

Lewis, M., & Ramsay, D. S. (2004b). Infant emotional response to goal blockage, control, and cortisol response. *Emotion Researcher, 19*(2), 8–9.

Lewis, M., & Ramsay, D. S. (2005). Infant emotional and cortisol responses to goal blockage. *Child Development, 76*(2), 518–530.

Lewis, M., Stanger, C., Sullivan, M. W., & Barone, P. (1991). Changes in embarrassment as a function of age, sex and situation. *British Journal of Developmental Psychology, 9*, 485–492.

Lewis, M., & Sullivan, M. (2005). The development of self-conscious emotions. In A. Elliott & C. Dweck (Eds.), *Handbook of competence and motivation* (pp. 185–201). New York: Guilford Press.

Lewis, M., Sullivan, M. W., Stanger, C., & Weiss, M.

(1989). Self-development and self-conscious emotions. *Child Development, 60*, 146–156.

Lewis, M., Takai-Kawakami, K., Kawakami, K., & Sullivan, M. (2010). Cultural differences in emotional responses to success and failure. *International Journal of Behavioral Development, 34*(1), 53–61.

Masciuch, S., & Kienapple, K. (1993). The emergence of jealousy in children 4 months to 7 years of age. *Journal of Social and Personal Relationships, 10*, 421–435.

Matthews, T. A., Sullivan, M. W., & Lewis, M. (2013, March). *Young children's self-evaluation and emotional behavior during achievement tasks*. Paper presented at the 2013 annual meeting of the Eastern Psychological Association, New York, NY.

Morrison, A. P. (1989). *Shame: The underside of narcissism*. Hillsdale, NJ: Analytic Press.

Mueller, C. M., & Dweck, C. S. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology, 75*, 33–52.

Nancekivell, S. E., Van de Vondervoort, J. W., & Friedman, O. (2013). Young children's understanding of ownership. *Child Development Perspectives, 7*(4), 243–247.

Nolan, E., Adams, S., & Kagan, J. (1980). Children's recognition memory for their drawings. *Journal of Genetic Psychology: Research and Theory on Human Development, 137*(1), 11–15.

Nolen-Hoeksema, S., Girgus, J. S., & Seligman, M. E. P. (1992). Predictors and consequences of childhood depressive symptoms: A 5-year longitudinal study. *Journal of Abnormal Psychology, 101*, 405–422.

Nolen-Hoeksema, S., Wolfson, A., Mumme, D., & Guskin, K. (1995). Helplessness in children of depressed and nondepressed mothers. *Developmental Psychology, 31*, 377–387.

Noles, N. S., Keil, F. C., Bloom, P., & Gelman, S. A. (2012). Children's and adults' intuitions about who can own things. *Journal of Cognition and Culture, 12*, 265–286.

Plutchik, R. (1980). A general psychoevolutionary theory of emotion. In R. Plutchik & H. Kellerman (Eds.), *Emotion: Theory, research, and experience* (Vol. 1, pp. 3–33). New York: Academic Press.

Premack, D. (2010). Why humans are unique: Three theories. *Perspectives on Psychological Science, 5*(1), 22–32.

Preston, S. D., & de Waal, F. B. M. (2002). Empathy: Its ultimate and proximate bases. *Behavioral and Brain Sciences, 25*, 1–71.

Ramsay, D., & Lewis, M. (2001). Temperament, stress, and soothing. In T. D. Wachs & G. A. Kohnstamm (Eds.), *Temperament in context* (pp. 23–41). Mahwah, NJ: Erlbaum.

Rothbart, M. K., Ahadi, S., & Hershey, K. L. (1994). Temperament and social behavior in childhood. *Merrill–Palmer Quarterly, 40*, 21–39.

Roth-Hanania, R., Davidov, M., & Zahn-Waxler, C. (2011). Empathy development from 8 to 16 months: Early signs of concern for others. *Infant Behavior and Development, 34*, 447–458.

Rozin, P., Haidt, J., & McCauley, C. (1993). Disgust. In M. Lewis & J. Haviland (Eds.), *Handbook of emotions* (pp. 575–594). New York: Guilford Press.

Sagi, A., & Hoffman, M. L. (1976). Empathic distress in the newborn. *Developmental Psychology, 12*(2), 175–176.

Schachter, S., & Singer, J. E. (1962). Cognitive, social, and physiological determinants of emotional state. *Psychological Review, 69*, 379–399.

Seligman, M. E. P. (1975). *Helplessness: On depression, development, and death*. San Francisco: Freeman.

Seligman, M. E. P., Peterson, C., Kaslow, N., Tanenbaum, R., Alloy, L., & Abramson, L. (1984). Attributional style and depressive symptoms among children. *Journal of Abnormal Psychology, 39*, 235–238.

Semin, G. R., & Manstead, A. S. R. (1981). The beholder beheld: A study in social emotionality. *European Journal of Social Psychology, 11*, 253–265.

Smiley, P. A., & Dweck, C. S. (1995). Individual differences in achievement goals among young children. *Child Development, 65*, 1723–1743.

Stipek, D. J. (1983). A developmental analysis of pride and shame. *Human Development, 26*(1), 42–54.

Stipek, D. J., Recchia, S., & McClintic, S. (1992). Self-evaluation in young children. *Monographs of the Society for Research in Child Development, 57*(1, Serial No. 226), 1–95.

Stuewig, J., Tangney, J. P., Kendall, S., Folk, J. B., Meyer, C. R., & Dearing, R. L. (2015). Children's proneness to shame and guilt predict risky and illegal behaviors in young adulthood. *Child Psychiatry and Human Development, 46*(2), 217–227.

Tangney, J. P. (1995). Shame and guilt in interpersonal relationships. In J. P. Tangney & K. W. Fischer (Eds.), *Self-conscious emotions: The psychology of shame, guilt, embarrassment, and pride* (pp. 114–139). New York: Guilford Press.

Tomkins, S. S. (1963). *Affect, imagery, and consciousness: Vol. 2. The negative affects*. New York: Tavistock/Routledge.

Tracy, J. L., Cheng, J. T., Robins, R. W., & Trzesniewski, K. H. (2009). Authentic and hubristic pride: The affective core of self-esteem and narcissism. *Self and Identity, 8*, 196–213.

Tracy, J. L., & Prehn, C. (2012). Arrogant or self-confident?: The use of contextual knowledge to differentiate hubristic and authentic pride from a single nonverbal expression. *Cognition and Emotion, 26*(1), 14–24.

Tracy, J. L., & Matsumoto, D. (2008). The spontaneous expression of pride and shame: Evidence for biologically innate nonverbal displays. *Proceedings of the National Academy of Sciences, 105*(33), 11655–11660.

Tracy, J. L., & Robins, R. W. (2007). Emerging insights into the nature and function of pride. *Current Directions in Psychological Science, 16*(3), 147–150.

Tracy, J. L., & Robins, R. W. (2008). The nonverbal expression of pride: Evidence for cross-cultural recognition. *Journal of Personality and Social Psychology, 94*(3), 516–530.

Tracy, J. L., & Robins, R. W. (2014). Conceptual and empirical strengths of the authentic/hubristic model of pride. *Emotion, 14*(1), 33–37.

Trevarthen, C. B., & Aitken, K. J. (2001). Infant intersubjectivity: Research, theory and clinical applications. *Journal of Child Psychology and Psychiatry, 42*, 3–48.

Tronick, E. Z., Als, H., Adamson, L., Wise, S., & Brazelton, T. B. (1978). The infant's response to entrapment between contradictory messages in face-to-face interaction. *Journal of the American Academy of Child Psychiatry, 17*, 1–13.

Wasserman, G. A., & Lewis, M. (1985). Infant sex differences: Ecological effects. *Sex Roles: A Journal of Research, 12*, 665–675.

Weinberg, K. M., & Tronick, E. Z. (1996). Infant affective reactions to the resumption of maternal interaction after the still-face. *Child Development, 67*, 905–914.

Weiner, B. (1986). *An attributional theory of motivation and emotion*. New York: Springer-Verlag.

Weiner, B., & Graham, S. (1989). Understanding the motivational role of affect: Life-span research from an attributional perspective. *Cognition and Emotion, 3*, 401–419.

Weinraub, M., & Lewis, M. (1977). The determinants of children's responses to separation. *Monographs of the Society for Research in Child Development, 42*(4, Serial No. 172), 1–78.

Witkin, H. (1965). Psychological differentiation and forms of pathology. *Journal of Abnormal Psychology, 70*, 317–336.

Zimbardo, P. G. (1977). *Shyness*. Reading, MA: Addison-Wesley.

CHAPTER 46

Disgust

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If there were a stock market in emotion research, you would have been wise to put your money on disgust back in the 1970s. According to PsycInfo,[1] the number of articles with the word "disgust" in the title or key-phrase fields has increased 80fold since then. "Anger," in contrast, increased only eightfold, and "happiness" grew only 13fold.

The first full book devoted to disgust, William Miller's *The Anatomy of Disgust*, was not published until 1997, well over 100 years after Darwin's (1872/1998) first chapter on disgust. In contrast, in the first 13 years of the 21st century, eight books devoted to disgust were published (Menninghaus, 2003; Miller, 2004; Olatunji & McKay, 2009; Korsmeyer, 2011; Kelly, 2011; McGinn, 2011; Herz, 2012; Curtis, 2013). The most comprehensive overall scholarly source is the edited book *Disgust and Its Disorders* (Olatunji & McKay, 2009). Furthermore, books with broad intellectual agendas have devoted substantial attention to disgust in recent years (Pinker, 1997; Bloom, 2004; Nussbaum, 2004; Haidt, 2012), with one additional book clearly related to disgust (Haslam, 2012). In addition, more than a few significant general theoretical/review articles have been written (e.g., Tybur, Lieberman, Kurzban, & DeScioli, 2013; Strohminger, 2014).

What accounts for this explosion of interest in disgust? First, there is the evolutionary perspective, focusing on pathogen avoidance (e.g., Tybur, Lieberman, Kurzban, & DeScioli, 2013; Curtis, 2013). Second, there is the cognitive neuroscience perspective (Schienele, 2009). Third, there is the psychopathology perspective, with disgust taking its place beside fear in the understanding of anxiety disorders (Olatunji & McKay, 2009).

Most of the major current theories of disgust (Tybur et al., 2013; Kelly, 2011; Rozin, Haidt, & McCauley, 2008) agree on four points: (1) disgust originates in part or whole as a food rejection system; (2) pathogen avoidance has some fundamental role in explaining the origins and expansion of disgust; (3) a process like preadapation (recruitment of something already present for a new function) is involved in the expansion of disgust elicitors; and (4) the disgust emotion program (facial and bodily expression, psychophysiological events, behavioral withdrawal, and feeling of revulsion) is relatively conservative as disgust expands, while the class of elicitors and their meanings is more plastic. We organize much of this chapter around attempts to make sense of the full range of disgust elicitors.

Definitions, Origins, and Expansions

There are two classic papers describing disgust, published some 70 years apart. The first, by Darwin (1872/1998), defined disgust as referring to "something revolting, primarily in relation to the sense of taste, as actually perceived or vividly imagined; and secondarily to anything which causes a similar feeling, through the sense of smell, touch and even of eyesight" (p. 253). Darwin related disgust not only to the experience of revulsion but to a characteristic facial expression. The second paper, by psychoanalyst Andras Angyal (1941, p. 395), held that disgust is "Revulsion at the prospect of oral incorporation of an offensive object." He identified body waste products as a focus of disgust, and related the strength of disgust to the degree of intimacy of contact. Our own description of what we call "core disgust" follows Angyal's definition, adding the sentence "The offensive objects are contaminants; that is, if they even briefly contact an acceptable food, they tend to render that food unacceptable" (Rozin & Fallon, 1987, p. 23). Most definitions focus on the mouth and real or imagined ingestion. Tomkins (1963, 1982) held that, of all the emotions, disgust has the clearest linkage to a specific motivation (hunger), and functions to oppose this motive. Ekman and Friesen (1975) see disgust as an aversion that centers on oral rejection.

The food origin of disgust is probably linked to minimizing the risk of consuming pathogens contained in food (Curtis & Biran, 2001; Curtis, 2013). The English term "disgust" literally means "bad taste," and one of the facial expressions of disgust (the gape and tongue protrusion; Rozin, Lowery, & Ebert, 1994; Widen, Pochedly, Pieloch, & Russell, 2013) serves functionally in rejecting unwanted foods. The most distinct physiological concomitant of disgust—nausea—is a gastrointestinal, food-related sensation that inhibits ingestion. Finally, the brain region most often activated in studies of disgust is the anterior insula (Vytal & Hamann, 2010), which, among its other functions, is the gustatory cortex in primates (Rolls, 1994).

Most scholars recognize the innate aversion to bitter (and its face) as the origin of disgust, although the rejection of bitterness itself is not disgust. All agree as well that a process like preadaptation (sometimes referred to as co-opting or exaptation) is responsible for the first full form of disgust, core disgust (or pathogen avoidance disgust), and the expansion of disgust to a wide range of elicitors. Preadaptation is the co-opting of an existing system for a new function (Mayr, 1960). It is a major force in biological evolution, and even more important in cultural evolution where adaptation is easier and faster. Kelly (2011), in particular, notes that a first step in disgust is a linkage of the innate bitter rejection system to a pathogen avoidance system. He calls this the entanglement hypothesis. We do not yet know how or when disgust originated in human history, or how or when any of the later expansions actually occurred.

The Components of Disgust and the Disgust Program

Paul Ekman (1992) has provided the clearest articulation of the characteristics of an emotion, and disgust meets seven or eight of his nine criteria. Scholars disagree about whether disgust qualifies for Ekman's criterion of presence in nonhuman primates, or in relation to that, whether disgust is uniquely human.

Behavioral Component

Disgust is manifested as a distancing from some object, event, or situation, and can be characterized as a rejection or withdrawal.

Physiological Component

Disgust is associated with a *specific* physiological state—nausea—that is typically measured by self-report. Disgust is the only "basic" emotion that has such a specific visceral signature. Visceral/autonomic correlates of disgust are reviewed by Vrana (2009) and Kreibig (2010). Meissner, Muth, and Herbert (2011) report relationships between the electrophysiological measures of nausea (the electrogastrogram) and both disgust sensitivity and the degree of disgust reported in response to disgust-eliciting pictures. Nausea may be manifested more in response to food and other core disgust elicitors, and less in response to pain-related blood and injury elicitors (Shenhav & Mendes, 2014).

There is some dispute about whether disgust involves net parasympathetic activation (Kreibig, 2010; Vrana, 2009), but it is clearly not a strong sympathetic activator, like anger and fear.

Expressive Component

Although the ability to recognize the expression of disgust has been studied extensively, almost the entire literature uses still (as opposed to dynamic) stimuli, and is focused on the faces made by individuals from Western cultures. The Natyashastra (Masson & Patwardhan, 1970), an ancient Hindu treatise on drama, treats disgust as a basic emotion and designates multiple dynamic displays of disgust, including the hands, face, and body. Americans as well as Indians are able to identify these dynamic disgust expressions remarkably well (Hejmadi, Davidson, & Rozin, 2000).

The characteristics of the "disgust face" have received particular attention from Darwin

(1872/1998); Izard (1971); Ekman (1972; Ekman & Friesen, 1975); Rozin, Lowery, et al. (1994); and Widen and Russell (2013). Four main components seem to be the gape, tongue extension, retraction of the upper lip, and the nose wrinkle. Contraction of the muscles around the eye typically occurs as well, but is not diagnostic because it tends to occur with other negative emotions (Vrana, 2009).

Darwin (1872/1998) described the disgust face in some detail:

> Extreme disgust is expressed by movements round the mouth identical with those preparatory to the act of vomiting. The mouth is opened widely, with the upper lip strongly retracted, which wrinkles the sides of the nose, and the lower lip protruded and everted as much as possible. (1998, p. 256)

Ekman, however, disagreed to some extent with Darwin:

> There are two disgust expressions. Darwin described one, but not the best one—in terms of people of various cultures agreeing that disgust, not contempt, is being shown. In this disgust expression the nose is wrinkled, the nostrils raised, and the inner corners of the brow lowered. (note by Ekman in Darwin, 1998, pp. 256–257)

Ekman and Friesen's (1978) celebrated work on facial expressions of emotion included all four components we have mentioned, but the upper lip retraction and nose wrinkle are almost exclusively used in disgust research. However, the most distinctive features of infant facial expressions in response to bitter tastes, taken by most scholars to be the precursor of adult disgust, are a gape and a tongue protrusion, actions serving to rid the mouth of a distasteful substance.

The gape face is typically selected by Western adults as related to food- and body-related disgusts, while the upper lip raise disgust becomes more commonly selected in response to moral offenses that are called disgusting (Rozin, Lowery, et al., 1994; Rozin, Lowery, Imada, & Haidt, 1999). Recently, Widen et al. (2013) have identified a "sick" face, which also centers on the oral rejection muscles as the principal face associated with disgusting objects (as opposed to people), and have shown that the gape-centered face is more reliably assigned to core disgust elicitors.

The upper lip raise is used as the standard indicator of disgust, but it is also part of one of two anger expressions. Functionally, it represents a baring of the teeth in the upper jaw. When both disgust faces and both anger faces are used in facial recognition studies (Rozin, Lowery, et al., 1994, 1999), it is clear that there is overlap in elicitors between (especially moral) disgust and anger faces that include the upper lip raise. Since the differentiation of disgust and anger as moral emotions is a matter of current concern, future research may need to give more attention to the gape or sick versions of the disgust face.

Qualia

Qualia, the mental or feeling component of emotion, may be at once the most central component of disgust and the most difficult to study. The qualia of disgust is often described as revulsion. In comparison to other emotions, the experience of disgust appears to be rather short in duration (Scherer & Wallbott, 1994).

Core (or Pathogen Avoidance) Disgust

We conceive of core disgust (Rozin, Haidt, & McCauley, 1993) as one of four categories of food rejection, the others being distaste (motivated by bad sensory properties), danger (motivated by fear of bodily harm), and inappropriateness (culturally classified as not edible; Fallon & Rozin, 1983). Like inappropriateness, disgust is defined by ideational factors, rather than by perceptual qualities: beliefs about the nature or origin of a potential food. Unlike inappropriate entities, disgusting entities are presumed to be both distasteful and dangerous. On this view, the appraisal that elicits core disgust requires (1) a sense of potential oral incorporation (and hence a linkage with food or eating), (2) a sense of offensiveness, and (3) contamination potency (Angyal, 1941; Rozin & Fallon, 1987).

Oral Incorporation

Rozin and Fallon (1987) noted that the mouth is the principal route of entry of material things into the body, and hence can be thought of as the gateway to the body. Aversion to an offensive entity in the mouth is usually stronger than aversion to the same entity on the body surface near but not inside the mouth, or inside the stomach (Rozin, Nemeroff, Horowitz, Gordon, & Voet, 1995).

The threat of oral incorporation is framed by a widespread belief that one takes on the properties of the food one eats ("You are what you eat"). In *The Golden Bough*, Frazer (1890/1922) noted:

"The savage commonly believes that by eating the flesh of an animal or man, he acquires not only the physical but even the moral and intellectual qualities which are characteristic of that animal or man" (p. 573). This belief is consistent with our general experience that when two things combine (in this case, a food and a person), the product resembles both. Nemeroff and Rozin (1989) found evidence for an implicit belief that "You are what you eat" in American college students.

Offensive Entities: Animals and Their Products

Angyal (1941) held that the center of disgust is animal (including human) waste products, which he saw as debasing. Body products are a focus of disgust, and are central to the related anthropological concept of pollution (Douglas, 1966; Meigs, 1978, 1984). There is widespread historical and cultural evidence for aversion and disgust to virtually all body products, including feces, vomit, saliva, mucus, sweat, urine, and blood (especially menstrual blood), but typically not tears or milk. In accord with Angyal's (1941) suggestion of an animal focus for disgust, Rozin and Fallon (1987) proposed that the elicitor category for core disgust is *all animals* and their products as potential foods. Martins and Pliner (2006) report a dimension of livingness/animalness emerging from multidimensional scaling of ratings of the disgustingness of a wide range of novel foods.

Almost all cultures eat only a small subset of potential animal foods. For example, with well over 4,000 species of mammals, Americans only regularly consume three (pig, cow, and sheep), and then consume only the muscle. Angyal (1941) pointed out that in many cultures some care is taken to disguise the animal origin of animal food by cutting, chopping, and other culinary preparations, as well as by having names for animal foods (e.g., "pork," "beef," in English) that are distinct from the corresponding animal names.

Animals and their products seem, cross-culturally, to be both the most favored of foods and the most tabooed (Tambiah, 1969). Most food taboos involve animals (Fessler & Navarette, 2003), and are very often backed up by disgust (Meigs, 1984). Some animals are disgusting because they bear some resemblance to body products such as mucus (e.g., slugs), or because they are commonly in contact with rotting animal flesh, feces, or other human wastes (e.g., flies, cockroaches, rats, vultures). Carnivorous land animals eat raw, often decaying animal flesh, and produce putrid feces; they are disgusting at both ends. Herbivores are much less likely to be prohibited cross-culturally.

Two other categories of animal food prohibitions deserve mention. Animals that are close to humans, either in appearance (e.g., other primates) or by virtue of a relationship with humans as pets, are rarely eaten and elicit disgust as food. And finally, there is a group of anomalous animals that seem to produce a mixture of fear (danger) and disgust (e.g., spiders and snakes). Davey and his colleagues (Davey, 1993; Matchett & Davey, 1991) offer evidence that the aversion to these animals is based more on disgust than fear.

Contamination

The contamination response—rejection of a potential food if it even briefly contacted a disgusting entity—appears to be powerful and universal among adults. American college students reject liked beverages after they have briefly contacted a dead cockroach (Rozin, Millman, & Nemeroff, 1986). Virtually all Americans reject foods that have been handled or bitten by either unsavory or disliked persons (Rozin, Nemeroff, Wane, & Sherrod, 1989). Although this aversion is typically justified as an avoidance of disease, removal of this justification (e.g., by sterilizing the offending dead cockroach) typically has only a small effect. Contamination seems likely to have been shaped as an adaptation for disease avoidance, but it is often expressed even when an individual realizes that there is no disease threat.

Contamination effects may be instances of the sympathetic magical law of contagion (Tylor, 1871/1974; Frazer, 1890/1922; Mauss, 1902/1972), which essentially holds that "once in contact, always in contact" (Rozin & Fallon, 1987; Rozin & Nemeroff, 1990).

Core Disgust or Pathogen Avoidance Disgust

If core disgust is an oral defense, then the most obvious thing it is defending the mouth against is pathogens. Pathogen avoidance as an origin for disgust has been suggested a number of times (Renner, 1944; Plutchik, 1980; Haidt, Rozin, McCauley, & Imada, 1997).

In the last decade, several scholars have made a much stronger case for the evolutionary origins of disgust as a pathogen avoidance mechanism (Curtis, de Barra, & Aunger, 2011; Curtis, 2013; Tybur et al., 2013; Oaten, Stevenson, & Case, 2009; Kelly, 2011). Pathogens are a major problem for animals, and there are many adaptations in nonhuman animals to reduce the risk of pathogens (Hart, 2011). The pathogen threat to humans may be especially high because of the high density of human habitation consequent on domestication of plants and animals, and the intimate contact between humans and animal vectors of infection due to the domestication of animals (Wolfe, Dunavan, & Diamond, 2007). Infectious diseases were likely the major causes of death to humans in the ancestral environment, and remain a major cause of death today in tropical Africa. The pathogen avoidance theory of disgust (PAT; Curtis et al., 2011; Curtis, 2013; see Oaten et al., 2009; Tybur, et al., 2013, for similar conclusions) is forwarded by Valerie Curtis, who is an infectious disease epidemiologist and field worker.

Oaten et al. (2009) examined 14 predictions that would follow from linking core disgust and pathogen avoidance, and find evidence for all of them. For example, (1) objects that elicit disgust are likely to be infection risks; (2) the focus of core disgust is on food, almost always food of animal origin, which is more likely to harbor pathogens than are plant foods; and (3) contamination sensitivity is exactly what one would predict for a pathogen avoidance system. Human groups are vulnerable to epidemics, so pathogen threats have been linked to cultural institutions and negative attitudes toward strangers or outsiders (Fincher & Thornhill, 2012; Schaller & Murray, 2008). Indeed, pathogen avoidance may constitute a basic feature of human life (Curtis, 2013).

Nevertheless, we think that biologically evolved pathogen avoidance is unlikely to provide a complete account of core disgust elicitors. Examples of problems with this exclusive approach are (1) infants do not show avoidance of feces and decay odors, (2) contamination sensitivity does not appear until 4–5 years of age, (3) toilet training is an often difficult and extended task, and (4) it is often difficult to convince people to use sanitary practices. Curtis (2013) notes that perhaps one in five humans alive today regularly washes his or her hands after defecation. If disgust were an innate pathogen avoidance system, we would expect that desires for hygiene and washing would be innate, or at least that there would be an evolutionary predisposition to learn such behaviors easily. Furthermore, the identification of a current human practice as adaptive in preventing infection is only a first step in making a biological evolutionary argument. Cooking, water purification, and antibiotics are probably the most powerful antipathogen adaptations for modern humans, and we know that these evolved culturally.

Animal–Nature Reminder Disgust

When we asked American and Japanese respondents to list the things they thought were disgusting, less than 25% of examples came from the core disgust domains of food, animals, and body products (Haidt et al., 1997). Many of the other examples could be classified into four additional domains: inappropriate sexual acts, poor hygiene, death, and violations of the ideal body "envelope" or exterior form (e.g., gore, deformity, obesity). In these additional domains, the focus of threat has spread from the mouth to the body in general. We described this set of disgust elicitors as reminders of our animal nature (Rozin et al., 1993).

Contact with death and corpses is a particularly potent elicitor of disgust. Two of the items in our 32-item disgust scale that correlate most highly with the total score are about contact with dead bodies (Haidt, McCauley, & Rozin, 1994). The prototypical odor of disgust is the odor of decay, which is the odor of death. The centrality of death in disgust suggests that disgust may be linked to existential threats beyond the threat of pathogens.

Becker (1973) has argued that the most important threat to the psyche is the certainty of death. Humans are the only animals that know they will die. In this framework, Becker's "denial of death" is served in part by disgust, which helps to suppress thoughts or experiences that suggest human mortality. Research on "terror management theory" has shown a connection between disgust and the fear of death: death reminders prime disgust sensitivity (Goldenberg et al., 2001). Conversely, exposure to disgusting stimuli, under some conditions, increases implicit death-related ideation (Cox, Goldenberg, Pyszczynski, & Weise, 2007).

The centrality of death in disgust led us to posit that anything that reminds us that we are animals is a potential elicitor of disgust (Rozin & Fallon, 1987; Rozin et al., 1993). Humans must eat, excrete, clean the body surface, and have sex, just like other animals. Each culture prescribes the proper way to perform these actions—for example, by placing most animals off limits as potential foods, and all animals and most people off limits as potential sexual partners. People who ignore these prescriptions are reviled as disgusting and animal-like. Furthermore, humans are like animals in having fragile body envelopes that, when breached, reveal blood and soft viscera that display our commonalities with animals. Human bodies, like animal bodies, die. On this view, envelope violations and death are disgusting in part because they are uncomfortable reminders of our animal vulnerability.

Plato offers us a vivid illustration of this concern. In *The Republic* Socrates distinguishes between the kind of man who pursues higher (intellectual) pleasures and the common man, who indulges his lower, more carnal and animal-like nature: "They bend over their tables, like sheep with heads bent over their pasture and eyes on the ground, they stuff themselves and copulate. . . . " (Plato, 1987/4th-century B.C.E., Book IX, 586a).

Elias (1939/1978), in *The History of Manners*, concluded that "people, in the course of the civilizing process, seek to suppress in themselves every characteristic that they feel to be 'animal' " (p. 120; see also Miller, 1997). Tambiah (1969) emphasized the importance of this distinction for humans, and pointed to the paradox of human fascination with and aversion to animals. Ortner (1973) noted that the one body product that does not reliably elicit disgust is tears, and these are seen as uniquely human. And Leach (1964) pointed out that animal words are used as insults in many cultures.

We note, however, that gods in many polytheistic societies often take animal forms, or are represented as being part human, part animal, which is a complication for our story. Furthermore, incest is almost universally prohibited to humans but widely attributed to some gods (and sometimes permitted for royalty). Such patterns show that humans can hold negative (disgust) and positive attitudes to the same object. They also show how disgust can be elaborated culturally and woven into the moral order.

Tybur et al. (2013) and Curtis (2013) are clearly correct in pointing out that corpses, sexuality, hygiene, and violations of the body envelope are all potential avenues of infection. This connection argues in favor of a pathogen avoidance alternative to reminders of our animal nature. Yet the many connections between the "animal nature" elicitors and concerns about mortality are not easy to dismiss. Whether or not disgust *originated* as a pathogen avoidance system, disgust as we now experience it, far into the civilizing process, may reflect and give rise to many concerns beyond disease avoidance (see Goldenberg, Pyszczynski, Greenberg, & Solomon, 2000, for a review).

Interpersonal Disgust

In our original formulation, we proposed an additional expansion of disgust into what we described as the interpersonal domain; most other people, including strangers, or individuals with some types of negative properties (e.g., membership in despised groups), elicit disgust (Rozin, Markwith, & McCauley, 1994). However, with the elaboration of the disgust-as-pathogen avoidance model, much of what we called interpersonal disgust could be included as examples of responses to pathogen threats represented by other humans (Curtis, 2013; Tybur et al., 2013; Schaller & Park, 2011). Other people become disgusting not just to the extent that they show signs of infectiousness, but to the extent that anything about them makes us want to avoid associating with them, and this is the key to understanding the social functions of disgust.

Sexual Disgust

There is little doubt that some sexual acts can trigger disgust. This can be accounted for as either a pathogen risk or an animal–nature reminder. But recently Tybur et al. (2013) proposed that core disgust was preadapted to help human beings optimize their mating choices. They point out that core disgust is already involved in sexuality, in that disgust must be down-regulated during sexual acts to enable contact with bodily parts and fluids that pose a pathogen threat and that would—in the absence of sexual arousal—trigger a core-disgust response.

Tybur et al. (2013) propose that sexual disgust "is just the felt output of computational procedures estimating expected sexual value" (by which Tybur et al. mean reproductive value).

This account makes good sense of sexual disgust as experienced by a woman facing an unwanted sexual advance, because she is the person whose body will be entered and she will have to live with the consequences of a successful mating. Less clear is how a reproductive value for sexual disgust could encompass male disgust toward sex with an unattractive but fertile woman. For third-party judgments of sexual acts, the mate-value account is even less clear and symbolic concerns about animality and degradation seem to become more relevant. For example, Plato's (1987/4th-century B.C.E.) disgust at wanton sexuality seems to be more a revulsion about animality than an expression of concern about maximizing mate value. It may be that sexual disgust involves multiple concerns about pathogens, mates, animality, and morality.

Moral Disgust

Many cultures conceive of human beings as falling along an explicitly vertical dimension in which God, divinity, spirit, goodness, and purity are at the top; demons, animals, evil, and impurity are at the bottom; and humans rise and fall in a range in the middle. This idea is evident in the quotation from Plato (1987/4th-century B.C.E.) above, in the Christian conception of a *scala natura* or great chain of being, and in Hindu notions of reincarnation. We hypothesized that moral disgust was a reaction not just to any moral violation, but to actions that made a person seem to be moving downward on this vertical dimension—actions that made us see the person as degraded, base, or subhuman (Rozin, Lowery, Imada, & Haidt, 1999).

Morality is multifaceted. Richard Shweder and colleagues proposed a theory of three modes of moral discourse (Shweder, Much, Mahapatra, & Park, 1997). The "ethics of autonomy" is dominant when we think about people as autonomous preference structures: we want to maximize the individual's ability to act freely, without interference or harm from others. The "ethics of community" is dominant when we think about people as having roles to play within a social structure; we talk about duty, hierarchy, and interdependence. The "ethic of divinity" is dominant when we think about people as spiritual beings created by God, who contain a soul or some other element of divinity inside, which must be protected from acts or contact with things that are degrading. The ethic of divinity underlies the frequent moralization and regulation of eating, hygienic practices, and sexuality in many of the world's religious scriptures.

We saw a rough match between Shweder et al.'s (1997) three ethics and three moral emotions: community/contempt, autonomy/anger, and divinity/disgust. Taking advantage of the coincidence that the first letters of the ethics and emotions match up, we called this the CAD triad hypothesis, and found empirical evidence for these linkages (Rozin et al., 1999), as did Horberg, Oveis, Keltner, and Cohen (2009). However, our conception of moral disgust and its relationship to the ethic of divinity has been controversial.

The Critique: Moral Disgust as Just a Metaphor for Anger

Royzman and Kurzban (2011) point out that when we say that we are "hungry for knowledge" or have a "lust for adventure" we are not actually hungry or sexually aroused. We are simply using evocative metaphors. They argue that moral disgust is the same sort of thing. It is a way of using words (and sometimes facial expressions) to *communicate* one's condemnation of an act, but the disgust program is not really activated, and no disgust is actually felt (see also Royzman & Sabini, 2001). Bloom (2004) made a similar argument, and Nabi (2002) showed that for speakers of English, the word "disgust" overlaps greatly with anger with respect to immoral disgust elicitors, whereas core disgust elicitors align more with the English expression "grossed out."

The "metaphor" critique has been reinforced by empirical research showing that cases of apparent moral disgust are usually intertwined with anger and perceptions of harm (Gray, Schein, & Ward, 2014). This view is supported by Royzman, Atanasov, Landy, Parks, and Gepty (2014), who noted a flaw in the original CAD research. The vignettes used as exemplars of divinity violations involved body-related events. When they ran their own version of the CAD study using vignettes that involved mistreating sacred objects but with no bodily component (e.g., using a crucifix as a doorstop), they found that anger (the word and the facial expression, along with desires for retaliation) was the dominant response, not disgust.

We believe that Gray et al. (2014) are correct in arguing that harm (broadly conceived) encompasses most moral violations and that Royzman and his colleagues (Royzman et al., 2014) are correct in nominating anger as the primary moral emotion. Nevertheless, we think that there is considerable evidence that disgust plays a unique and important role in moral judgment. Chapman and Anderson (2013) offer a comprehensive review of the studies of moral disgust. We briefly summarize the literature using their three categories of evidence.

Many Moral Transgressions Elicit Disgust

People usually report that moral violations, including pure violations of the ethics of autonomy (e.g., stealing and lying) cause them to feel some degree of disgust, and this has been found for children as well as adults (Danovitch & Bloom, 2009). But such self-reports on their own are easily explained by the metaphor critique.

There is one set of results that is not easily explained by either the metaphor or animal nature critiques. Rottman, Keleman, and Young (2014) asked participants to read suicide obituaries that did not mention anything disgusting. People varied in their moralization of suicide. Disgust ratings predicted these judgments, whereas anger ratings did not. Ratings of the "impurity" of the act predicted condemnation, whereas ratings of the harmfulness did not.

Eliciting Disgust Makes Moral Judgments More Severe

If disgust is involved in moral judgments, then activating feelings of incidental disgust might amplify moral judgments. Wheatley and Haidt (2005) found such an effect using disgust induced by posthypnotic suggestion, and others have replicated the effect using a variety of other means, including bad smells, bad tastes, and disgusting film clips (Schnall, Haidt, Clore, & Jordan, 2008; Eskine, Kacinik, & Prinz, 2011; Moretti & di Pellegrino, 2010; but see Landy & Goodwin, 2015).

Disgust Sensitivity Predicts Moral Judgment

Social conservatives have repeatedly been found to score higher than liberals and libertarians on the disgust scale (Inbar, Pizarro, & Bloom, 2009; Iyer, Koleva, Graham, Ditto, & Haidt, 2012). Furthermore, even after partialing out political ideology, disgust sensitivity predicts increased moralization primarily on divinity topics such as abortion and homosexuality (Inbar et al., 2009).

Koleva, Graham, Iyer, Ditto, and Haidt (2012) found that the "sanctity" subscale (roughly equivalent to divinity) of the Moral Foundations Questionnaire (Graham et al., 2011) was a strong predictor of many "culture-war" attitudes, even after partialing out religiosity and conservatism, and even for some issues that involved no physical disgust (such as flag burning). The care/harm foundation was a poor predictor. The key to understanding the role of the sanctity foundation is Shweder et al.'s (1997) idea that some objects (such as flags) carry an invisible essence that must be protected from desecration.

Moral Disgust Reconsidered

Several lines of evidence therefore indicate that disgust sometimes serves—among its many other functions—as a moral emotion. There is no question that moral violations that involve some degree of core, animal–nature, or sexual elicitors produce disgust. A major review paper by Russell and Giner-Sorolla (2013) calls this emotion "bodily moral disgust." On the other hand, repeated demonstrations that cheating, lying, and unfair treatment produce disgust falsify our strong view of a tight and exclusive link between divinity violations and disgust. Furthermore, clear divinity violations (such as when American servicemen burned Korans) produce more anger than disgust (Royzman et al., 2014).

A possible resolution may be found in the social–functionalist account of moral emotions offered by Hutcherson and Gross (2011), who analyzed the appraisals and action tendencies associated with anger, contempt, and disgust. They found that anger and disgust were both frequent responses to moral violations, and that the key differentiator was not the Shweder et al. (1997) ethic of the violation, but the nature of the most adaptive response to the violation. Anger is an approach-oriented emotion, and when a moral violation involved some offense to the self for which attack might be an appropriate response, then anger was generally selected by participants as the most relevant emotion. However, when a moral violation was not committed against the self, but the violation indicated that a third party was not trustworthy (e.g., the person lied or cheated), then moral disgust became much more important. This is consistent with disgust's role as an emotion of withdrawal or avoidance.

In sum, there is continuing controversy, but emerging evidence indicates that moral disgust is not just a metaphor. Or, as Chapman and Anderson (2013) suggest, disgust may be a metaphor in a deeper and more substantive sense: "theories of embodied cognition propose that abstract concepts or knowledge are grounded in modality-specific perceptual and motor systems" (p. 310). Disgust is an ancient perceptual and motor system, rooted originally in distaste and localized partly in the anterior insula, which may serve as the embodied grounding of at least some of our higher-level cognition about morality.

The Development of Disgust and Contamination Sensitivity

For adults, feces seems to be a universal disgust substance (Angyal, 1941; Rozin & Fallon, 1987), with the odor of decay as perhaps the most potent sensory attribute associated with disgust. It is also possible that vomit is a primary substance for disgust. Since feces, vomit, and decay are associated with disease vectors, it would be reasonable to suppose that there would be an innate rejection of such things. However, none of these seems to be reliably rejected by nonhuman animals or young children (Rozin, Hammer, Oster, Horowitz, & Marmara, 1986). Rather, it appears that the infant may be attracted to feces, and that many cultures use disgust during the process of toilet training, which turns this attraction into disgust/aversion (Freud, 1910/1957; Jones, 1912/1948). The preponderance of evidence suggests that there are no negative nonirritant odors that are clearly aversive to infants, and that a rejection of decay odors (with or without a referent object present) appears somewhere between 3 and 7 years of age (Petó, 1936; Schmidt & Beauchamp, 1988; Stein, Ottenberg, & Roulet, 1958). Disgust seems to require enculturation—a supposition confirmed by Malson's (1964/1972) review of some 50 feral humans, none of whom showed any sign of disgust.

Toilet training may be the initial disgust-generating experience. Expansion of disgust elicitors may occur either by generalization from existing disgusting entities (Ferenczi, 1952) or by evaluative conditioning (Schienle, Stark, & Vaitl, 2001). There may be a predisposition or expectancy to associate certain entities, such as certain types of animals, with already disgusting entities (Davey, Cavanagh, & Lamb, 2003). Disgust may also be acquired by witnessing facial displays of emotions that elicit the experience of those emotions (Tomkins, 1963), perhaps engaging processes that involve mirror neurons (Gallese, Keysers, & Rizzolatti, 2004; Wicker et al., 2003). A recent study provides evidence for a link between parents' displays of disgust and their children's exhibitions of disgust responses (Stevenson, Oaten, Case, Repacholi, & Wagland, 2010).

Locating the onset of true disgust in development depends on subtle measures of "offensiveness" or "ideational rejection" and the appearance of contamination sensitivity. Contamination sensitivity is not present in children under 3–5 years of age (Fallon, Rozin, & Pliner, 1984; Siegal & Share, 1990; Hejmadi, Rozin, & Siegal, 2004).

Contamination sensitivity is a sophisticated ability requiring a separation of appearance and reality. There is no sensory residue of past contamination in a contaminated entity; it is the history of contact that is critical (Rozin & Nemeroff, 1990; Nemeroff & Rozin, 2000).

Adult contamination sensitivity is a mixture of at least two types of conceptions. One involves transfer of invisible material through contact, and hence is often sensitive to manipulations like washing (material essence). A second is more indelible, and involves the passing of what is felt to be some type of nonmaterial force that is not subject to removal by chemical and physical treatments ("spiritual essence"; Nemeroff & Rozin, 1994). There is evidence that at its first appearance in children, the essence producing contamination sensitivity is more like the indelible, "spiritual" than material form (Hejmadi et al., 2004), and appears somewhat earlier and in greater intensity in Hindu Indians as opposed to American children.

A particularly thorough study of the development of different types of disgust used parent interviews as well as direct testing of children's (ages 2–16 years) responses to a wide range of disgust elicitors (Stevenson et al., 2010). The findings indicate that in most cases, the order of appearance of disgust responses across years is core first, then animal reminder, then moral.

The picture of the development of disgust, particularly the recognition of disgust faces over the childhood years, has changed owing to a suite of studies by Widen and Russell, and others, summarized in a review by Widen and Russell (2013). They suggest that in development, the first stage is that disgust elicitors produce a general, nonspecific unhappy state, later elicited specifically by bad tastes or smells. Then a verbal label ("disgust," "yucky," "gross") is acquired, then rejection, and finally the disgust facial expression.

Widen and Russell (2013) note consistent confusion between assignment of the standard (upper lip raise and nose wrinkle) disgust face to "anger" versus "disgust," in adults as well as children. Widen and Russell suggest that part of the reason for the reported delayed onset of disgust face recognition may be that the primal and unambiguous disgust face involves the gape that is not part of the most frequently studied disgust faces. The developmental trajectory of disgust recognition may have to be reassessed using the "sick face" (Rozin, Lowery, et al., 1994; Widen et al., 2013). The only study that assesses "moral disgust" in children used the "standard" disgust face and verbal "disgust" responses (Danovitch & Bloom, 2009). A minority of 5- to 9-year-old American children endorsed disgust for moral autonomy violations. On both measures, disgust responses were much higher for core disgust scenarios.

In brief, it appears that social learning and increasing cognitive ability may both be needed for the appearance of full core disgust, including contamination, by approximately 5 years of age. In the absence of any socializing agents, it seems that core disgust might not emerge on its own. Disgust might therefore be like snake phobia (Mineka & Cook, 1988): easy to acquire because of an evolved predisposition.

Individual Differences

The paper-and-pencil Disgust Scale (DS) introduced by Haidt et al. (1994) had eight subscales: seven domains of disgust elicitors (food, animals, body products, sex, death, body envelope violations, and hygiene violations) and one domain of magical thinking (disgust by similarity and contagion that cut across the domains of elicitors). Half of the items asked how disgusting (not, slightly, very) a particular experience was; half presented a disgusting experience and asked (true/false) whether the respondent would be bothered by or try to avoid this experience. The 32-item DS had alpha reliability in the .80s in several samples, although the alphas for each of the eight short subscales (.40–.60) were adequate only for group comparisons. In a follow-up study Rozin et al. (1999) found a correlation of .57 between the DS and willingness to engage in disgusting tasks in a laboratory.

Structure of Disgust

More recent research on individual differences in disgust has moved toward reducing the number of domains and increasing the number of items in each domain, in search of more reliable domain scores. Following psychometric analyses of the DS by Olatunji, Williams, et al. (2007), a revised Disgust Scale (DS-R) dropped seven items (including all four sex items) and reduced the number of domains to three: core disgust (12 items from the old food, animals, and body product categories), animal-reminder disgust (eight items from the old death and envelope violation categories), and contamination disgust (five items from the hygiene and magical thinking categories). Using a Dutch version of the DS-R, van Overveld, de Jong, Peters, and Schouten (2011) confirmed the three-factor model, but other studies have reported numbers of factors ranging from one to six (Kang et al., 2012; Melli, Chiorri, & Smurra, 2013; Sand'in et al., 2013).

Moving in a different direction from the original DS, Tybur, Lieberman, and Griskevicius (2009) have introduced the Three-Domain Disgust Scale (TDDS) with separate scores for pathogen, sexual, and moral disgust. Seven items for each domain are assessed on a 7-point scale ("not at all disgusting" to "extremely disgusting"). The domain scores have alpha reliability in the .80s but intercorrelate only in the .30s (Tybur & de Vries, 2013). The pathogen subscale corresponds in content to the core disgust subscale of the DS-R, but the other subscales are quite different. The sex subscale of the TDDS combines moralization of sexual acts (e.g., using pornography, sex with strangers) with perceptions of sexual threat (a stranger rubs your thigh in an elevator), and both first- and third-party framings (your thigh vs. someone's thigh). The moral subscale focuses exclusively on violations of the ethics of autonomy (e.g., cheating, stealing) and hence may be more of a measure of anger as opposed to disgust sensitivity (Olatunji et al., 2012). The TDDS items are all in the disgust-rating format, leaving open the possibility mentioned earlier that, especially for moral items, some respondents use "disgust" metaphorically to mean only "bad."

Another innovation in assessing individual differences in disgust (van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006) has been to distinguish propensity (frequency of experiencing disgust) from sensitivity (unpleasantness of the experience). Olatunji, Cisler, Deacon, Connolly, and Lohr (2007) report psychometric results for an eight-item propensity scale and an eight-item sensitivity scale: propensity and sensitivity factors were correlated (.66) and showed similar and small correlations (.07–.34) with anxiety-disorder symptoms, including fear of spiders, spider avoidance, injection phobia anxiety, injection fainting, injection avoidance, and contamination fear.

In short, different studies have used different rating scales (disgust vs. true/false, frequency vs. unpleasantness) and produced different numbers of factors or domains (ranging from one to eight). The source of this variability clearly includes differing theories and measurement instruments, and may also include cultural variation. Metaphoric use of disgust to signal simply "bad" argues against scales that rely only on ratings of disgustingness. Finally, we suspect that there is no single answer to the question of the structure of disgust. How to cluster items from the array of disgust-item intercorrelations, and the number of items per scale, will depend on the goals of the investigator.

Perhaps the strongest correlate of sensitivity to disgust is gender: females consistently score about a half standard deviation higher on disgust than males. We believe that this difference is real, although some portion of the measured effect may be due to a male reluctance to admit disgust. (Facing down disgust is sometimes used as a test of machismo, as in some college fraternity initiation rites.) Many other correlates of disgust sensitivity have been reported; too many for systematic review here. Positive correlates include political conservatism, blood phobia, neuroticism, low self-esteem, food disorders, posttraumatic stress disorder (PTSD), and behavioral inhibition. Notable negative correlates include openness to experience in the Big Five personality system and the thrill and adventure seeking and experience seeking subscales of Zuckerman's sensation seeking system (Olatunji, Haidt, McKay, & David, 2008; Terrizzi, Shook, & McDaniel, 2013). In general, this network of correlations is consistent with seeing disgust as a defensive emotion that is positively related to a more general sensitivity to negative feelings and events, and negatively related to attraction to what is new and risky.

Disgust and the Brain

Disgust has received considerable attention in the last decade from cognitive and affective neuroscientists. Studies using imaging techniques (principally functional magnetic resonance imaging [fMRI]) have suggested that three interconnected brain areas are characteristically activated when there is exposure to disgust faces, disgust eliciting images, disgust-related odors, or thoughts about disgusting entities (Phillips et al., 1997; Wicker et al., 2003; Wright, He, Shapira, Goodman, & Liu, 2004). The areas are the anterior insula, the basal ganglia, and parts of the prefrontal cortex (see Husted, Shapira, & Goodman, 2006, for a review). A linkage between disgust and the anterior insula and basal ganglia is also demonstrated in the case of a patient with damage to both areas who showed a selective impairment in both the recognition and experience of disgust (Calder, Keane, Manes, Antoun, & Young, 2000). Wicker et al. (2003) have reported activation in the anterior insula from both disgusting odors and images of disgust faces in the same participants, opening up the possibility that the anterior insula can perhaps be a "mirror area" for disgust, and that there might be individual neurons activated by both the experience and observation of disgust.

The relation between disgust and activity in specific brain areas has been reviewed by Schienle (2009); Kurth, Zilles, Fox, Laird, and Eickhoff (2010); and Vytal and Hamann (2010). The Vytal and Hamann meta-analysis of 83 studies implicates two brain areas—the anterior insula and the inferior frontal gyrus—as specifically involved with disgust, as opposed to emotions in general. The anterior insula link is particularly appropriate for core/pathogen disgust because the insula is the primary cortical projection area for both taste inputs and visceral inputs, notably nausea (Stern, Koch, & Andrews, 2011). The analysis of insula activity by Kurth et al. (2010) suggests differentiation within the insula with respect to activation involving, for example, sensory versus sociomoral inputs, and makes suggestions about the integration of these inputs. Also, Rolls (1994) noted excitation of the insula in nonhuman primates in response to unpleasant tastes and odors. This is consistent with the food basis of core disgust.

It is also clear that the pathology of Huntington's disease, which involves primarily basal ganglia degeneration, is associated with a fairly specific deficit in disgust recognition in the absence of any measured expressive or experiential deficit (Sprengelmeyer et al., 1996; Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998). Disgust-recognition deficits are also seen in people who have the Huntington genotype but are still too young to show any of the classical symptoms (Gray, Young, Barker, Curtis, & Gibson, 1997). In addition, Kipps, Duggins, McCusker, and Calder (2007) have shown a link between Huntington's disease and the anterior insula.

Despite numerous positive findings, there is one line of research that questions whether insula and basal ganglia activation distinguishes disgust from fear (e.g., Stark et al., 2003; Schienle, Schafer, Stark, Walter, & Vaitl, 2005). Another issue is that most of the brain imaging work on disgust has used the standard disgust face (upper lip raise) that is often associated with anger rather than disgust (Rozin, Lowery, et al., 1994; Widen & Russell, 2013), and frequently uses harm-based autonomy violations, which we think are not prototypical elicitors of moral disgust. There are good prospects that further research on the neural basis of disgust will inform disgust theory in important ways. In particular, the relations among core disgust, moral disgust, and moral violations in general could be enlightened by increased understanding of the neural pathways and processing of the relevant elicitors. There are suggestions of both common and different areas activated by moral and core disgust elicitors (Moll et al., 2005). Using event-related potential (ERP) technology, there are differences between core disgust and moral violations that emerge at the earliest stages of processing, with evidence that distinct brain responses to moral violations may occur earlier than responses to core disgust (Yang, Li, Xiao, Zhang, & Tian, 2014). However, up to this time, the neural data has primarily served the important purpose of designating the appropriate neural structures and circuits.

Disgust and Psychopathology

Disgust has been linked with several kinds of psychopathology: obsessive–compulsive disorder (OCD), animal phobias, blood–injury–injection (BII) phobia, eating disorders, and sexual dysfunction. A key reference for these linkages is the book *Disgust and Its Disorders*, edited by Olatunji and McKay (2009; see also Rachman, 2006).

Obsessive–Compulsive Disorder

Disgust and individual differences in disgust have been associated with contamination fear, a common symptom of OCD that is particularly related to compulsive washing (Rachman, 2006). A question raised in this literature is whether the various aspects of OCD are differentially associated with various subtypes of disgust, as measured by the DS-R. Symptoms of OCD related to contamination and germs have been found to be more strongly correlated with the core and contamination subscales of the DS-R than with the animal-reminder subscale; the reverse is true for fears of death, injury, injections, and blood. These results support the utility of distinguishing animal-reminder concerns from pathogen-focused concerns (Olatunji et al., 2008; see also Olatunji, Williams, Lohr, & Sawchuk, 2005). A later study found that all three subscales were equally correlated with willingness to touch bathroom fixtures, although only contamination disgust emerged as a significant predictor in a regression analysis (Olatunji, Ebesutani, Haidt, & Sawchuk, 2014).

Animal Phobias

Davey and his colleagues have linked disgust with anxiety disorders. Individuals with animal phobias are about half of all individuals reporting any phobia (Davey & Marzillier, 2009). Animals that commonly trigger phobias include spiders, snakes, lizards, rats, mice, cockroaches, beetles, moths, maggots, slugs, snails, and worms. Individual differences in disgust measured by various scales (including the DS and DS-R) are correlated with fear of these animals but not with fear of predatory animals (e.g., lions). This literature has accorded special attention to spider phobia. Comparing individuals who are spider phobic with nonphobics shows the expected higher scores on disgust sensitivity for the phobics (Davey & Marzillier, 2009).

Blood–Injury–Injection Phobia

Persistent and excessive fear and avoidance of blood, injury, and injections (BII) is a problem for about 3% of the U.S. population (Page & Tan, 2009). As with animal phobias, both disgust and fear are high for individuals with BII phobia, but it appears that BII phobics show greater disgust reactions than fear reactions to BII stimuli (Page & Tan, 2009).

As with animal phobics, an open question is whether disgust is part of the origin of BII phobia or only a multiplier. Perhaps some individuals respond to BII stimuli with fear, others respond with disgust, and a third group responds with both fear and disgust (Woody & Teachman, 2000).

Eating Disorders and Sexual Dysfunction

Disgust seems to be involved in both of the major eating disorders (anorexia nervosa and bulimia nervosa), which are often accompanied by fat or fatness phobias (Troop & Baker, 2009). Similarly, disgust may be involved in understanding sexual dysfunction (DeJong & Peters, 2009). In both cases, there is a complex mixture of fear and disgust that has to be analyzed, and in both cases, there is an involvement of shame. Shame relates to eating in public or perceived fatness for eating disorders, and to poor performance or nonstandard preferences in the sexual domain.

Disgust in Intergroup Relations

Hodson et al. (2013) have introduced a new individual differences measure of intergroup disgust sensitivity (ITG-DS) that assesses disgust toward encounters with ethnic outgroups, including beliefs in stigma transfer and social superiority. This measure is related to previous measures of disgust sensitivity, authoritarianism, and sensitivity to negative affect, and it predicts negative attitudes toward outgroups, including Muslims in Western nations.

Schaller and Park (2011) review research indicating that disgust is more easily triggered when individuals are, or believe themselves to be, more vulnerable to pathogen infection. They find that disgust in reaction to people and events—even without pathogen risk—can contribute to negative attitudes toward outgroups and to cultural differences more broadly. Consistent with Schaller's suggestion, Terrizzi et al. (2013) review 24 studies to show that fear of contamination and disgust sensitivity are positively related to social conservatism (i.e., right-wing authoritarianism, social dominance orientation, religious fundamentalism, ethnocentrism, collectivism, and political conservatism).

Disgust may be a predictor of violent intergroup conflict. Taylor (2007) found that ideological hate speech expressed more disgust than fear. Matsumoto, Hwang, and Frank (2014) compared emotions expressed by leaders before attacking a rival group (e.g., JFK before the 1961 Bay of Pigs invasion) with emotions expressed by leaders before nonviolent resistance (e.g., Martin Luther King, Jr., before the 1963 March on Washington). Videos of leaders' speeches were coded for anger, contempt, and disgust, both when the leader was talking about the rival group and when the leader was talking about something else. Before an attack, leaders expressed more anger, contempt, and disgust when talking about the rival than when talking about something else; this difference was not found for leaders of nonviolent resistance.

Research in intergroup conflict has sometimes averaged ratings of disgust and contempt to produce an index labeled *contempt* (Cuddy, Fiske, & Glick, 2007) or *dehumanization* (Maoz & McCauley, 2008). A possible link between contempt and disgust is that both include the idea that the target group has a bad essence (Haslam, 2006). For instance, Petersen (2011) defines contempt as "cognition that a group or object is inherently inferior or defective; action tendency toward avoidance" (p. 43). Hutcherson and Gross (2011) found both overlap and distinctions among contempt, anger, and disgust (CAD) in reactions to individual bad behaviors, but additional research will be required to test these distinctions in reactions to events in intergroup conflict.

The perception of bad essence is often reflected in descriptions of an enemy as a disgusting animal, as Tutsi were described by Hutu, as cockroaches in the Rwanda genocide and as Jews were described by Nazis as lice, cockroaches, and vermin. It may be that disgust and contamination fear are highest in genocides where perpetrators and victims are most similar (Chirot & McCauley, 2006). As rational choice models of intergroup conflict are broadened to take account of emotions, disgust and contempt will join anger and fear in research aimed at understanding extreme forms of intergroup violence.

Cultural Differences in Disgust

Almost the entire literature on disgust comes from the approximately 6% of the world in which English is *the* native language. We believe that the cultural evolution of disgust has made few changes on the output side, but has created substantial cultural variation on the input side. For example, most cultures value some kind of decayed/fermented food that is disgusting in most other cultures, but that food varies quite a bit (e.g., cheese for Europeans, decayed meat for Inuit, fermented fish sauce for Southeast Asians). Similarly, cultures differ about whether dogs are best friends or dirty scavengers, or about whether or not corpses should be touched during mourning, or about whether mouth-to-mouth kissing is erotic or disgusting.

It is in the expansion of disgust into the social world that cultural differences seem to be greatest. Interpersonal disgust is particularly elaborated in Hindu India, compared with Western nations in which people rarely worry about the social status (caste) or background of the people cooking their food. Purity is a moral virtue to be protected in India, and in this respect, food is a "biomoral" substance (Appadurai, 1981). When reporting instances in which they had experienced disgust, Japanese often talked about situations in which there had been a failure to achieve a good fit in social relationships, such as when somebody else ignored them, or criticized them unfairly. Americans never mentioned such situations; instead they talked about racism, cruelty, and violence, especially toward people or animals who are weak or defenseless (Haidt et al., 1997). Cultures are social constructions, but as Lakoff and Johnson (1980) pointed out, embodied experience (including disgust) is one of the richest sources of building materials for those constructions.

Disgust in Humor, Sex, and Aesthetics

Given that our body is a repository of disgusting entities and that we live in a contaminated environment, humans are frequently poised on the edge of potential disgust. While we manage, by habituation or framing, to ignore most of the disgust elicitors around us, there are some situations in which we seek out and enjoy disgust. The powerful negativity of disgust seems perversely to encourage its involvement and enjoyment in at least three domains: humor, romantic attachment, and art (Strohminger, 2014).

Disgust plays a significant role in humor via jokes, cartoons, and casual word play. Boys and adolescent males use disgust to tease, question or confront adult norms, and to establish status within their peer groups (Fine, 1988). Bloom (2004) emphasizes the dignity-destroying aspect of disgust, and sees disgust humor as taking advantage of the fact that the human body is disgusting. The enjoyment of disgust has been documented among American adults, and has been described as an example of "benign masochism": enjoyment of a normally negative experience when it is not threatening and is at some distance from the self, perhaps as an exercise of mind over body (Rozin et al., 2013).

In intimate, often romantic, sexual encounters, body substances that are normally disgusting in others may become neutral or even attractive in a loved one. In many ways, enjoying the odors and/or body substances of a lover can be viewed as a statement of devotion, attraction, and the dissolution of the normal boundary between the self and another person.

Finally, some aspects of visual art, especially horror movies, depend on elaborate and disgusting images or sequences to appeal to mass audiences (McCauley, 1998). This appeal may again be an example of benign masochism.

Disgust as a Barrier to Progress

Recycled water is available with efficient technology that converts sewage water directly to tap water. Disgust has retarded the adoption of this "toilet to tap" technology despite water shortages in the U.S. Southwest (Rozin, Haddad, Nemeroff, & Slovic, 2015).

Food for a growing world population could come from increased consumption of insects; they provide excellent nutrition and make a minimal ecological footprint. Although about one billion humans eat them regularly, with no ill effects, they are rejected by almost everyone in the developed world. A major reason for this is disgust (Ruby, Rozin, & Chan, 2015). Similarly, much of the opposition to genetically modified foods is morally based, and is fueled by disgust at these products (Scott, Inbar, & Rozin, in press).

Disgust in Relation to Other Emotions

There is a special relation between disgust and contempt: the facial expressions are similar and there is a sense of looking down on, in both cases. The richest discussion of contempt is in Miller's (1997) *Anatomy of Disgust*. Both Miller (1997) and Hutcherson and Gross (2011) identify a strong theme of looking down on someone as incompetent, rather than immoral.

Disgust, particularly when it is framed as contamination, pathogen, or death risk, can be understood as a subcategory of fear. However, although both are withdrawal emotions, their expressions, physiological manifestations, and neural substrates are very different.

In the moral domain, there is substantial similarity in elicitors for disgust and anger. Both emotions share one aspect of facial expression (upper lip raise), but anger involves approach and disgust is accompanied by withdrawal. While moral disgust seems closely related to anger, core and animal-reminder disgust (or pathogen avoidance disgust) seem to be most related to fear (Lee & Ellsworth, 2013).

Both shame and disgust often involve moral censure, but in disgust it is oriented to others, and in shame it is oriented to the self. Lewis (1995) elaborates another important shame–disgust link: shame is often established by disgust responses of others to the self.

Conclusion

The rapid growth in the disgust literature has increased empirical knowledge and produced valuable theoretical advances. It has engaged social, cultural, evolutionary and clinical psychologists, epidemiologists, biologists, and philosophers. It has raised issues both specific (What is the best disgust face?) and general (How do emotions relate to the nature and structure of morality?).

The particularly wide range of disgust elicitors—as varied as dog feces, body sores, cremated ashes, unfamiliar humans, incest, axe murderers, and swindlers—has presented a theoretical challenge for which at least three solutions have been offered. One is that almost all references to and expressions of disgust for nonbodily elicitors are metaphoric. Another is that almost the entire range can be accounted for as responses to one or two evolutionary selection pressures. A third view—our view—is that some uses of disgust in the social and moral domain are metaphoric, and some really are built on core disgust (see figure in Rozin, Haidt, & Fincher, 2009). We do not know when and how social and moral elicitors of disgust came to be part of the human repertoire, but we believe that both biological and cultural evolution must be invoked to understand the current range of human disgust reactions.

Most generally, our view (to some degree also subscribed to by Tybur et al., 2013, and Kelly, 2011) is that a broadening array of disgust elicitors arose by a process of preadaptation, and amount to a "cultural wastebasket." The only theory that would explain what people in developed nations throw in the garbage is "things they want to get rid of." Rotted food, old newspapers, expired batteries, and printed advertisements have nothing in common except that they are not wanted. This view fits well with the social functionalist view of disgust proposed by Hutcherson and Gross (2011).

The breadth and complexity of disgust in human affairs mean that disgust research is likely to remain a growth stock for at least another decade.

Note

1. Analysis carried out by authors in July of 2014. We compared the number of hits in the PsycInfo database that had "disgust" or "anger" in the keyword or title fields, in 5-year blocks, specifically, 2009–2013 as a multiple of 1979–1983.

References

Angyal, A. (1941). Disgust and related aversions. *Journal of Abnormal and Social Psychology, 36*, 393–412.

Appadurai, A. (1981). Gastro-politics in Hindu South Asia. *American Ethnologist, 8*, 494–511.

Becker, E. (1973). *The denial of death*. New York: Free Press.

Bloom, P. (2004). *Descartes' baby: How the science of child development explains what makes us human*. New York: Basic Books.

Calder, A. J., Keane, J., Manes, F., Antoun, N., & Young, A. W. (2000). Impaired recognition and experience of disgust following brain injury. *Nature Neuroscience, 3*, 1077–1088.

Chapman, H. A., & Anderson, A. K. (2013). Things rank and gross in nature: A review and synthesis of moral disgust. *Psychological Bulletin, 139*, 300–327.

Chirot, D., & McCauley, C. (2006). *Why not kill all of them?: The logic and prevention of mass political murder*. Princeton, NJ: Princeton University Press.

Cox, C. R., Goldenberg, J. L., Pyszczynski, T., & Weise, D. (2007). Disgust, creatureliness and the accessibility of death-related thoughts. *European Journal of Social Psychology, 37*(3), 494–507.

Cuddy, A. J. C., Fiske, S. T., & Glick, P. (2007). The BIAS map: Behaviors from intergroup affect and stereotypes. *Journal of Personality and Social Psychology, 92*(4), 631–648.

Curtis, V. (2013). *Don't look, don't touch, don't eat: The science behind revulsion*. Chicago: University of Chicago Press.

Curtis, V., & Biran, A. (2001). Dirt, disgust, and disease: Is hygiene in our genes? *Perspectives in Biology and Medicine, 44*, 17–31.

Curtis, V., de Barra, M., & Aunger, R. (2011). Disgust as an adaptive system for disease avoidance. *Philosophical Transactions of the Royal Society B: Biological Sciences, 366*, 389–401.

Danovitch, J., & Bloom, P. (2009). Children's extension of disgust to physical and moral events. *Emotion, 9*(1), 107–112.

Darwin, C. R. (1998). *The expression of the emotions in man and animals* (Def. ed. with introduction, afterword, and commentaries by P. Ekman). Oxford, UK: Oxford University Press. (Original work published 1872)

Davey, G. C. L. (1993). Factors influencing self-rated fear to a novel animal. *Cognition and Emotion, 7*, 461–471.

Davey, G. C. L., Cavanagh, K., & Lamb, A. (2003). Differential aversive outcome expectancies for high- and low-predation fear-relevant animals. *Journal of Behavior Therapy and Experimental Psychiatry, 34*, 117–128.

Davey, G. C. L., & Marzillier, S. (2009). Disgust and animal phobias. In B. O. Olatunji & D. McKay (Eds.), *Disgust and its disorders: Theory, assessment, and treatment implications* (pp. 169–190). Washington, DC: American Psychological Association.

DeJong, P. J., & Peters, M. L. (2009). Sex and the sexual dysfunctions: The role of disgust and contamination sensitivity. In B. O. Olatunji & D. McKay (Eds.), *Disgust and its disorders: Theory, assessment, and treatment implications* (pp. 253–270). Washington, DC: American Psychological Association.

Douglas, M. (1966). *Purity and danger*. London: Routledge and Kegan Paul.

Ekman, P. (1972). Universals and cultural differences in facial expressions of emotion. In J. K. Cole (Ed.), *Nebraska Symposium on Motivation* (Vol. 19, pp. 207–283). Lincoln: University of Nebraska Press.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion, 6*, 169–200.

Ekman, P., & Friesen, W. V. (1975). *Unmasking the face*. Englewood Cliffs, NJ: Prentice-Hall.

Ekman, P., & Friesen, W. V. (1978). *Facial Action Coding System: A technique for the measurement of facial movement*. Palo Alto, CA: Consulting Psychologists Press.

Elias, N. (1978). *The history of manners: Vol. 1. The civilizing process* (E. Jephcott, Trans.). New York: Pantheon Books. (Original work published 1939)

Eskine, K. J., Kacinik, N. A., & Prinz, J. J. (2011). A bad taste in the mouth: Gustatory influences on moral judgment. *Psychological Science, 22*, 295–299.

Fallon, A. E., & Rozin, P. (1983). The psychological bases of food rejections by humans. *Ecology of Food and Nutrition, 13*, 15–26.

Fallon, A. E., Rozin, P., & Pliner, P. (1984). The child's conception of food: The development of food rejections with special reference to disgust and contamination sensitivity. *Child Development, 55*, 566–575.

Ferenczi, S. (1952). The ontogenesis of the interest in money. In S. Ferenczi (Ed.) & E. Jones (Trans.), *First contributions to psychoanalysis* (pp. 319–331). London: Hogarth Press. (Original work published 1914)

Fessler, D. M. T., & Navarrete, C. D. (2003). Meat is good to taboo: Dietary proscriptions as a product of the interaction of psychological mechanisms and social processes. *Journal of Cognition and Culture, 3*, 1–40.

Fincher, C. L., & Thornhill, R. (2012). Parasite-stress promotes in-group assortative sociality: The cases of strong family ties and heightened religiosity. *Behavioral and Brain Sciences, 35*, 1–59.

Fine, G. A. (1988). Good children and dirty play. *Play and Culture, 1*, 43–56.

Frazer, J. G. (1922). *The golden bough: A study in magic and religion* (abridged ed., T. H. Gaster, Ed.). New York: Macmillan. (Original work published 1890)

Freud, S. (1957). Five lectures on psychoanalysis. In J. Strachey (Ed. & Trans.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. 11, pp. 3–56). London: Hogarth Press. (Original work published 1910)

Gallese, V., Keysers, C., & Rizzolatti, G. (2004). A unifying view of the basis of social cognition. *Trends in Cognitive Science, 8*, 398–403.

Goldenberg, J. L., Pyszczynski, T., Greenberg, J., & Solomon, S. (2000). Fleeing the body: A terror management perspective on the problem of human corporeality. *Personality and Social Psychology Review, 4*, 200–218.

Goldenberg, J. L., Pyszczynski, T., Greenberg, J., Solomon, S., Kluck, B., & Cornwell, R. (2001). I am not an animal: Mortality salience, disgust, and the denial of human creatureliness. *Journal of Experimental Psychology: General, 130*, 427–435.

Graham, J., Nosek, B. A., Haidt, J., Iyer, R., Koleva, S., & Ditto, P. H. (2011). Mapping the moral domain. *Journal of Personality and Social Psychology, 101*, 366–385.

Gray, J. M., Young, A. W., Barker, W. A., Curtis, A., & Gibson, D. (1997). Impaired recognition of disgust in Huntington's disease gene carriers. *Brain, 1120*, 2029–2038.

Gray, K., Schein, C., & Ward, A. F. (2014). The myth of harmless wrongs in moral cognition: Automatic dyadic completion from sin to suffering. *Journal of Experimental Psychology: General, 143*, 1600–1615.

Haidt, J., (2012). *The righteous mind: Why good people are divided by politics and religion*. New York: Pantheon.

Haidt, J., McCauley, C. R., & Rozin, P. (1994). A scale to measure disgust sensitivity. *Personality and Individual Differences, 16*, 701–713.

Haidt, J., Rozin, P., McCauley, C. R., & Imada, S. (1997). Body, psyche, and culture: The relationship between disgust and morality. *Psychology and Developing Societies, 9*, 107–131.

Hart, B. L. (2011). Behavioural defences in animals against pathogens and parasites: Parallels with the pillars of medicine in humans. *Philosophical Transactions of the Royal Society Series B: Biological Sciences, 366*, 3406–3417.

Haslam, N. (2006). Dehumanization: An integrative review. *Personality and Social Psychological Review, 10*(3), 252–264.

Haslam, N. (2012). *Psychology in the bathroom*. Houndsville, UK: Palgrave-Macmillan.

Hejmadi, A., Davidson, R., & Rozin, P. (2000). Exploring Hindu Indian emotion expressions: Evidence for accurate recognition by Americans and Indians. *Psychological Science, 11*, 183–187.

Hejmadi, A., Rozin, P., & Siegal, M. (2004). Once in contact, always in contact: Contagious essence and conceptions of purification in American and Hindu Indian children. *Developmental Psychology, 40*, 467–476.

Herz, R. (2012). *That's disgusting: Unraveling the mysteries of repulsion*. New York: Norton.

Hodson, G., Choma, B., Boisvert, J., Hafer, C. L., Macinnis, C. C., & Costello, K. (2013). The role of intergroup disgust in predicting negative outgroup evaluations. *Journal of Experimental Social Psychology, 49*(2), 195–205.

Horberg, E. J., Oveis, C., Keltner, D., & Cohen, A. B. (2009). Disgust and the moralization of purity. *Journal of Personality and Social Psychology, 97*, 963–976.

Husted, D. S., Shapira, N. A., & Goodman, W. K. (2006). The neurocircuitry of obsessive–compulsive disorder and disgust. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 30*, 389–399.

Hutcherson, C. A., & Gross, J. J. (2011). The moral emotions: A social–functionalist account of anger, disgust, and contempt. *Journal of Personality and Social Psychology, 100*(4), 719–737.

Inbar, Y., Pizarro, D. A., & Bloom, P. (2009). Conservatives are more easily disgusted than liberals. *Cognition and Emotion, 23*, 714–725.

Iyer, R., Koleva, S. P., Graham, J., Ditto, P. H., & Haidt, J. (2012). Understanding Libertarian morality: The psychological roots of an individualist ideology. *PLoS ONE, 7*, e42366.

Izard, C. E. (1971). *The face of emotion*. New York: Appleton-Century-Crofts.

Jones, E. (1948). Anal–erotic character traits. In *Papers on psychoanalysis* (pp. 413–437). Boston: Beacon Press. (Original work published 1912)

Kang, J. I., Kim, S. J., Cho, H. J., Jhung, K., Lee, S. Y., Lee, E., et al. (2012). Psychometric analysis of the Korean version of the Disgust Scale–Revised. *Comprehensive Psychiatry, 53*(5), 648–655.

Kelly, D. (2011). *Yuck!: The nature and moral significance of disgust*. Cambridge, MA: MIT Press.

Kipps, C. M., Duggins, A. J., McCusker, E. A., & Calder, A. J. (2007). Disgust and happiness recognition correlate with anteroventral insula and amygdala volume respectively in preclinical Huntington's disease. *Journal of Cognitive Neuroscience, 19*, 1206–1217.

Koleva, S. P., Graham, J., Iyer, R., Ditto, P. H., & Haidt, J. (2012). Tracing the threads: How five moral concerns (especially purity) help explain culture war attitudes. *Journal of Research in Personality, 46*, 184–194.

Korsmeyer, C. (2011). *Savoring disgust: The foul and the fair in aesthetics*. Oxford, UK: Oxford University Press.

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology, 84*, 394–421.

Kurth, F., Zilles, K., Fox, P. T., Laird, A. R., & Eickhoff, S. B. (2010). A link between the systems: Functional differentiation and integration within the human insula revealed by meta-analysis. *Brain Structure and Function, 214*, 519–534.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: University of Chicago Press.

Landy, J. F., & Goodwin, G. P. (2015). Does incidental disgust amplify moral judgment?: A meta-analytic review of experimental evidence. *Perspectives on Psychological Science, 10*(4), 518–536.

Leach, E. (1964). Anthropological aspects of language: Animal categories and verbal abuse. In E. Lenneberg (Ed.), *New directions in the study of language* (pp. 23–64). Cambridge, MA: MIT Press.

Lee, S. W. S., & Ellsworth, P. C. (2013). Maggots and morals: Physical disgust is to fear as moral disgust is to anger. In K. R. Scherer & J. R. J. Fontaine (Eds.), *Components of emotional meaning: A sourcebook* (pp. 271–280). New York: Oxford University Press.

Lewis, M. (1995). *Shame: The exposed self*. New York: Free Press.

Malson, L. (1972). *Wolf children* (E. Fawcett, P. Ayrton, & J. White, Trans.). New York: Monthly Review Press. (Original work published 1964)

Maoz, I., & McCauley, C. (2008). Threat, dehumanization, and support for aggressive retaliatory policies in asymmetric conflict. *Journal of Conflict Resolution, 52*(1), 93–116.

Martins,Y., & Pliner, P. (2006). "Ugh! That's disgusting!": Identification of the characteristics of foods underlying rejections based on disgust. *Appetite, 1*(46), 75–85.

Masson, J. L., & Patwardhan, M. V. (1970). *Aesthetic rapture: The Rasadhyaya of the Natyasastra*. Poona, India: Deccan College.

Matchett, G., & Davey, G. C. L. (1991). A test of a disease-avoidance model of animal phobias. *Behaviour Research and Therapy, 29*, 91–94.

Matsumoto, D., Hwang, H. C., & Frank, M. G. (2014). Emotions expressed by leader in video predict political aggression. *Behavioral Sciences of Terrorism and Political Aggression, 6*(3), 212–218.

Mauss, M. (1972). *A general theory of magic* (R. Brain, Trans.). New York: Norton. (Original work published 1902)

Mayr, E. (1960). The emergence of evolutionary novelties. In S. Tax (Ed.), *Evolution after Darwin: Vol. 1. The evolution of life* (pp. 349–380). Chicago: University of Chicago Press.

McCauley, C. (1998). When screen violence is not attractive. In J. Goldstein (Ed.), *Why we watch: The attractions of violent entertainment* (pp. 144–162). New York: Oxford University Press.

McGinn, C. (2011). *The meaning of disgust*. Oxford, UK: Oxford University Press.

Meigs, A. S. (1978). A Papuan perspective on pollution. *Man, 13*, 304–318.

Meigs, A. S. (1984). *Food, sex, and pollution: A New Guinea religion*. New Brunswick, NJ: Rutgers University Press.

Meissner, K., Muth, E. R., & Herbert, B. M. (2011). Bradygastric activity of the stomach predicts disgust sensitivity and perceived disgust intensity. *Biological Psychology, 86*, 9–16.

Melli, G., Chiorri, C., & Smurra, R. (2013). Ulteriore revisione e proprietà psicometriche della versione Italiana della [Disgust Scale–Revised] *Psicoterapia Cognitiva e Comportamentale, 19*(1), 63–93.

Menninghaus, W. (2003). *Disgust: Theory and history of a strong sensation* (H. Eiland & J. Golb, Trans.). Albany: State University of New York Press.

Miller, S. B. (2004). *Disgust: The gatekeeper emotion*. Hillsdale, NJ: Analytic Press.

Miller, W. I. (1997). *The anatomy of disgust*. Cambridge, MA: Harvard University Press.

Mineka, S., & Cook, M. (1988). Social learning and the acquisition of snake fear in monkeys. In T. R. Zentall & J. B. G. Galef (Eds.), *Social learning: Psychological and biological perspectives* (pp. 51–74). Hillsdale, NJ: Erlbaum.

Moll, J., Oliveira-Souza, R. de Moll, F. T., Igancio, F. A., Bramati, I. E., Caparelli-Daquer, E. M., et al. (2005). The moral affiliations of disgust: A functional MRI study. *Cognitive Behavioral Neurology, 18*, 68–78.

Moretti, L., & di Pellegrino, G. (2010). Disgust selectively modulates reciprocal fairness in economic interactions. *Emotion, 10*(2), 169.

Nabi, R. L. (2002). The theoretical versus the lay meaning of disgust: Implications for emotion research. *Cognition and Emotion, 16*, 695–703.

Nemeroff, C., & Rozin, P. (2000). The makings of the magical mind: The nature and function of sympathetic magical thinking. In K. Rosengren, C. Johnson, & P. Harris (Eds.), *Imagining the impossible: Magical, scientific, and religious thinking in children* (pp. 1–34). New York: Cambridge University Press.

Nemeroff, C. J., & Rozin, P. (1989). "You are what you eat": Applying the demand-free "impressions" technique to an unacknowledged belief. *Ethos, 17*(1), 50–69.

Nemeroff, C. J., & Rozin, P. (1994). The contagion concept in adult thinking in the United States: Transmission of germs and interpersonal influence. *Ethos, 22*(2), 158–186.

Nussbaum, M. C. (2004). *Hiding from humanity*. Princeton, NJ: Princeton University Press.

Oaten, M., Stevenson, R. J., & Case, T. I. (2009). Disgust as a disease avoidance mechanism. *Psychological Bulletin, 135*, 303–321.

Olatunji, B. O., Adams, T., Ciesielski, B., David, B., Sarawgi, S., & Broman-Fulks, J. (2012). The Three Domains of Disgust Scale: Factor structure, psychometric properties, and conceptual limitations. *Assessment, 19*, 205–225.

Olatunji, B. O., Cisler, J. M., Deacon, B., Connolly, K., & Lohr, J. M. (2007). The Disgust Propensity and Sensitivity Scale–Revised: Psychometric properties and specificity in relation to anxiety disorder symptoms. *Journal of Anxiety Disorders, 21*, 918–930.

Olatunji, B. O., Ebesutani, C., Haidt, J., & Sawchuk, C. N. (2014). Specificity of disgust domains in the prediction of contamination anxiety and avoidance: A multimodal examination. *Behavior Therapy, 45*, 469–481.

Olatunji, B. O., Haidt, J., McKay, D., & David, B. (2008). Core, animal-reminder, and contamination disgust: Three kinds of disgust with distinct personality, behavioral, physiological, and clinical correlates. *Journal of Research in Personality, 42*, 1243–1259.

Olatunji, B. O., & McKay, D. (Eds). (2009). *Disgust and its disorders: Theory, assessment, and treatment implications*. Washington, DC: American Psychological Association.

Olatunji, B. O., Williams, N. L., Lohr, J. M., & Sawchuk, C. N. (2005). The structure of disgust: Domain specificity in relation to contamination ideation and excessive washing. *Behaviour Research and Therapy, 43*, 1069–1086.

Olatunji, B. O., Williams, N. L., Tolin, D. F., Sawchuk, C. N., Abramowitz, J. S., Lohr, J. M., et al. (2007). The Disgust Scale: Item analysis, factor structure, and suggestions for refinement. *Psychological Assessment, 19*, 281–297.

Ortner, S. B. (1973). Sherpa purity. *American Anthropologist, 75*, 49–63.

Page, A. C., & Tan, B. J. (2009). Disgust and blood-injury injection phobia. In B. O. Olatunji & D. McKay (Eds.), *Disgust and its disorders: Theory, assessment, and treatment implications* (pp. 191–210). Washington, DC: American Psychological Association.

Petersen, R. D. (2011). *Western intervention in the Balkans: The strategic use of emotion in conflict*. New York: Cambridge University Press.

Pető, E. (1936). Contribution to the development of smell feeling. *British Journal of Medical Psychology, 15*, 314–320.

Phillips, M. L., Young, A. W., Senior, C., Brammer, M., Andrew, C., Calder, A. J., et al. (1997). A specific neural substrate for perceiving facial expressions of disgust. *Nature*, 389(6650), 495–498.

Pinker, S. (1997). *How the mind works*. New York: Norton.

Plato. (1987). *The republic* (D. Lee, Trans.). London: Penguin. (Original work published 4th-century B.C.E.)

Plutchik, R. (1980). *Emotion: A psychoevolutionary synthesis*. New York: Harper & Row.

Rachman, S. (2006). *Fear of contamination: Assessment and treatment*. Oxford, UK: Oxford University Press.

Renner, H. D. (1944). *The origin of food habits*. London: Faber & Faber.

Rolls, E. T. (1994). Central taste anatomy and physiology. In R. L. Doty (Ed.), *Handbook of clinical olfaction and gustation* (pp. 549–573). New York: Dekker.

Rottman, J., Kelemen, D., & Young, L. (2014). Tainting the soul: Purity concerns predict moral judgments of suicide. *Cognition*, *130*(2), 217–226.

Royzman, E., Atanasov, P., Landy, J. F., Parks, A., & Gepty, A. (2014). CAD or MAD?: Anger (not disgust) as the predominant response to pathogen-free violations of the divinity code. *Emotion, 14*, 892–907.

Royzman, E., & Kurzban, R. (2011). Minding the metaphor: The elusive character of moral disgust. *Emotion Review*, *3*(3), 269–271.

Royzman, E. B., & Sabini, J. (2001). Something it takes to be an emotion: The interesting case of disgust. *Journal for the Theory of Social Behaviour, 31*, 29–61.

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94*, 23–41.

Rozin, P., Guillot, L., Fincher, K., Rozin, A., & Tsukayama, E. (2013). Glad to be sad and other examples of benign masochism. *Judgment and Decision Making, 8*, 439–447.

Rozin, P., Haddad, B., Nemeroff, C., & Slovic, P. (2015). Psychological aspects of the rejection of recycled water: Contamination, purification and disgust. *Judgment and Decision Making, 10*(1), 50–63.

Rozin, P., Haidt, J., & Fincher, K. (2009). From oral to moral: Is moral disgust an elaboration of a food rejection system. *Science, 323*, 1179–1180.

Rozin, P., Haidt, J., & McCauley, C. R. (1993). Disgust. In M. Lewis & J. Haviland (Eds.), *Handbook of emotions* (pp. 575–594). New York: Guilford Press.

Rozin, P., Haidt, J., & McCauley, C. R. (2008). Disgust. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 757–776). New York: Guilford Press.

Rozin, P., Hammer, L., Oster, H., Horowitz, T., & Marmara, V. (1986). The child's conception of food: Differentiation of categories of rejected substances in the 1.4 to 5 year age range. *Appetite, 7*, 141–151.

Rozin, P., Lowery, L., & Ebert, R. (1994). Varieties of disgust faces and the structure of disgust. *Journal of Personality and Social Psychology*, 66, 870–881.

Rozin, P., Lowery, L., Imada, S., & Haidt, J. (1999). The CAD triad hypothesis: A mapping between three moral emotions (contempt, anger, disgust) and three moral codes (community, autonomy, divinity). *Journal of Personality and Social Psychology, 76*, 574–586.

Rozin, P., Markwith, M., & McCauley, C. R. (1994). The nature of aversion to indirect contact with other persons: AIDS aversion as a composite of aversion to strangers, infection, moral taint and misfortune. *Journal of Abnormal Psychology, 103*, 495–504.

Rozin, P., Millman, L., & Nemeroff, C. (1986). Operation of the laws of sympathetic magic in disgust and other domains. *Journal of Personality and Social Psychology, 50*, 703–712.

Rozin, P., Nemeroff, C., Horowitz, M., Gordon, B., & Voet, W. (1995). The borders of the self: Contamination sensitivity and potency of the mouth, other apertures and body parts. *Journal of Research in Personality, 29*, 318–340.

Rozin, P., Nemeroff, C., Wane, M., & Sherrod, A. (1989).

Operation of the sympathetic magical law of contagion in interpersonal attitudes among Americans. *Bulletin of the Psychonomic Society, 27*, 367–370.

Rozin, P., & Nemeroff, C. J. (1990). The laws of sympathetic magic: A psychological analysis of similarity and contagion. In J. Stigler, G. Herdt, & R. A. Shweder (Eds.), *Cultural psychology: Essays on comparative human development* (pp. 205–232). Cambridge, UK: Cambridge University Press.

Ruby, M. B., Rozin, P., & Chan, C. (2015). Determinants of willingness to eat insects in the USA and India. *Journal of Insects as Food and Feed, 1*(3), 215–225.

Russell, P. S., & Giner-Sorolla, R. (2013). Bodily moral disgust: What it is, how it is different from anger, and why it is an unreasoned emotion? *Psychological Bulletin, 139*(2), 328–351.

Sand'in, B., Chorot, P., Valiente, R. M., Santed, M. A., Olmedo, M., & Pineda, D. (2013). Construcción y validación preliminar de la Escala Multidimensional de Sensibilidad al Asco (EMA). *Revista de Psicopatología y Psicología Clínica, 18*(1), 1–18.

Schaller, M., & Murray, D. R. (2008). Pathogens, personality, and culture: Disease prevalance predicts worldwide variability in sociosexuality, extraversion, and openness to experience. *Journal of Personality and Social Psychology, 95*, 212–221.

Schaller, M., & Park, J. H. (2011). The behavioral immune system (and why it matters). *Current Directions in Psychological Science, 20*(2), 99–103.

Scherer, K. R., & Wallbott, H. G. (1994). Evidence for universality and cultural variation of differential emotion response patterning. *Journal of Personality and Social Psychology, 66*, 310–328.

Schienle, A. (2009). The functional neuroanatomy of disgust. In B. Olatunji, & D. McKay (Eds.), *Disgust and its disorders: Theory, assessment and treatment implications* (pp. 145–165). Washington, DC: American Psychological Association.

Schienle, A., Schafer, A., Stark, R., Walter, B., & Vaitl, D. (2005). Relationship between disgust sensitivity, trait anxiety and brain activity during disgust induction. *Neuropsychobiology, 51*, 86–92.

Schienle, A., Stark, R., & Vaitl, D. (2001). Evaluative conditioning: A possible explanation for the acquisition of disgust responses? *Learning and Motivation, 32*, 65–83.

Schmidt, H., & Beauchamp, G. (1988). Adult-like odor preferences and aversions in three-year-old children. *Child Development, 59*, 1136–1143.

Schnall, S., Haidt, J., Clore, G. L., & Jordan, A. H. (2008). Disgust as embodied moral judgment. *Personality and Social Psychology Bulletin, 34*, 1096–1109.

Scott, S., Inbar, Y., & Rozin, P. (in press). Evidence for disgust and absolute opposition to genetically modified food. *Perspectives on Psychological Science*.

Shenhav, A., & Mendes, W. B. (2014). Aiming for the stomach and hitting the heart: Dissociable triggers and sources for disgust reactions. *Emotion, 14*, 301–309.

Shweder, R. A., Much, N. C., Mahapatra, M., & Park, L. (1997). The "big three" of morality (autonomy, community, divinity), and the "big three" explanations of suffering. In A. Brandt & P. Rozin (Eds.), *Morality and health* (pp. 119–169). New York: Routledge.

Siegal, M., & Share, D. L. (1990). Contamination sensitivity in young children. *Developmental Psychology, 26*, 455–458.

Sprengelmeyer, R., Rausch, M., Eysel, U. T., & Przuntek, H. (1998). Neural structures associated with recognition of facial expressions of basic emotions. *Philosophical Transactions of the Royal Society B: Biological Sciences, 22*, 1927–1931.

Sprengelmeyer, R., Young, A. W., Calder, A. J., Karnat, A., Lange, H., Homberg, V., et al. (1996). Loss of disgust: Perception of faces and emotions in Huntington's disease. *Brain, 119*, 1647–1665.

Stark, R., Schienle, A., Walter, B., Kirsch, P., Sammer, G., Ott, U., et al. (2003). Hemodynamic responses to fear and disgust-inducing pictures: An fMRI study. *International Journal of Psychophysiology, 50*, 225–234.

Stein, M., Ottenberg, P., & Roulet, N. (1958). A study of the development of olfactory preferences. *Archives of Neurology and Psychiatry, 80*, 264–266.

Stern, R. M., Koch, K. L., & Andrews, P. L. R. (2011). *Nausea: Mechanisms and management.* New York: Oxford University Press.

Stevenson, R., Oaten, M., Case, T., Repacholi, B. M., & Wagland, P. (2010). Children's response to adult disgust elicitors: Development and acquisition. *Developmental Psychology, 46*, 165–177.

Strohminger, N. (2014). Disgust talked about. *Philosophy Compass*, *9*(7), 478–493.

Tambiah, S. J. (1969). Animals are good to think and good to prohibit. *Ethnology, 8*, 423–459.

Taylor, K. (2007). Disgust is a factor in extreme prejudice. *British Journal of Social Psychology, 46*(3), 597–617.

Terrizzi, J. A., Jr., Shook, N. J., & McDaniel, M. A. (2013). The behavioral immune system and social conservatism: A meta-analysis. *Evolution and Human Behavior, 34*(2), 99–108.

Tomkins, S. S. (1963). *Affect, imagery, consciousness: Vol. 2. The negative affects*. New York: Springer.

Tomkins, S. S. (1982). Affect theory. In P. Ekman (Ed.), *Emotion in the human face* (2nd ed., pp. 353–395). Cambridge, UK: Cambridge University Press.

Troop, N., & Baker, A. (2009). Food, body, and soul: The role of disgust. In B. O. Olatunji & D. McKay (Eds.), *Disgust and its disorders: Theory, assessment, and treatment implications* (pp. 229–252). Washington, DC: American Psychological Association.

Tybur, J. M., & de Vries, R. E. (2013). Disgust sensitivity and the HEXACO model of personality. *Personality and Individual Differences*, *55*(6), 660–665.

Tybur, J. M., Lieberman, D., & Griskevicius, V. (2009). Microbes, mating, and morality: Individual differences in three functional domains of disgust. *Journal of Personality and Social Psychology, 97*, 103–122.

Tybur, J. M., Lieberman, D., Kurzban, R., & DeScioli, P. (2013). Disgust: Evolved function and structure. *Psychological Review, 120*(1), 65–84.

Tylor, E. B. (1974). *Primitive culture: Researches into the development of mythology, philosophy, religion, art and custom*. New York: Gordon Press. (Original work published 1871)

van Overveld, M., de Jong, P. J., Peters, M. L., & Schouten, E. (2011). The Disgust-Scale-R: A valid and reliable index to investigate separate disgust domains. *Personality and Individual Differences, 51*, 325–330.

van Overveld, W. J. M., de Jong, P. J., Peters, M. L., Cavanagh, K., & Davey, G. C. L. (2006). Disgust propensity and disgust sensitivity: Separate constructs that are differentially related to specific fears. *Personality and Individual Differences, 41*, 1241–1252.

Vrana, S. R. (2009). The psychophysiology of disgust: Motivation, action, and autonomic support. In B. O. Olatunji & D. McKay (Eds.), *Disgust and its disorders: Theory, assessment and treatment implications* (pp. 123–143). Washington, DC: American Psychological Association.

Vytal, K., & Hamann, S. (2010). Neuroimaging support for discrete neural correlates of basic emotions: A voxel-based meta-analysis. *Journal of Cognitive Neuroscience, 22*, 2864–2885.

Wheatley, T., & Haidt, J. (2005). Hypnotic disgust makes moral judgments more severe. *Psychological Science, 16*, 780–784.

Wicker, B., Keysers, C., Plailly, J., Royet, J. P., Gallese, V., & Rizzolatti, G. (2003). Both of us disgusted in my insula: The common neural basis of seeing and feeling disgust. *Neuron, 40*, 655–664.

Widen, S. C., Pochedly, J. T., Pieloch, K., & Russell, J. A. (2013). Introducing the sick face. *Motivation and Emotion, 37*, 550–557.

Widen, S. C., & Russell, J. A. (2013). Children's recognition of disgust in others. *Psychological Bulletin, 139*, 271–299.

Wolfe, N. D., Dunavan, C. P., & Diamond, J. (2007). Origins of major human infectious diseases. *Nature, 447*, 279–283.

Woody, S. R., & Teachman, B. A. (2000). Intersection of disgust and fear: Normative and pathological views. *Clinical Psychology: Science and Practice, 7*, 291–311.

Wright, P., He, G., Shapira, N. A., Goodman, W. K., & Liu, Y. (2004). Disgust and the insula: fMRI responses to pictures of mutilation and contamination. *NeuroReport for Rapid Communication of Neuroscience Research, 15*, 2347–2351.

Yang, Q., Li, A., Xiao, X., Zhang, Y., & Tian, X. (2014). Dissociation between morality and disgust: An event-related potential study. *International Journal of Psychophysiology, 94*(1), 84–91.

CHAPTER 47

Gratitude and Compassion

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Gratitude and compassion stand as some of the best exemplars of affective states tied to sociality. Unlike many other emotions, their evocation and intensity require interaction with another. The other need not be human, of course, as individuals can feel grateful to a divine entity or compassion for an animal in pain. Such others, however, must be perceived as sentient (or at least usually so). This close tie to social interaction marks these emotions as somewhat special in terms of their functionality, as at base they primarily function to build social capital and well-being over the long run (Bartlett & DeSteno, 2006; DeSteno, 2009; Valdesolo & DeSteno, 2011).

Although many dilemmas faced in social life might be framed as decisions between selfish and selfless behaviors (e.g., choosing to help another at some cost to oneself), most may also be understood as a tradeoff between immediate and long-term gain. For example, refusing to repay a debt to someone might leave one with more financial or hedonic rewards in the moment, but long term, it bodes ill for the development or continuation of a relationship that would likely offer greater rewards aggregated over time. Accordingly, many social dilemmas fit within an intertemporal choice framework (DeSteno, 2009). As its name implies, intertemporal choice refers to a situation where decisions hold different consequences as time unfolds. Combine this framework with the fact that the mind tends to overly discount the value of future rewards, and one readily recognizes the fact that humans possess something of a built-in bias for immediate gratification (Ainslie, 1975).

Within the realm of social interaction, gratitude and compassion appear to motivate decisions and behaviors meant to build resources, and thus well-being, for the long term—that is, they increase the probability that individuals will act in ways that tend to increase the strength and stability of interpersonal relationships and well-being over time, even though such acts require immediate costs to oneself in terms of effort, time, or money. Of import, the benefits of these emotions likely derive not only from their influence on an experiencer's choices, but also from the impact their expression has on others witnessing it—that is, the expression of these emotions may serve as markers to others of an individual's motive to behave in a manner meant to benefit relationship development (e.g., Williams & Bartlett, 2015). One, gratitude, functions to do so by nudging individuals to pay back benefits that have been given to them by others, while simultaneously suggesting to observers that grateful individuals are worthwhile relationship partners. The other, compassion, often motivates the initial impulse to offer assistance in the first place. Together, they get and keep the wheels of social exchange greased. In what follows, we examine each state individually.

Gratitude

Gratitude is a positive emotion one feels with the receipt of a gift from another person or entity (i.e., a higher power). The gift can be tangible in nature or intangible—like help in a time of need—

but must be perceived by the recipient as positive, intentional, and beneficial, for gratitude to result (McCullough, Kilpatrick, Emmons, & Larson, 2001). Phenomenologically, gratitude, unlike indebtedness, is experienced as a positive state, but one that is differentiable both cognitively and behaviorally from a more general feeling of positive affect (Bartlett & DeSteno, 2006; Emmons & McCullough, 2003; Watkins, 2007). As noted above, a primary purpose of gratitude is to build long-term well-being through directly or indirectly enhancing the value placed on decisions and behaviors that maximize virtue and its associated increases in social capital. Here, we first review gratitude's role in shaping relationships, and then examine its benefits for personal well-being.

Benefits for Relationships

Helping

Much of the recent literature has considered how gratitude acts to build and maintain relationships. It helps people accept short-term costs (e.g., spending time or money to help someone else) in exchange for long-term gains (e.g., building a strong relationship one can rely on in the future). In particular, gratitude seems to promote helping behavior, which likely bolsters feelings of trust within a relationship that subsequently strengthen cooperation. In support of this notion, Bartlett and DeSteno (2006) conducted a series of experiments that induced gratitude by confronting participants with a problem and then having them receive the assistance of another to fix it. They found that grateful individuals were not only more willing to agree to help their benefactor or a complete stranger subsequently, but also devoted more effort to doing so than did individuals who were experiencing a neutral affective state. Of import, this effect of gratitude on helping clearly diverged from that of a more general positive state. Individuals who were induced to experience happiness as opposed to gratitude did not engage in any increased helping behavior. Additionally, Bartlett and DeSteno (2006) ruled out the possibility that increased helping derived from simple awareness of norms for reciprocity or "paying it forward" by using a paradigm to correct for affective misattribution (cf. Schwarz & Clore, 1996). When individuals feeling grateful were reminded to whom those feelings applied, increased efforts to aid the stranger disappeared. Binding the feeling of gratitude to its source prevented its use as an informational cue to acquiesce to the requests of aid of another.

Attesting to the link of gratitude and prosocial helping, several other researchers have reported similar findings. For example, grateful individuals reported increased motives to give back to others (Algoe & Haidt, 2009), and expressions of gratitude by one person motivated receivers of that expression to work harder to assist him or her (Grant & Gino, 2010). Thus, it appears that gratitude can serve both to (1) motivate people to reciprocate helping, which, over time, could potentially inspire a cycle of mutual give-and-take that would strengthen the relationship; as well as (2) pay it forward, using gratitude toward one individual to inspire prosociality in the general social sphere. These provisions of assistance, although requiring an initial cost in terms of hedonic, temporal, or physical resources, function to foster social capital, which will be of future benefit.

Forming Relationships

For individuals to receive the benefits associated with social relationships, they must first meet the challenge of forming a bond with others. Here, gratitude has clearly been shown to play a supportive role. For example, work by Algoe, Haidt, and Gable (2008) examined the ways in which gratitude influenced the relationships between new members of a sorority and their assigned "big sisters." After new "little sisters" initially joined the sorority, big sisters would give them anonymous gifts for a week. The gratitude that little sisters felt during that first week predicted their feelings of relationship quality not only at that time but also 1 month later. In addition, little sisters' gratitude also predicted how their big sisters viewed the relationship. Stronger expressions of gratitude by gift recipients (i.e., little sisters) corresponded to more positive views of the relationships by their benefactors (i.e., big sisters). Thus, for both the benefactor and recipient, gratitude seemed to play a role in building a strong relationship—likely through inspiring a reciprocal relationship that would continue to grow.

In a similar vein, feelings of gratitude toward another stand as a primary predictor of intentions and desires to spend more time with a previously unknown benefactor in the future—a sign of a desire to attempt to construct a relationship from a single instance of gratitude toward a stranger (Bartlett, Condon, Cruz, Baumann, & DeSteno, 2012).

Maintaining and Strengthening Relationships

Once relationships have been formed, gratitude has also been shown to aid their maintenance. Participants instructed to think about a time when they were grateful to someone reported a motivation to repay this other, indicating a desire to maintain and continue the relationship (Algoe & Haidt, 2009). Other empirical findings demonstrated that expressing gratitude in relationships was associated with increasing relationship strength (Lambert, Clark, Durtschi, Fincham, & Graham, 2010). After controlling for variables including relationship length and relationship satisfaction, higher levels of gratitude expression significantly predicted higher levels of perceived relationship durability with regard to friendships and romantic relationships both immediately and after a 6-week lag. In addition, Lambert et al. (2010) confirmed that when controlling for relationship strength at outset, the act of expressing gratitude to a friend twice a week for 3 weeks significantly elevated the expressers' assessments of relationship quality at the end of this period.

In a reciprocal manner, receiving and experiencing gratitude within romantic relationships conveys important benefits as well (Gordon, Impett, Kogan, Oveis, & Keltner, 2012). Here, individuals who reported feeling more appreciated by their partners also reported feeling more appreciation for their partners. This effect occurred both at an overarching level, as well as in more micro, time-lagged situations. For example, feelings of appreciation and gratefulness on a given day were significantly associated with corresponding feelings on the next day. Moreover, attesting to the power of appearing grateful, gratitude expressed by one's partner predicted feelings of relationship commitment the next day. Finally, with regard to its impact on relationship stability, individuals who felt more grateful toward their partners at the start of the study were more likely to still be in the relationship 9 months later, as compared to those with lower levels of gratefulness at baseline.

Other studies have also found relationships between gratitude and positive relationship outcomes. For example, gratitude levels on one day were found to predict increases in reported relationship connection and satisfaction on the next day (Algoe, Gable, & Maisel, 2010). Expressions of gratitude led people to feel more comfortable talking about concerns they may have for the relationship—an important way to make sure concerns do not go unaddressed and result in the deterioration of the relationship—and also led them to perceive their partner in a more positive light (Lambert & Fincham, 2011). For partners in long-term marriages, an individual's felt gratitude and expressed gratitude positively covaried with his or her feelings of marital satisfaction (Gordon, Arnett, & Smith, 2011). Furthermore, felt gratitude (but not expressed gratitude) also predicted the spouse's reports of marital satisfaction (Gordon, Arnett, & Smith, 2011). Finally, higher levels of gratitude for one's partner assessed over a 1-week period predicted increases in relationship commitment 9 months later (Joel, Gordon, Impett, MacDonald, & Keltner, 2013).

Perceived responsiveness—acting in ways that show understanding, acceptance, and consideration of the other person's needs and thus evoke feelings of gratitude—also plays a central role in positive relationship outcomes. For example, Gordon and colleagues (2012) found that increased feelings of appreciation for one's partner on a given day strongly predicted increases in responsiveness to the partner on the next day. Employing a slightly different paradigm with a different sample, Gordon et al. (2012) also had third-party observers rate participants' responsiveness to their partners by watching a videotape of the couple interacting; here again, more appreciative participants were seen as being more responsive and committed to their partners and the relationship than those who were less appreciative. In a similar vein, Algoe and colleagues found that the intensity of expressions of gratitude witnessed during a moment of exchange predicted improvements in the quality of a relationship 6 months later (Algoe, Fredrickson, & Gable, 2013). Kubacka, Finkenauer, Rusbult, and Keijsers (2011) likewise found responsiveness to be an important component of the gratitude experience such that it suggests a cyclical relationship for couples: Person A feels grateful for something and then acts to maintain the relationship (i.e., working in some way to promote relationship cohesion), which is then noticed by Person B, who feels Person A is acting in a responsive manner, which then causes Person B to feel grateful to Person A, followed by Person B then continuing the cycle. Thus it appears that gratitude and perceived responsiveness are linked, with gratitude functioning to motivate behavioral responses that build and maintain relationships.

Promoting Social Inclusion

Gratitude works at times to inspire not only relationship formation and maintenance but also general social network development, spreading the effects of relationship building to larger social contexts by influencing social inclusion and cooperation. In the sorority study mentioned previously (Algoe et al., 2008), gratitude felt toward a particular sorority sister during 1 week predicted how integrated individuals felt within the sorority house as a whole at a later point, thus demonstrating that particular instances of gratitude can have far-reaching effects. Additionally, work by Bartlett and colleagues (2012) revealed that grateful individuals strove to include their previous benefactors in social situations in which they were being excluded. Perhaps more interesting was the fact that grateful individuals were willing to accept a financial cost to bring about this inclusion, thereby lending support to the idea that gratitude serves to promote social inclusion even at the cost of individual reward. Similarly, in a separate study, gratitude enhanced preferences for financial decisions that benefited communal interests as opposed to immediate profit accumulation (DeSteno, Bartlett, Baumann, Williams, & Dickens, 2010). That is, feelings of gratitude mediated decisions that favored the equal sharing of profits through cooperation than the asymmetric accumulation of profits for one individual at the cost of another.

Using more macro levels of social networks, Froh and colleagues found that gratitude directly and indirectly predicted social integration, which then, itself, functioned to increase subsequent experiences of gratitude (Froh, Bono, & Emmons, 2010). A similar finding within the context of a medical support group showed that women diagnosed with breast cancer who both expressed their emotions and also were likely to respond to situations in a grateful manner reported an increase in perceived social support, as compared to women who did not express their emotions or respond to help in a grateful manner (Algoe & Stanton, 2012).

Benefits for General Well-Being

Gratitude has been examined both as a trait (i.e., a grateful disposition) and a state. Although not substantively different from the state classification, the notion of a trait classification can be best understood in this case as reflecting a tendency to experience gratitude more frequently due to an increased readiness to bring reciprocity-relevant cognitions to bear on events of daily life (cf. Barrett, 2012). Attesting to the benefits of gratitude, much research has documented positive correlations between a grateful disposition and aspects of general well-being (e.g., Emmons & Kneezel, 2005; McCullough, Emmons, & Tsang, 2002; McCullough, Tsang, & Emmons, 2004; see Wood, Froh, & Geraghty, 2010, for a comprehensive review). More specifically, a tendency to experience gratitude has been found to positively covary with life satisfaction (Wood, Joseph, & Maltby, 2008), psychological well-being (Wood, Joseph, & Maltby, 2009), and a sense of "coherence" (a feeling that "life is manageable, meaningful and comprehensible"; Lambert, Graham, Fincham, & Stillman, 2009, p. 462). Moreover, in studies investigating gratitude's relation to health outcomes, evidence has linked more experiences of gratitude to fewer depressive symptoms (Krause, 2007; Lambert, Fincham, & Stillman, 2012), lower aggression (DeWall, Lambert, Pond, Kashdan, & Fincham, 2012), better physical health (Hill, Allemand, & Roberts, 2013), and even better sleep (Wood, Joseph, Lloyd, & Atkins, 2009).

Although a majority of these health-relevant findings are of a correlational nature, experimental evidence demonstrates that gratitude can be cultivated and produce benefits over time. These experiments usually involve "gratitude interventions" in which participants are randomly assigned to complete gratitude exercises (e.g., completing a diary entry to reflect on an event that made them feel grateful) as a way to foster this state in their daily lives. The results of such interventions have been examined in several populations, including schoolchildren (Froh, Kashdan, Ozimkowski, & Miller, 2009; Froh, Sefick, & Emmons, 2008), people experiencing depression (Mongrain & Anselmo-Matthews, 2012; Sergeant & Mongrain, 2011), and those with physical illness (e.g., neuromuscular disease; Emmons & McCullough, 2003). In all cases, individuals completing gratitude exercises generally demonstrate increased well-being, happiness, and life satisfaction as soon as 1 or 2 weeks following the start of the intervention. Of import, these beneficial changes reflected increases not only from preintervention levels of well-being, but also from extant levels of well-being among control group members (i.e., members of the same sample who were not assigned to complete gratitude exercises; e.g., Emmons & McCullough, 2003; Froh et al., 2008). Accordingly, it seems that experiencing gratitude frequently aids individuals in achieving self-improvement goals.

A relatively unique line of research concerns gratitude's effects on materialism and financial decision making. It appears that gratitude is related to decreased materialism (Polak & McCullough, 2006). Lambert, Fincham, Stillman, and Dean (2009) found that this relationship was mediated by life satisfaction. Feelings of gratitude led people to report higher satisfaction with life, which then led to reduced materialism (as compared with a condition that induced feelings of envy). In terms of financial decision making, inducing gratitude in individuals made them opt for delayed, larger rewards rather than immediate, smaller rewards, helping them overcome the human propensity to engage in temporal discounting (DeSteno, Li, Dickens, & Lerner, 2014). Here again we can see that a primary mechanism underlying gratitude's effects involves nudging people to forgo actions that—although bringing short-term gain—tend to inhibit the accumulation of long-term benefit.

Compassion

Scholars have long proposed that compassion, like gratitude, is a sentiment that stands at the foundation of morality and virtue (Darwin 1871/2004; Goetz, Keltner, & Simon-Thomas, 2010; Nussbaum, 1996; Smith, 1759/2009). Emerging scientific evidence has begun to echo this claim by demonstrating the role of compassion in promoting prosocial behavior, cooperative relationships, and physical and psychological well-being. Although compassion, like gratitude, is sometimes conceived of as a dispositional trait, recent findings stemming from both examinations of meditation practice and subtle environmental nudging provide evidence that compassion is itself quite variable within individuals and thus amenable to being manipulated or trained as a skill.

Historically, the term "compassion" has been used interchangeably with terms such as "empathy," "empathic concern," "sympathy," and "pity" (e.g., Batson, 1991, 2009; Wispé, 1986). Yet many authors now differentiate *compassion* from *empathy*. Empathy typically refers to processes that allow an individual to understand another person's mental state, either through perspective taking (sometimes called "cognitive empathy," "theory of mind," "mental state attribution," or "mentalizing") or through emotional contagion (sometimes called "affective empathy" or "experience sharing"; Zaki & Ochsner, 2012). Compassion can be differentiated from empathy based on the motivations that underlie one's resonance with another's mental state. We adopt the definition offered by Goetz and colleagues (2010), who define compassion as an other-oriented emotional state that arises in response to another's suffering and motivates one to act in a prosocial manner to alleviate another's suffering. In short, whereas compassion includes a motivational component to relieve another's suffering, empathy typically refers to processes that merely provide access to the content or experience of another's state.

Unlike the case with gratitude, a large, historical body of research has demonstrated that compassion promotes helping behavior aimed to alleviate another's suffering. This work, usually employing the term *empathic concern* as opposed to compassion, comprised much of the social psychological literature on helping behavior in the late 20th century and has received considerable attention in other reviews (Batson, 1991, 2011; Eisenberg & Miller, 1987). We do not review that work here, but note that compassion functions as an affective state that increases the probability of costly helping independent of other factors that increase helping, such as social recognition (Batson, 1991, 2011; Goetz et al., 2010). Instead, we focus on recent findings that provide additional insight into the role that compassion plays in promoting short-term costs in favor of long-term gain with respect to social systems, relationships, and psychological well-being.

Compassion and Stable Social Systems

As noted, a fundamental problem of human social living concerns the development of cooperative social relationships and communities—a task that often proves difficult because individuals must forgo short-term benefits for the self in favor of long-term benefits for the greater good. Compassion appears to function as an emotional experience that promotes the attainment of cooperative social relationships by supporting the development of emerging relationships and, thereby, the growth in one's social network.

Indeed, the impact of compassionate motives has been demonstrated to predict the development of novel relationships. Crocker and colleagues have studied the experiences of first-semester college freshmen who have been randomly assigned a roommate and demonstrated that people who care about the well-being of others (i.e., those motivated by "compassionate goals") are more likely to satisfy their own and others' needs compared with those who are motivated by self-interest (i.e., "self-image goals"; see Crocker & Canevello, 2012 for a review). Whereas pursuing self-esteem can have various short- and long-term costs, including a reduced sense of relatedness and increased anxiety and depression, caring for the well-being of others functions to indirectly promote one's own well-being through the building of social capital (Crocker & Canevello, 2008). Based on longitudinal data that tracked college freshmen over their first semester, Crocker and Canevello found that those who maintained compassionate goals, compared with those who prioritized self-image goals, provided more support to others in the context of new relationships. Furthermore, those individuals who simultaneously endorsed high-compassionate goals and low-self-image goals reported receiving greater social support and greater interpersonal trust among friends and significant others. Thus, compassionate dispositions appeared to support the development of emerging relationships. These findings also suggest a positive impact of compassion on overall well-being: compassionate goals predicted downstream psychological well-being as indicated by self-reported feelings of trust, closeness, and reduced loneliness and interpersonal conflict (Crocker & Canevello, 2008).

The effects of compassion on the development of cooperative relationships may also extend to larger groups beyond dyadic relationships. For example, emerging empirical evidence supports the notion that cooperative groups accumulate the largest amounts of resources over time compared with groups that engage in punitive action. Using simulated economic exchanges, Dreber and colleagues confirmed that groups that refrain from punitive action reap greater communal gains compared with groups characterized by punitive behavior (Dreber, Rand, Fudenberg, & Nowak, 2008). Cooperation, rather than punishment, promotes a flourishing community. It is therefore of great value to identify the factors that might promote cooperation despite uncertainty about potential losses of resources in the short run. In this vein, researchers have taken interest in the potential of compassion as a moral force that can extend prosocial behavior and forgiveness toward those who have committed social violations or transgressions.

Initial investigation in this realm has produced findings indicating that compassion can in fact promote a reduction in punishment directed at individuals who commit a transgression, even in cases where the transgression occurs against a third party and no forgiveness is sought (Condon & DeSteno, 2011). Using an orchestrated scenario, Condon and DeSteno had participants witness a confederate (i.e., an actor) cheat on a task to win money. Participants later had the opportunity to punish the transgressor by deciding the amount of hot sauce he would be forced to consume (cf. Lieberman, Solomon, Greenberg, & McGregor, 1999). Some participants were also exposed to the intense sadness of a nearby female confederate. As expected, the experience of compassion in response to the female confederate's state mediated a reduction in the amount of hot sauce administered to the transgressor. Compassion may therefore be an effective mechanism for reducing escalations of violence. Although unpunished transgressions could prove costly, the avoidance of aggressive action can result in less psychological stress and greater hedonic well-being in the long run (Bushman, 2002; Carlsmith, Wilson, & Gilbert, 2008), suggesting that compassionate action even toward transgressors may prove worthwhile. An emerging question concerns the manner in which compassion promotes cooperative behavior in contexts that involve such moral violations. The motivation to reduce suffering would likely lead individuals to endorse policies and values that protect the rights of others (Goetz et al., 2010), thus it is likely that compassion would motivate an individual to engage in action to correct the actions of a transgressor with the ultimate aim to reduce collective suffering, albeit in a nonviolent manner that minimizes the transgressor's suffering. This interpretation remains speculative, however, and awaits empirical investigation. In sum, compassion supports the development of novel relationships and communal interest, in part by nudging people to forgo short-term benefits for the self and by attenuating impulses to engage in third-party punishment.

Compassion and Individual Well-Being

Various researchers have suggested that compassion may serve as a nourishing, replenishing experience that can contribute to one's personal well-being (e.g., Klimecki & Singer, 2012). This is in stark contrast with the notion that people can become overburdened by "compassion fatigue" when providing care for others, such as in health care settings or among people who take on the role of a primary caregiver for a family member. Yet several authors have distinguished compassion from empathic distress or empathy fatigue by suggesting that compassion moves beyond the simulation of another's pain and includes feelings of concern and love for those who suffer (Condon & Barrett, 2013; Klimecki & Singer, 2012). In line with this suggestion, several scholars have provided evidence that compassion might indeed promote psychological and physical well-being to individuals, as opposed solely to larger social groups.

Not surprisingly, the impact of compassionate goals compared with self-image goals—as reviewed above—extends to one's personal well-being (Crocker, Canevello, Breines, & Flynn, 2010). As previously noted, Crocker and colleagues examined the effect of compassionate goals in college freshmen on experiences of anxiety, dysphoria, and distress throughout their first semester. Compassionate goals predicted social support given and received, but interestingly, social support given to others uniquely predicted participants' own changes in distress from the beginning to the end of the semester. Thus, caring for the well-being of others over time appears to benefit an individual's own psychological well-being.

Similar effects extend to physiological outcomes as well. Individual differences in self-reported compassion have been found to moderate the effect of social support on reactions to a stress-inducing public speech task (Cosley, McCoy, Saslow, & Epel, 2010). Specifically, high dispositional compassion was associated with reduced blood pressure, reduced cortisol, and higher high-frequency heart rate variability, suggesting reduced sympathetic and increased parasympathetic activity during a stress-inducing public speech (Cosley et al., 2010). Recent experimental work has also confirmed that manipulating compassionate goals can reduce stress reactivity to a stress-inducing public speech task (Abelson et al., 2014). Specifically, individuals who thought about ways to help others while in a job interview setting experienced less hypothalamic–pituitary–adrenal (HPA) axis reactivity, which acts as a primary contributor to the negative impacts of stress on health. Thus, compassion could play a fundamental role in promoting psychological and physical well-being in response to stress.

Similar findings have emerged with respect to caregiving behavior. Brown and colleagues have demonstrated across differing samples that giving support and providing care for others can contribute to one's own health and psychological well-being (Brown, Brown, House, & Smith, 2008; Brown, Nesse, Vinokur, & Smith, 2003; Brown et al., 2009). Large-scale prospective survey research of individuals over the age of 65 has demonstrated that giving instrumental support (e.g., help with work, tasks) and emotional support (e.g., offering love and care for one's spouse) reliably predicted reduced mortality risk over a 5-year period, even after controlling for relevant factors such as health, income, education, socioeconomic status, personality factors, social contact, and support received (Brown et al., 2003). Data from the same sample also confirmed that, among participants who recently lost a spouse, self-reported compassion-related helping behavior was associated with decreased depressive symptoms (Brown et al., 2008). Data from a separate sample revealed that caregiving for a spouse predicted reduced risk of mortality (Brown et al., 2009). Similarly, survey research has shown that volunteering rates among people who adopt positive views of others predict lower rates of mortality and psychological distress even when exposed to high levels of stress (Poulin, 2014). Although much research has documented the negative effects of a caregiving role, this newer body of work has shown that compassion-based caregiving can increase self-reported feelings of self-worth, meaning in life, a strengthening in one's relationships, feelings of uplift or elevation, and a reduction in anxiety and depression (see Schulz & Monin, 2012, for a review).

These benefits of compassion-related caregiving are consistent with other findings showing the impact of prosocial action on one's own feeling of happiness. In a recent field experiment, Dunn, Aknin, and Norton (2008) demonstrated that participants who were randomly assigned to spend the cash they were endowed with on other people reported greater levels of happiness compared with participants who were randomly assigned to spend similar amounts of money on themselves. Of import, this effect has been replicated across numerous cultures (Aknin et al., 2013). Such findings are also consistent with neuroimaging evidence suggesting that charitable and cooperative behavior is experienced as rewarding (Moll et al., 2006; Rilling et al., 2002). Although these findings do not specifically focus on compassion, they suggest that other-oriented costly behavior of the type associated with compassion can promote subjective experiences of well-being.

Modulating Compassion

Numerous factors have been documented that decrease compassionate responding to another's suffering, including outgroup membership (Stürmer, Snyder, & Omoto, 2005), the presence of nonresponsive bystanders in a social context (Darley & Latané, 1968), heightened time pressure (Darley & Batson, 1973), higher socioeconomic status

(Piff, Kraus, Côté, Cheng, & Keltner, 2010; Stellar, Manzo, Kraus, & Keltner, 2012), and an increased number of people suffering (Cameron & Payne, 2011). These factors all decrease the likelihood that one will respond in a prosocial manner to those in need. Yet emerging evidence is beginning to identify factors that increase compassion as well, including Buddhist-inspired meditation programs and subtle situational cues.

Much of the scientific activity on meditation has focused on the personal health and psychological benefits of meditation, such as decreased anxiety and depression (Hölzel et al., 2011) and enhanced cognitive performance (e.g., Slagter, Lutz, Greischar, Nieuwenhuis, & Davidson, 2009). Recently, scientists extended the meditation-based literature to the interpersonal domain by examining the role of meditation in promoting helping and cooperation. A handful of initial studies provided compelling evidence that different types of meditation increase prosocial and compassionate responses to another's suffering. Fredrickson and colleagues (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008; Kok et al., 2013) have demonstrated that short-term training in loving-kindness meditation (LKM) increases daily experiences of positive emotions throughout training and self-reported social resources measured at posttraining (e.g., greater self-reported social connection). More specifically, they showed that participants completing LKM, compared with those assigned to a wait-list control, reported increased positive emotion, which accounted for increases in a variety of personal resources, including self-reported positive relations with others and self-reported social connection (Fredrickson et al., 2008; Kok et al., 2013).

Several independent groups have demonstrated that compassion-based meditation—a technique similar to, but distinct from LKM—increases empathic responses to others' suffering (Klimecki, Leiberg, Ricard, & Singer, 2014; Lutz, Brefczynski-Lewis, Johnstone, & Davidson, 2008; Mascaro, Rilling, Tenzin Negi, & Raison, 2013). Of import, this increased empathic response has been shown to be predictive of subsequent prosocial acts. As one example, loving-kindness and compassion-based training have been shown to increase economic generosity in computer-based transactions (Leiberg, Klimecki, & Singer, 2011; Weng et al., 2013). In an effort to link meditation to compassionate responses to the suffering of others directly, work by Condon and colleagues has confirmed that just a few weeks of training in either compassion- or mindfulness-based meditation significantly enhances the likelihood that individuals will act to relieve the pain of others, even within the context of bystander situation in which others are ignoring the suffering (Condon, Desbordes, Miller, & DeSteno, 2013; Lim, Condon & DeSteno, 2015).

A variety of non-meditation–based techniques may also prove effective for increasing compassion. Experimental research indicates that increases in feelings of similarity (Valdesolo & DeSteno, 2011) and security (Mikulincer, Shaver, Gillath, & Nitzberg, 2005) enhance compassion and helping behavior. In both lines of research, subtle cues were sufficient to increase feelings of compassion and downstream helping behavior. With respect to similarity, a simple measure of motor synchrony resulted in magnified feelings of similarity to a stranger, which subsequently mediated the experience of compassion for the stranger's plight and behaviors meant to assist him (Valdesolo & DeSteno, 2011). Mikulincer and colleagues likewise demonstrated that subtle manipulations of felt security increase compassionate responding to the other's suffering (Mikulincer et al., 2005). Participants in these studies viewed subliminal primes of the names of secure attachment figures (e.g., the name a person who has provided care and responsiveness in times of need, such as the participant's mother, a close friend, or other relationship partner) and later reported greater willingness to help a woman in need, compared with participants who viewed subliminal primes of neutral content.

Interventions that incorporate these factors may stand as potential targets for interventions that do not require protracted efforts involving meditation-based training. As the field matures, it will be noteworthy to examine possible contextual factors that predict the degree to which meditation increases compassionate outcomes (e.g., social context, practice settings) and individual susceptibility to compassion-based enhancements via meditation training. At present, however, it is interesting to note a potential common element that may tie some of these relatively nascent findings together. The goal of many meditative techniques is to foster a state of equanimity: a state in which the social categories typically used to separate people are broken down (Desbordes et al., 2015). Such a state, by definition, increases the similarity seen between individuals. Accordingly, the ability of subtle similarity manipulation to increase compassion may represent an efficient "hack" to achieve similar benefits that come from more chronic training of the mind. This view is supported by work showing that inductions of compassion enhance feelings of similarity to others (Oveis, Horberg, & Keltner, 2010), thereby suggesting a possible reciprocal interaction between the relevant mechanisms. A sense of increased similarity to another individual, of course, stands as a marker that this individual is likely to be more willing to repay the favor by providing subsequent aid in the future (de Waal, 2008).

Conclusion

As the preceding review makes abundantly clear, gratitude and compassion share several commonalities. Both are intrinsically linked with building social relationships. Both motivate behaviors that, although costly in the moment—in terms of social, financial, temporal, or hedonic resources—typically lead to opportunities for greater accumulation of similar rewards when aggregated over time. As such, these emotions enhance well-being by nudging individuals to behave virtuously (DeSteno, 2009). For all their similarities, however, they do constitute unique states that also address distinct challenges. Gratitude primarily functions to motivate behaviors likely to maintain relationships (e.g., repayment of debts, offering of social support to previous benefactors). Although it has been shown that gratitude can result in pay-it-forward behavior to strangers, such acts likely stem from a misattribution of the feeling state to others and thus represent a highly beneficial spandrel as opposed to a central functional outcome (cf. Bartlett & DeSteno, 2006). A unique aspect of compassion, on the other hand, is its ability to motivate supportive behavior and diminish aggressive behavior in the absence of any preexisting relationship. Thus, compassion and gratitude may work together to build social capital, with compassion motivating the initial impulse to be a benefactor to a new individual and gratitude motivating subsequent repayments meant to continue the exchange.

References

Abelson, J. L., Erickson, T. M., Mayer, S. E., Crocker, J., Briggs, H., Lopez-Duran, N. L., et al. (2014). Brief cognitive intervention can modulate neuroendocrine stress responses to the Trier Social Stress Test: Buffering effects of a compassionate goal orientation. *Psychoneuroendocrinology, 44*, 60–70.

Ainslie, G. (1975). Specious reward: A behavioral theory of impulsiveness. *Psychological Bulletin, 82*, 463–496.

Aknin, L. B., Barrington-Leigh, C. P., Dunn, E. W., Helliwell, J. F., Burns, J., Biswas-Diener, R., et al. (2013). Prosocial spending and well-being: Cross-cultural evidence for a psychological universal. *Journal of Personality and Social Psychology, 104*, 635–652.

Algoe, S. B., Fredrickson, B. L., & Gable, S. L. (2013). The social functions of the emotion of gratitude via expression. *Emotion, 13*, 605–609.

Algoe, S. B., Gable, S. L., & Maisel, N. C. (2010). It's the little things: Everyday gratitude as a booster shot for romantic relationships. *Personal Relationships, 17*, 217–233.

Algoe, S. B., & Haidt, J. (2009). Witnessing excellence in action: The "other-praising" emotions of elevation, gratitude, and admiration. *Journal of Positive Psychology, 4*, 105–127.

Algoe, S. B., Haidt, J., & Gable, S. L. (2008). Beyond reciprocity: Gratitude and relationships in everyday life. *Emotion, 8*, 425–429.

Algoe, S. B., & Stanton, A. L. (2012). Gratitude when it is needed most: Social functions of gratitude in women with metastatic breast cancer. *Emotion, 12*, 163–168.

Barrett, L. F. (2012). Emotions are real. *Emotion, 12*, 413–429.

Bartlett, M. Y., Condon, P., Cruz, J., Baumann, J., & DeSteno, D. (2012). Gratitude: Prompting behaviours that build relationships. *Cognition and Emotion, 26*, 2–13.

Bartlett, M. Y., & DeSteno, D. (2006). Gratitude and prosocial behavior: Helping when it costs you. *Psychological Science, 17*, 319–325.

Batson, C. D. (1991). *The altruism question: Toward a social-psychological answer.* Hillsdale, NJ: Erlbaum.

Batson, C. D. (2009). These things called empathy: Eight related but distinct phenomena. In J. Decety & W. Ickes (Eds.), *The social neuroscience of empathy* (pp. 3–15). Cambridge, MA: MIT Press.

Batson, C. D. (2011). *Altruism in humans.* New York: Oxford University Press.

Brown, S. L., Brown, R. M., House, J. S., & Smith, D. M. (2008). Coping with spousal loss: Potential buffering effects of self-reported helping behavior. *Personality and Social Psychology Bulletin, 34*, 849–861.

Brown, S. L., Nesse, R. M., Vinokur, A. D., & Smith, D. M. (2003). Providing social support may be more beneficial than receiving it: Results from a prospective study of mortality. *Psychological Science, 14*, 320–327.

Brown, S. L., Smith, D. M., Schulz, R., Kabeto, M. U., Ubel, P. A., Poulin, M., et al. (2009). Caregiving behavior is associated with decreased mortality risk. *Psychological Science, 20*, 488–494.

Bushman, B. J. (2002). Does venting anger feed or extinguish the flame?: Catharsis, rumination, distraction, anger, and aggressive responding. *Personality and Social Psychology Bulletin, 28*, 724–731.

Cameron, C. D., & Payne, B. K. (2011). Escaping affect: How motivated emotion regulation creates insensitivity to mass suffering. *Journal of Personality and Social Psychology, 100*, 1–15.

Carlsmith, K. M., Wilson, T. D., & Gilbert, D. T. (2008). The paradoxical consequences of revenge. *Journal of Personality and Social Psychology, 95*, 1316–1324.

Condon, P., & Barrett, L. F. (2013). Conceptualizing and experiencing compassion. *Emotion, 13*, 817–821.

Condon, P., Desbordes, G., Miller, W. B., & DeSteno, D. (2013). Meditation increases compassionate responses to suffering. *Psychological Science, 24*, 2125–2127.

Condon, P., & DeSteno, D. (2011). Compassion for one reduces punishment for another. *Journal of Experimental Social Psychology, 47*, 698–701.

Cosley, B. J., McCoy, S. K., Saslow, L. R., & Epel, E. S. (2010). Is compassion for others stress buffering?: Consequences of compassion and social support for physiological reactivity to stress. *Journal of Experimental Social Psychology, 46*, 816–823.

Crocker, J., & Canevello, A. (2008). Creating and undermining social support in communal relationships: The role of compassionate and self-image goals. *Journal of Personality and Social Psychology, 95*, 555–575.

Crocker, J., & Canevello, A. (2012). Consequences of self-image and compassionate goals. In P. G. Devine & A. Plant (Eds.), *Advances in experimental social psychology* (pp. 229–277). New York: Elsevier.

Crocker, J., Canevello, A., Breines, J. G., & Flynn, H. (2010). Interpersonal goals and change in anxiety and dysphoria in first-semester college students. *Journal of Personality and Social Psychology, 98*, 1009–1024.

Darley, J., & Batson, C. (1973). From Jerusalem to Jericho: A study of situational and dispositional variables in helping behavior. *Journal of Personality and Social Psychology, 27*, 100–108.

Darley, J., & Latané, B. (1968). Bystander intervention in emergencies: Diffusion of responsibility. *Journal of Personality and Social Psychology, 8*, 377–383.

Darwin, C. (2004). *The descent of man.* New York: Penguin Classics. (Original work published 1871)

de Waal, F. B. M. (2008). Putting the altruism back into altruism: The evolution of empathy. *Annual Review of Psychology, 59*, 279–300.

Desbordes, G., Gard, T., Hoge, E. A., Hölzel, B., Kerr, C. E., Lazar, S. W., et al. (2015). Moving beyond mindfulness: Defining equanimity as an outcome measure in meditation and contemplative research. *Mindfulness, 6*(2), 356–372.

DeSteno, D. (2009). Social emotions and intertemporal choice: "Hot" mechanisms for building social and economic capital. *Current Directions in Psychological Science, 18*, 280–284.

DeSteno, D., Bartlett, M. Y., Baumann, J., Williams, L. A., & Dickens, L. (2010). Gratitude as moral sentiment: Emotion-guided cooperation in economic exchange. *Emotion, 10*, 289–293.

DeSteno, D., Li, Y., Dickens, L., & Lerner, J. S. (2014). Gratitude: A tool for reducing economic impatience. *Psychological Science, 25*(6), 1262–1267.

DeWall, C., Lambert, N. M., Pond, R. R., Kashdan, T. B., & Fincham, F. D. (2012). A grateful heart is a nonviolent heart: Cross-sectional, experience sampling, longitudinal, and experimental evidence. *Social Psychological and Personality Science, 3*, 232–240.

Dreber, A., Rand, D. G., Fudenberg, D., & Nowak, M. A. (2008). Winners don't punish. *Nature, 452*, 348–351.

Dunn, E. W., Aknin, L. B., & Norton, M. I. (2008). Spending money on others promotes happiness. *Science, 319*(5870), 1687–1688.

Eisenberg, N., & Miller, P. A. (1987). The relation of empathy to prosocial and related behaviors. *Psychological Bulletin, 101*, 91–119.

Emmons, R. A., & Kneezel, T. T. (2005). Giving thanks: Spiritual and religious correlates of gratitude. *Journal of Psychology and Christianity, 24*, 140–148.

Emmons, R. A., & McCullough, M. E. (2003). Counting blessings versus burdens: An experimental investigation of gratitude and subjective well-being in daily life. *Journal of Personality and Social Psychology, 84*, 377–389.

Fredrickson, B. L., Cohn, M. A., Coffey, K. A., Pek, J., & Finkel, S. M. (2008). Open hearts build lives: Positive emotions, induced through loving-kindness meditation, build consequential personal resources. *Journal of Personality and Social Psychology, 95*, 1045–1062.

Froh, J. J., Bono, G., & Emmons, R. (2010). Being grateful is beyond good manners: Gratitude and motivation to contribute to society among early adolescents. *Motivation and Emotion, 34*, 144–157.

Froh, J. J., Kashdan, T. B., Ozimkowski, K. M., & Miller, N. (2009). Who benefits the most from a gratitude intervention in children and adolescents?: Examining positive affect as a moderator. *Journal of Positive Psychology, 4*, 408–422.

Froh, J. J., Sefick, W. J., & Emmons, R. A. (2008). Counting blessings in early adolescents: An experimental study of gratitude and subjective well-being. *Journal of School Psychology, 46*, 213–233.

Goetz, J. L., Keltner, D., & Simon-Thomas, E. (2010). Compassion: An evolutionary analysis and empirical review. *Psychological Bulletin, 136*, 351–374.

Gordon, A. M., Impett, E. A., Kogan, A., Oveis, C., & Keltner, D. (2012). To have and to hold: Gratitude promotes relationship maintenance in intimate bonds. *Journal of Personality and Social Psychology, 103*, 257–274.

Gordon, C. L., Arnette, R. M., & Smith, R. E. (2011). Have you thanked your spouse today?: Felt and expressed gratitude among married couples. *Personality and Individual Differences, 50*, 339–343.

Grant, A. M., & Gino, F. (2010). A little thanks goes a long way: Explaining why gratitude expressions motivate prosocial behavior. *Journal of Personality and Social Psychology, 98*, 946–955.

Hill, P. L., Allemand, M., & Roberts, B. W. (2013). Examining the pathways between gratitude and self-rated physical health across adulthood. *Personality and Individual Differences, 54*, 92–96.

Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work?: Proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science, 6*, 537–559.

Joel, S., Gordon, A. M., Impett, E. A., MacDonald, G., & Keltner, D. (2013). The things you do for me: Perceptions of a romantic partner's investments promote gratitude and commitment. *Personality and Social Psychology Bulletin, 39*, 1333–1345.

Klimecki, O. M., Leiberg, S., Ricard, M., & Singer, T. (2014). Differential pattern of functional brain plasticity after compassion and empathy training. *Social Cognitive and Affective Neuroscience, 9*, 873–879.

Klimecki, O. M., & Singer. T. (2012). Empathic distress fatigue rather than compassion fatigue?: Integrating findings from empathy research in psychology and social neuroscience. In B. Oakley, A. Knafo, G. Madhavan, & D. S. Wilson (Eds.), *Pathological altruism* (pp. 368–383). New York: Oxford University Press.

Kok, B. E., Coffey, K. A., Cohn, M. A., Catalino, L. I., Vacharkulksemsuk, T., Algoe, S. B., et al. (2013). How positive emotions build physical health: Perceived positive social connections account for the upward spiral between positive emotions and vagal tone. *Psychological Science, 24*, 1123–1132.

Krause, N. (2007). Self-expression and depressive symptoms in late life. *Research on Aging, 29*, 187–206.

Kubacka, K. E., Finkenauer, C., Rusbult, C. E., & Keijsers, L. (2011). Maintaining close relationships: Gratitude as a motivator and a detector of maintenance behavior. *Personality and Social Psychology Bulletin, 37*, 1362–1375.

Lambert, N. M., Clark, M. S., Durtschi, J., Fincham, F. D., & Graham, S. M. (2010). Benefits of expressing gratitude: Expressing gratitude to a partner changes one's view of the relationship. *Psychological Science, 21*, 574–580.

Lambert, N. M., & Fincham, F. D. (2011). Expressing gratitude to a partner leads to more relationship maintenance behavior. *Emotion, 11*, 52–60.

Lambert, N. M., Fincham, F. D., & Stillman, T. F. (2012). Gratitude and depressive symptoms: The role of positive reframing and positive emotion. *Cognition and Emotion, 26*, 615–633.

Lambert, N. M., Fincham, F. D., Stillman, T. F., & Dean, L. (2009). More gratitude, less materialism: The mediating role of life satisfaction. *Journal of Positive Psychology, 4*, 32–42.

Lambert, N. M., Graham, S. M., Fincham, F. D., & Stillman, T. F. (2009). A changed perspective: How gratitude can affect sense of coherence through positive reframing. *Journal of Positive Psychology, 4*, 461–470.

Leiberg, S., Klimecki, O., & Singer, T. (2011). Short-term compassion training increases prosocial behavior in a newly developed prosocial game. *PLoS ONE, 6*, e17798.

Lieberman, J. D., Solomon, S., Greenberg, J., & McGregor, H. A. (1999). A hot new way to measure aggression: Hot sauce allocation. *Aggressive Behavior, 25*, 331–348.

Lim, D., Condon, P., & DeSteno, D. (2015). Mindfulness and compassion: An examination of mechanism and scalability. *PLoS ONE, 10*(2), e0118221.

Lutz, A., Brefczynski-Lewis, J., Johnstone, T., & Davidson, R. J. (2008). Regulation of the neural circuitry of emotion by compassion meditation: Effects of meditative expertise. *PLoS ONE, 3*, e1897.

Mascaro, J. S., Rilling, J. K., Tenzin Negi, L., & Raison, C. L. (2013). Compassion meditation enhances empathic accuracy and related neural activity. *Social Cognitive and Affective Neuroscience, 8*, 48–55.

McCullough, M. E., Emmons, R. A., & Tsang, J. (2002). The grateful disposition: A conceptual and empirical topography. *Journal of Personality and Social Psychology, 82*, 112–127.

McCullough, M. E., Kilpatrick, S. D., Emmons, R. A., & Larson, D. B. (2001). Is gratitude a moral affect? *Psychological Bulletin, 127*, 249–266.

McCullough, M. E., Tsang, J., & Emmons, R. A. (2004). Gratitude in intermediate affective terrain: Links of grateful moods to individual differences and daily emotional experience. *Journal of Personality and Social Psychology, 86*, 295–309.

Mikulincer, M., Shaver, P. R., Gillath, O., & Nitzberg, R. A. (2005). Attachment, caregiving, and altruism: Boosting attachment security increases compassion and helping. *Journal of Personality and Social Psychology, 89*, 817–839.

Moll, J., Krueger, F., Zahn, R., Pardini, M., de Oliveira-Souza, R., & Grafman, F. (2006). Human fronto–mesolimbic networks guide decisions about charitable donation. *Proceedings of the National Academy of Sciences, 103*(42), 15623–15628.

Mongrain, M., & Anselmo-Matthews, T. (2012). Do positive psychology exercises work? A replication of Seligman et al. (2005). *Journal of Clinical Psychology, 68*, 382–389.

Nussbaum, M. C. (1996). Compassion: The basic social emotion. *Social Philosophy and Policy, 13*, 27–58.

Oveis, C., Horberg, E. J., & Keltner, D. (2010). Compassion, pride, and social intuitions of self-other similarity. *Journal of Personality and Social Psychology, 98*, 618–630.

Piff, P. K., Kraus, M. W., Côté, S., Cheng, B. H., & Keltner, D. (2010). Having less, giving more: The influence of social class on prosocial behavior. *Journal of Personality and Social Psychology, 99*(5), 771–784.

Polak, E. L., & McCullough, M. E. (2006). Is gratitude an alternative to materialism? *Journal of Happiness Studies, 7*, 343–360.

Poulin, M. J. (2014). Volunteering predicts health among those who value others: Two national studies. *Health Psychology, 33*, 120–129.

Rilling, J., Gutman, D., Zeh, T., Pagnoni, G., Berns, G., & Kilts, C. (2002). A neural basis for social cooperation. *Neuron, 35*, 395–405.

Schulz, R., & Monin, J. K. (2012). The costs and benefits of informal caregiving. In S. L. Brown, R. M. Brown, & L. A. Penner (Eds.), *Moving beyond self-interest: Perspectives from evolutionary biology, neuroscience, and the social sciences* (pp. 178–198). New York: Oxford University Press.

Schwarz, N., & Clore, G. L. (1996). Feelings and phenomenal experiences. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 433–465). New York: Guilford Press.

Sergeant, S., & Mongrain, M. (2011). Are positive psychology exercises helpful for people with depressive personality styles? *Journal of Positive Psychology, 6*, 260–272.

Slagter, H. A., Lutz, A., Greischar, L. L., Nieuwenhuis, S., & Davidson, R. J. (2009). Theta phase synchrony and conscious target perception: Impact of intensive mental training. *Journal of Cognitive Neuroscience, 21*, 1536–1549.

Smith, A. (2009). *The theory of moral sentiments*. New York: Penguin Classics. (Original work published 1759)

Stellar, J. E., Manzo, V. M., Kraus, M. W., & Keltner, D. (2012). Class and compassion: Socioeconomic factors predict responses to suffering. *Emotion, 12*, 449–459.

Stürmer, S., Snyder, M., & Omoto, A. M. (2005). Prosocial emotions and helping: The moderating role of group membership. *Journal of Personality and Social Psychology, 88*, 532–546.

Valdesolo, P., & DeSteno, D. (2011). Synchrony and the social tuning of compassion. *Emotion, 11*, 262–266.

Watkins, P. C. (2007). Gratitude. In R. Baumeister & K. Vohs (Eds.), *Encyclopedia of social psychology*. Thousand Oaks, CA: Sage.

Weng, H. Y., Fox, A. S., Shackman, A. J., Stodola, D. E., Caldwell, J. Z. K., Olson, M. C., et al. (2013). Compassion training alters altruism and neural responses to suffering. *Psychological Science, 24*, 1171–1180.

Williams, L. A., & Bartlett, M. Y. (2015). Warm thanks: Gratitude expression facilitates social affiliation in new relationships via perceived warmth. *Emotion, 15*(1), 1–5.

Wispé, L. (1986). The distinction between sympathy and empathy: To call forth a concept, a word is needed. *Journal of Personality and Social Psychology, 50*, 314–321.

Wood, A. M., Froh, J. J., & Geraghty, A. W. A. (2010). Gratitude and well-being: A review and theoretical integration. *Clinical Psychology Review, 30*(7), 890–905.

Wood, A. M., Joseph, S., Lloyd, J., & Atkins, S. (2009). Gratitude influences sleep through the mechanism of pre-sleep cognitions. *Journal of Psychosomatic Research, 66*, 43–48.

Wood, A. M., Joseph, S., & Maltby, J. (2008). Gratitude uniquely predicts satisfaction with life: Incremental validity above the domains and facets of the five factor model. *Personality and Individual Differences, 45*, 49–54.

Wood, A. M., Joseph, S., & Maltby, J. (2009). Gratitude predicts psychological well-being above the Big Five facets. *Personality and Individual Differences, 46*, 443–447.

Zaki, J., & Ochsner, K. (2012). The neuroscience of empathy: Progress, pitfalls and promise. *Nature Neuroscience, 15*, 675–680.

CHAPTER 48

Love

Positivity Resonance as a Fresh, Evidence-Based Perspective on an Age-Old Topic

Barbara L. Fredrickson

What is love? Humans have pondered the meaning of this splendored phenomenon for millennia. Anything that so reliably stirs the human heart, preoccupies the mind, and ignites passionate action certainly merits this long-standing and continued inquiry. Artistic expressions of what love is and how it works abound—in poetry, books, songs, and movies. Scientific perspectives are less prevalent. Although scientific psychology began in the late 1800s, more than six decades into this collective endeavor, Harry Harlow (1958), then president of the American Psychological Association, decried that psychologists had "failed" to advance beyond poets and novelists in understanding the "wondrous state" of love, "deep, tender, and rewarding" (p. 673). In the nearly six decades since receiving this failing grade, two strands of psychological science have taken the love question seriously: Developmental science has investigated how love emerges between infants and their caregivers (e.g., Ainsworth, 1985; Stern, 2008), and relationship science has explored romantic love, including how early childhood attachment shapes adulthood love relationships (Hazan & Shaver, 1987; Bartholomew & Horowitz, 1991; Mikulincer, Shaver, Sapir-Lavid, & Avihou-Kanza, 2009).[1]

Neighboring emotion science lags behind. Although a few emotion scientists have devoted attention to the love question over the years (e.g., Fehr & Russell, 1991; Gonzaga, Keltner, Londahl, & Smith, 2001; Shaver, Morgan, & Wu, 1996), these efforts have not germinated a thriving study of love within affective science. As long-time love scholar, Elaine Berscheid (2010) recently noted, "emotion theorists have their own problems [in defining emotions] and are not yet in a position to help love scholars" (p. 8). For emotion scientists, who by definition favor the study of momentary phenomena, love may well seem too large, too all-encompassing, if not too pop culture.

The largeness of love is evident by the diverse set of psychological phenomena that fit under the umbrella term "love": the preoccupying and strong *desire* for further connection, the powerful *bonds* people hold with a select few and the *intimacy* that grows between them, the *commitments* to loyalty and faithfulness. Indeed, when one person says, "I love you" to another, it can point to any or all of the above—that is, this ubiquitous utterance may reflect a strong craving for physical contact or proximity, or serve as a means to invite or secure the other person into one's innermost circle of social ties, or it may signal a deep and abiding trust, or a commitment to be loyal. Yet, in addition to desire, bonds, intimacy, and commitment, love is an *emotion*—a phenomenon that arises to infuse both mind and body for a moment, and then dissipates.

This chapter puts forth a new perspective on love, one that emanates from emotion science. The goal is to provide a conceptual framework to support a fresh wave of empirical research on this revered emotional state. This new perspective holds that, at its core, love is a pleasant and momentary experience of connection with another person (or persons). In this framework, other constructs that are commonly taken as synonyms of "love"—such as desire, bonds, intimacy, and commitments—are cast as *products* of the accumulation of fleeting emotional states of love. As such, the range of other phenomena that go by the name "love," in both scientific and common language, may best be seen as part of a larger and dynamic "love system."

The hub concept that drives this dynamic system is a potent and pleasant emotional state. Like all positive emotions, the emotional state of love obeys the ancestral logic of the broaden-and-build theory (cf. Fredrickson, 1998, 2013a). Love-the-emotion broadens mind-sets by expanding people's awareness, particularly of self–other overlap (Aron, Aron, & Smollen, 1992; Waugh & Fredrickson, 2006), creating perceptions of togetherness, connection, unity, or oneness. Love-the-emotion builds resources for survival by forging and strengthening people's social desire, bonds, intimacy, and commitments. Each of these other concepts within the broader love system grows stronger as moments of love-the-emotion accumulate. Yet the causal arrows also run in the other direction. Each of these other concepts within the more encompassing love system—the desire, the bonds, the intimacy, the commitments—also facilitate subsequent moments of love-the-emotion, creating the dynamics of an upward spiral. Put simply, it is far easier for two or more people to connect when their desire, bonds, intimacy, or commitments are present and strong.

Perhaps it is no wonder that love has puzzled so many for so long. Part of the confusion is that the word "love" has been affixed to different parts of this larger, dynamic love system. A primary mission of science, however, is to peer into complex systems to discover the order therein. We are now equipped to use the lenses of emotion science to sharpen our appreciation of love. These lenses add to the understandings of love that neighboring relationship science and developmental science have offered by drawing particular attention to the momentary nature of love, its biological bases, and by offering the framework and logic of the broaden-and-build theory of positive emotions.

The sharper appreciation for love to be developed here also illuminates the value of mild or low-intensity forms of this consequential state. Mild forms of love-the-emotion are too often eclipsed by the overwhelming intensity of select love experiences, the ones that forge life's strongest bonds, such as those between an infant and his or her caregivers, or between two new romantic partners just now "falling in love." The study of positive emotions, however, cautions researchers not to be blinded by intensity: Ample empirical evidence reveals that the frequency of pleasant affective states is far more consequential than the intensity of those states (Diener, Sandvik, & Pavot, 1991; Folkman, 1997; Isen, 1993), and that the consequences of mild pleasant affective states for health and well-being are considerable (Cohn, Fredrickson, Brown, Mikels, & Conway, 2009; Moskowitz, 2003; Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008). Love-the-emotion likely follows this same pattern. Mild yet consequential forms of love can infuse everyday positive connections between and among family, friends, acquaintances—even strangers—to forge and fortify bonds, alliances, meaning, and purpose, as well as community and collective health and well-being.

Toward a Formal Definition of Love-the-Emotion

Views from Emotion Science

Emotion scientists distinguish between love experiences and love relationships (Lazarus, 1991), and direct their focus to the former, the transient feeling states of love, rather than the latter, the long-standing social ties that are infused with, and supported by love-the-emotion. Even so, it bears underscoring that transient experiences of love are felt *toward* and *with* specific individuals (e.g., one's mother, friend, lover, or child), and are therefore contextualized by these interpersonal connections. Many theorists have pointed out that love is not actually a single emotional state, but rather comes in multiple forms, some more tender and low-key, and others more joyful and high energy. As Rempel and Burris (2005) put it, "love seems to be reflected in multiple emotions rather than one distinct emotion" (p. 298). Supporting this view, in examining 14 pleasant emotions, Ellsworth and Smith (1988) found that love was among the least differentiated.

Whereas Rempel and Burris (2005) use love's lack of specificity to argue that love is not, in fact, an emotion, other theorists, like Izard (1977) and Fredrickson (1998), use this same observation to support a different, contextualized view of love. This alternate view holds that experiences of love can be seen as the experience of any other positive emotion when that emotion is felt in the context of a safe, often close relationship. For Izard (1977), who at the time identified only interest and joy as among the other positive emotions he considered, love was taken to be the joy and interest that people feel in connection with others. In his words, "acquaintances or friends renew your interest by revealing new aspects of themselves and the resulting increase in familiarity (deeper knowledge of the person) brings joy. In lasting friendships or love relationships this cycle is repeated endlessly" (p. 243).

More recently, Fredrickson (2009) expanded on Izard's (1977) illustration to include eight additional positive emotions alongside the appraisal patterns associated with each, arguing that each of these moments might be equally described as love:

> In the early stages of a relationship, tied up with your initial attraction, you're deeply *interested* in anything and everything this new person says and does. You share *amusements* and laugh together, often as a result of the awkwardness of coming together for the first time. As your relationship builds and perhaps surpasses your expectations, it brings great *joy*. You begin to share your *hopes* and dreams for your future together. As the relationship becomes more solid, you sink back into the cozy *serenity* [contentment] that comes with the security of mutual love. You're *grateful* for the joys your beloved brings into your life, as *proud* of their achievements as you are of your own, *inspired* by their good qualities, and perhaps in *awe* of the forces of the universe that brought you two together. (p. 47)

Following Izard's (1977) footsteps, my earliest scholarly description of love-the-emotion took an "all of the above" approach, defining it as any positive emotion felt in the context of a safe, often close relationship (Fredrickson, 1998). Although I still hold that acknowledging the many different flavors of love-the-emotion is a vital step, for two reasons, I now see that this step is not nearly big enough. First and foremost, this earlier conceptualization remains a one-person psychology, positioning the other person as merely the "context" for the focal person's experience of love. A richer understanding of love-the-emotion emerges when we widen the lens to also include what the other person is, at that same moment, feeling. Stepping up to this two-person psychology,[2] I now more specifically position love-the-emotion as emerging any time a positive emotion is momentarily shared by two (or more) individuals. Second, I find the emphasis on established close relationships to be limiting and unjustifiable. Initial or one-time connections with novel interaction partners can also support the emergence of shared positive emotions. The differences between these connections and those that emerge within close relationships may be largely a matter of degree, rather than kind.

So, to expand the scope of past conceptualizations of love within emotion science, I posit here that one core element of love-the-emotion is shared positive emotions. To lay the foundation for two additional core elements, I outline views offered by relationship science and developmental science in turn.

Views from Relationship Science

A dominant approach within relationship science is to demark different types of love relationships. Berscheid (2010), for instance, identifies companionate, romantic, and compassionate, as well as attachment love relationships (see also Hatfield & Rapson, 1993; Sternberg, 1986; Fehr, Sprecher, & Underwood, 2008; Fisher, Aron, Mashek, Li, & Brown, 2002). Recent advances in understanding love, for instance, have explored the unique neural correlates of romantic versus companionate love (Acevedo, Aron, Fisher, & Brown, 2012).

Whereas these various forms of love certainly differ from one another, they also share certain family resemblances. In contrast to the dominant approach of defining love as a prototype (Fehr, 1988; Shaver, Schwartz, Kirson, & O'Connor, 1987), recent work by Hegi and Bergner (2010) attempts to articulate a formal definition of love, one that identifies necessary and sufficient conditions for using the word "love" correctly across a range of love relationships. Building on work by Clark and colleagues on communal relationships (Clark & Mills, 1979; Clark & Monin, 2006), as well as work by Singer (1984) and Rempel and Burris (2005), Hegi and Bergner (2010) hypothesize that essential to a range of love relationships—companionate, romantic, compassionate, and attachment—is "investment in the well-being of the other, for his or her own sake" (p. 621). They draw support for their hypothesis from surveys that capture respondents' schemas for what counts as love. Specifically, respondents consider hypothetical examples of different types of relationships in which a certain relationship characteristic is missing on the part of one individual in the relationship, and indicate the degree to which they would find it contradictory to say that this person loves the other under those circumstances. In examining relationship characteristics ranging from similarity and trust to exclusivity and enjoyment, they found that only the absence of "investment in the well-being of the other for his or her own sake" was deemed "very contradictory" to the presence of a love relationship by the vast majority of respondents (Hegi & Bergner, 2010). The authors use these data to argue that such investment is a necessary and essential feature of human love of various kinds. As such, love, by definition, conveys a caring orientation toward others.

The interpersonal counterpart to love's caring orientation toward the other appears to be the concept of "perceived partner responsiveness to the self," which reflects the extent to which the other person registers that he or she is being attentively cared for (e.g., Reis, Clark, & Holmes, 2004)—that is, to the extent that Person A invests in the well-being of Person B, for B's own sake, Person B may come to believe that Person A understands and values him or her, and responds supportively. Perceived partner responsiveness is positioned as "a cardinal process in closeness and intimacy" (Reis et al., 2004, p. 220; see also Laurenceau, Barrett, & Pietromonaco, 1998), particularly within communal relationships. Assessments of the degree to which another person understands, cares for, and validates you inform your overarching belief that this other person truly "gets you," and uses his or her privileged knowledge thoughtfully, for your benefit. Responsive parenting is also a cornerstone concept within attachment theory (Bowlby, 1969/1982), with studies showing that parental responsiveness to a child's needs is the root of secure attachment and the development of stable and positive internal models of self in relation to others (Bowlby, 1969/1982; Ainsworth, Blehar, Waters, & Wall, 1978), which in turn shape thoughts, emotions, and behavior throughout childhood and into adulthood (Mikulincer et al., 2009).

Research on perceived responsiveness underscores that love is not a unidirectional phenomenon, concerning one person's feelings toward another, but is instead a *bidirectional transaction*, in which each person's perceptions of the other's feelings toward the self are also vital to the emergence of intimacy. Responsiveness is known to be consequential across a range of emotional exchanges. For instance, when one member of a romantic couple thanks the other (Algoe, Fredrickson, & Gable, 2013), or reacts as the other shares some personal good fortune (Gable, Gonzaga, & Strachman, 2006), the extent to which the other person perceives that thanks or that reaction to be responsive forecasts future relational well-being, and even the longevity of the relationship. Responsiveness may also be consequential to physical health. A national U.S. survey of individuals who are married or cohabitating with a romantic partner found that high received emotional support from the partner is associated with increased mortality risk for those who rate their partners as lacking responsiveness, whereas this risk is absent among those who rate their partners as high in responsiveness (Selcuk & Ong, 2013).

Although most studied within communal relationships, responsiveness—and the perception of it—can also characterize exchange relationships, even one-time encounters with strangers. As a traveler to an unfamiliar city, for instance, you may come to appreciate that the barista who makes your morning brew is especially attuned to your wishes and mood, eager to please and connect. As you make your economic transaction, the two of you smile and chat with ease and openness. Walking away from this exchange, you might feel more uplifted and energized than you had felt just moments ago. Dutton and colleagues describe such encounters as *high-quality connections* (HQCs; Stephens, Heaphy, & Dutton, 2011; see also Heaphy & Dutton, 2008). HQCs are short-term, positive interactions that are experienced as enlivening, characterized by mutual perceived responsiveness. Although these positive encounters may be part of ongoing relationships, they need not be. They can also readily emerge within one-time encounters with shopkeepers or customers, health care providers or patients, or any time two or more people interact.

Rapport is also commonly used to describe the sorts of positive connections that emerge between and among people who are said to "click" or have "chemistry." Conceptually, rapport is an emergent, interpersonal phenomenon marked by mutual attentiveness, positivity, and coordination (Tickle-Degnen & Rosenthal, 1990), all the hallmarks of responsiveness. Nonverbally, rapport is embodied through mutual direct body orientation and gaze, accompanied by smiles, nods, and forward leans (Tickle-Degnen & Rosenthal, 1990), as well as behavioral synchrony (Vacharkulksemsuk & Fredrickson, 2012). Whereas the concept of "love," in its traditional usage, tends to imply long-standing intimate relationships, the concept of "rapport" all but implies a lack of intimacy and history. By contrast, I hold that the concepts of love and rapport may differ primarily in degree, rather in kind, and that it may be more generative to consider them as examples of the same underlying biopsychosocial phenomenon.

For the present purposes, I denote the reciprocal combination of "investment in the well-being of the other, for his or her own sake" and "perceived partner responsiveness to the self" by the shorthand phrase "mutual care." Although mutual care is perhaps most obvious within people's longstanding love relationships—with, for instance, romantic partners and other family members—it is not an exclusive property of these communal relationships. In milder, perhaps less obvious forms, mutual care can also infuse more casual encounters with friends, coworkers, acquaintances, and even strangers. Indeed, any time embodied rapport or HQCs emerge, mutual care is, by definition, present. Importantly, this care is neither heavy-handed nor role bound, as in being a caregiver. Rather it is as light, nonconscious, and momentary as the unbidden concern you would feel if the person with whom you were connecting suddenly had a heavy object fall on his or her foot: you would wince also, then quickly assess your companion's well-being. Mutual care describes a state in which each person would show this minimal level of engagement with, concern for, and investment in the well-being of the other. I posit that mutual care is a second core element of love-the-emotion.

Views from Developmental Science

If mutual care, with its hallmark mutual concern for the other's well-being and mutual perceived responsiveness, is taken as an additional core element of love-the-emotion, it might seem that encounters or relationships that involve dependence or asymmetry—as with an infant, or child (or an otherwise needy individual) with a parent or caregiver—are ruled out of such mutuality. While doting parents clearly love their newborns, can their newborns truly love them back? With their limited capacities, how can newborns muster up the selfless other-focus that defines love?

The way out of this seeming conundrum is to recognize that warmth-infused other-focus requires no mustering at all. Rather, it unfolds automatically and effortlessly, completely without higher symbolic or effortful mental processes. Indeed, developmental psychologists have argued that, from birth, infants are biologically prepared to perceive cross-modal correspondences between what they see on their interaction partners' faces and what they sense, proprioceptively, on their own faces (Meltzoff & Moore, 1989; Trevarthen, 1998). This ability is what enables infants to synchronize their movements—in form, tempo, and intensity—with those of others, to the extent that their motor control allows (Meltzoff & Moore, 1989).

Notably, behavioral synchrony goes beyond mimicry because matching often occurs across modalities, such as when the rhythm of an infant's movements sync up with the rhythm of his or her mother's vocalizations. Such cross-modal analogies point to a resonance between infants and their interaction partners at the level of subjective mind states and emotions, and not merely at the level of observable behaviors. Behavioral synchrony can thus be taken to reveal an intersubjectivity (Beebe, Sorter, Rustin, & Knoblauch, 2003), or affective attunement (Stern, 1985), described as an innate form of intimacy, a way to find and show delight in communing, connecting, or being with another. Through such affective sharing, an infant "experiences being experienced" (Beebe et al., 2003, p. 786) or "feel[s] felt" by the other (Siegel, 2001, p. 78), a momentary experience akin to what relationship scientists, as described above, have termed "perceived partner responsiveness to the self." Importantly, "feeling felt" is itself a positive emotional experience (Beebe et al., 2003).

Developmental science has also shown that the attentive dance of behavioral synchrony that emerges between infants and their responsive caregivers—a dance laced with smiles, coos, and other gestures of positivity—is absolutely vital to normal human development, as vital a good nutrition (Stern, 1985; Siegel, 2001). The classic "still-face paradigm," for instance, reveals how avidly infants seek it out. Researchers who use this paradigm invite parent–infant dyads to the laboratory to videotape them during typical face-to-face play, after a few minutes of which the researchers signal the parent to adopt a still, neutral face, while maintaining eye contact with his or her infant. The parent's still face sends a mixed message to the infant: the parent's gaze signals readiness to engage, yet his or her passive face conveys unavailability. Behavioral coding of infant responses to the still-face paradigm reveals that, in the first half minute or so, infants typically continue to gaze and smile at their parent, making "positive bids" for reengagement. These hopeful bids are destined to fail, however, because parents are instructed to maintain a passive face for 2 minutes. Faced with this failure, the infants' positivity typically wanes and gives way to negativity, marked by lowered brows and open-mouth cries (Ekas, Haltigan, & Messinger, 2013).

More sobering evidence for the developmental necessity of the positive intersubjectivity signaled by behavioral synchrony comes from caregivers who struggle with depression, who are far less likely to show the "dance" of behavioral synchrony with the infants in their care. Studies show that depression, which affects 10–12% of postpartum mothers, slows both speech and body movements, and disrupts parent–infant synchrony (Feldman, 2007). Widely viewed as a disorder of the positive emotion system (Davidson, 2000), depression stifles the emergence of intersubjectivity and shared positivity. Ample research confirms that maternal depression in infancy forecasts a child's impairments in cognitive and socioemotional skills even decades later (see Feldman, 2007, for a review).

More recent evidence suggests that positive behavioral synchrony—the degree to which an infant and a parent (through eye contact and affectionate touch) laugh, smile, and coo together—corresponds with oxytocin synchrony. Researchers have measured oxytocin levels in the saliva of dads, moms, and infants both before and after a videotaped, face-to-face parent–infant interaction. For parent–infant pairs that show mutual positive engagement, oxytocin levels also come into sync. Without such engagement, however, no oxytocin synchrony emerged (Feldman, Gordon, & Zagoory-Sharon, 2010).

Based on the aforementioned evidence from developmental science, I posit that biobehavioral synchrony is a third core element of love-the-emotion.

Pushing Emotion Science Further: A New Hybrid View

Distinct, albeit overlapping, views of love have emerged within the neighboring disciplines of emotion science, relationship science, and developmental science. Further integrating these views, I propose a new hybrid view that positions love as a momentary emotional phenomenon that is coexperienced by any two or more interacting people. Distilling to a formal definition, I define love-the-emotion as a *micro moment of positivity resonance*, during which three core elements—(1) shared positive emotion, (2) mutual care, and (3) biobehavioral synchrony—emerge with temporal coherence between and among people.

Departing from relationship science, love, as conceptualized here, is not an enduring or intimate relationship. In keeping, however, with the adaptationist logic of the broaden-and-build theory of positive emotions (Fredrickson, 1998, 2013b), micro moments of positivity resonance fertilize the growth of consequential personal and social resources, including enduring close and intimate relationships, as well as mental and physical health.

Taking a cue from relationship science, I also elevate micro moments of positivity resonance above the experiences of other positive emotions—that is, I hypothesize that positivity that resonates between and among people is particularly efficient for building consequential resources, relative to positive emotions that are experienced in isolation or absent the elements of mutual care and biobehavioral synchrony. Accordingly, I have called out love as "our supreme emotion" (Fredrickson, 2013a). This approach departs sharply from an unspoken tradition within emotion science, which implicitly take specific, discernable emotions—fear, anger, joy, and pride—as roughly equal-status categories, each holding value for human survival in its own way. Under this traditional logic, no emotion, love included, is set apart as on a different plane, or scale of importance. By contrast, relationship science unabashedly positions love relationships as distinct from other relationships and more consequential to human welfare. Likewise, for its ability to weave individuals into the social fabric of community, love-the-emotion may well be more consequential to human welfare than any other emotion.

Mileage Gained from the Concept of Positivity Resonance

Preconditions for Positivity Resonance

Micro moments of positivity resonance between and among people do not emerge at random, regardless of conditions. In this way, love is not unconditional. (I acknowledge that I deploy the term "unconditional" in a different manner than have humanistic psychologists.) Love's first precondition, I posit, is perceived safety. As for most positive emotions, momentary perceptions of safety appear to be an important prerequisite. When people appraise their current circumstances as somehow threatening or dangerous, the ability to share an experience of positivity resonance becomes highly improbable. Fortunately, true threats to safety are statistically rare: Most moments are benign (Oishi et al., 2007). Yet, unfortunately, many people do not experience the safety in which their lives are embedded. Those who suffer from anxiety, depression, loneliness, or low self-esteem, for instance, perceive threats far more often than their objective circumstances warrant (e.g., Cacioppo & Hawkley, 2009). This overalert state thwarts the emergence of all positive emotions, including love. More generally, the inability to experience safety in the company of others is a poignant obstacle to love.

Love's second precondition, I posit, is sensory connection. Neither abstract nor mediated, sensory connection is physical and unfolds in real time. It requires the copresence of bodies, through touch, voice, or visibly synchronized postures, gestures, or facial expressions. Arguably, however, the main mode of sensory connection is eye contact (Farroni, Csibra, Simion, & Johnson, 2002). Newborns, for instance, show an immediate preference for eye contact, as well as innate skills for establishing it with the adults who come into their visual range. Eye contact is also a gateway construct within the simulation of smiles (SIMS) model, articulated by Niedenthal and colleagues (Niedenthal, Mermillod, Maringer, & Hess, 2010). Making eye contact with someone who smiles, according to the SIMS model, triggers a rapid and nonconscious embodied simulation of that smile—through facial mimicry and neural activation—that implicitly functions to disambiguate the meaning of that smile. In support of the SIMS model, controlled laboratory experiments confirm that mutual eye gaze, relative to averted gaze, triggers facial mimicry to dynamic emotional stimuli (Schrammel, Pannasch, Graupner, Mojzisch, & Velichkovsky, 2009), and that facial mimicry enables more accurate decoding of the genuineness of dynamic smiles (Maringer, Krumhuber, Fischer, & Niedenthal, 2011). These processes may account infants' ability to detect inauthentic emotions (Walle & Campos, 2014). To the extent that eye contact during emotional episodes triggers embodied simulations, infants' prescient skills for making eye contact can be viewed as evolved adaptations that help infants wordlessly and accurately convey their evershifting emotional needs to engaged caregivers (Niedenthal et al., 2010). Through sensory connection, then, positive emotions "jump the gap" between people to become shared experiences of positivity resonance, marked biobehavioral synchrony, and mutual care.

Products of Positivity Resonance

Even though micro moments of positivity resonance are often mild and by definition fleeting, the accumulated frequency of these experiences over time builds a range of resources important to subjective, relational, and physical well-being. For instance, the experience of pleasure or "liking" precedes and lays the foundation for desire or "wanting" (Berridge, 2007). In the case of positivity resonance, the pleasure of feeling connected to a new romantic partner or "crush," assessed as self–other overlap (Aron et al., 1992), prospectively predicts the frequency of positive spontaneous thoughts about that person, which can serve to motivate subsequent efforts to reconnect (Rice, Schenker, & Fredrickson, 2014). Likewise, experiencing positivity resonance with the same person repeatedly over time builds trust and loyalty, social attitudes vital to successful friendships and community alliances. The recurrence of positivity resonance also seeds the motivation for secure attachments, social bonds, and more formal commitments to loyalty such as marriage (Cohn & Fredrickson, 2006; Brown & Brown, 2006). As stated previously, these enduring resources—desire, bonds, and commitments—are themselves identified as "love" in both scientific and lay writings. To increase scientific precision, I offer positivity resonance (love-the-emotion), as the recurrent biopsychosocial mechanisms, or "tiny engines," that drive a larger love system that also includes these more enduring products of positivity resonance.

Evidence for Positivity Resonance

A range of converging evidence inspired me to formulate the concept of positivity resonance and articulate key hypotheses about it. Within my own laboratory, the work of Tanya Vacharkulksemsuk has been foundational (Vacharkulksemsuk & Fredrickson, 2012). She and I studied pairs of previously unacquainted dyads that we had randomly assigned to complete one of two interaction tasks, which we videotaped: either a variant of Aron's self-disclosure induction paradigm (Aron, Melinat, Aron, Vallone, & Bator, 1997), or a neutral, collaborative proofreading task. Trained coders later viewed the muted video recordings and rated the extent of simultaneous movement, tempo similarity, and coordination and smoothness in the dyad's nonverbal behaviors, which we then summed into an aggregate index of behavioral synchrony. We learned that the physical and dynamic property of behavioral synchrony mediated the association between self-disclosure condition and subsequent reports of embodied rapport, even when controlling for reports of positive emotion (Vacharkulksemsuk & Fredrickson, 2012). Our evidence for the importance of naturally occurring behavioral synchrony complements research that has manipulated behavioral synchrony to show that it breeds affiliation (Hove & Risen, 2009), cooperation (Wiltermuth & Heath, 2009), and compassion (Valdesolo & DeSteno, 2011).

Going beyond behavioral synchrony—and unseen within ordinary interactions—is the biological synchrony that emerges when two or more people share a positive emotional state. As previously mentioned, oxytocin synchrony arises during positive interactions within parent–infant dyads (Feldman et al., 2010). More compelling still is evidence from recent neuroimaging studies that show widespread neural synchrony within dyads and groups sharing a positive emotional experience (Hasson, 2010; Hasson, Nir, Levy, Fuhrmann, & Malach, 2004; Stephens, Silbert, & Hasson, 2010). It appears, then, that when people share a positive emotional state, they also share gestural, biochemical, and neural patterns. This momentary biobehavioral synchrony unifies the interacting individuals within a shared experience of positive resonance.

Two additional streams of evidence also contributed to my theorizing on love. First, a longstanding body of prospective studies shows that having diverse and rewarding social relationships robustly forecasts better physical health and greater longevity. For instance, a recent meta-analysis of 148 studies concludes that the influence of social integration on mortality risk is on par with that of other, well-established health risk factors, including smoking, excessive alcohol intake, obesity, and lack of physical exercise (Holt-Lunstad, Smith, & Layton, 2010). Second, conspicuously similar prospective evidence links the frequent experience of positive emotions to living longer and healthier lives (see Chida & Steptoe, 2008; Howell, Kern, & Lyubomirsky, 2007, for meta-analytic reviews). Uniting these two streams of evidence, recent work from my laboratory shows that perceived positive social connections—a proxy measure of positivity resonance—accounts for the relationship between positive emotions and physical health (Kok et al., 2013). Specifically, people's daily experiences of feeling "close" and "in tune" with their social interaction partners mediated the effect of an experimental intervention that taught study participants how to self-generate positive emotions (via loving-kindness meditation; see also Fredrickson et al., 2008) on improvements in cardiac vagal tone, a proxy measure of physical health. Thus, it appears that when people's efforts to cultivate positive emotions culminate in experiences of day-to-day positivity resonance with others, they incur particular boosts to their physical health. Much like our day-to-day habits of being physically active and eating nutritious foods, our day-to-day habits of cultivating positivity resonance with others may well function as positive health behaviors.

Research Agenda

Research on the concept of positivity resonance remains scant, to be sure. As such, opportunities abound to test and refine this new definition of love. Key to the success of this work will be the development of valid and reliable measures of positivity resonance that honor its momentary and multifaceted nature. Although self-report measures may capture the phenomenological aspects of positivity resonance, nonverbal behavioral and biological measures with appropriate temporal resolution gathered from interacting dyads will also be essential. In addition, longitudinal research will be needed to test the claim that positivity resonance merits elevation above other positive emotions in its ability to augment well-being and physical health. Longitudinal and dynamic statistical modeling may be especially relevant tools as this research area matures.

Theoretical Implications

What good is a smile? What is it for? Although a range of past theorists have addressed these questions, the new concept of positivity resonance offers a fresh take on the evolved adaptive function of spontaneous and genuine smiles—what have been termed "Duchenne smiles" in the research literature. Following Charles Darwin (1872/1998), Ekman and colleagues contend that such smiles evolved as an outward expression or readout of a person's otherwise unseen inner subjective state (Ekman, Davidson, & Friesen, 1990). An opposing view shifts the focus onto the recipient of a smile, and proposes that smiles evolved not because they provided readouts of positive emotional states, but instead because they evoked positive emotions in those who meet a smiling person's gaze (Owren & Bachorowski, 2003; see also Gervais & Wilson, 2005). Maintaining the focus on the person who meets the smiler's gaze, the embodied cognition perspective of the SIMS model suggests that, through neural simulation, smiles tune an observer toward a better understanding the smiler's subjective experience and motives, so that the perceiver can, for instance, disambiguate sincere affiliative bids from domineering or self-absorbed smiles (Niedenthal et al., 2010). Each of these accounts of the function of genuine smiles seems viable, although each remains incomplete by remaining anchored too exclusively within a one-person psychology (focused *either* on the one person who smiles *or* the one person who witnesses a smile).

Stepping up to a two-person psychology, in which both the smiling individual and the smile recipient play equal and important roles, I propose that the function of at least a subset of Duchenne smiles is "all of the above" and then some. Specifically, the adaptive significance of a genuine, affiliative smile may be to create a momentarily unified mind-set between two people, or intersubjectivity, that is characterized by positivity resonance, as reflected by the trio of love's features: a now shared positive emotion, biobehavioral synchrony, and an orientation toward mutual care. Research documents that a smile draws our eye more than any other facial expression (Becker, Anderson, Mortensen, Neufeld, & Neel, 2011). As we have seen, eye contact nonconsciously triggers facial mimicry (Schrammel et al., 2009), which in turn triggers neural simulation (Niedenthal et al., 2010). When the original smile emanates from a sincere affiliative bid, the momentary intersubjectivity created by neural synchrony will include orientations toward mutual care and responsivity. In short, the evolved adaptive significance of genuine affiliative smiles may be to seed states of positivity resonance. Harkening back to the broaden-and-build theory (Fredrickson, 1998, 2013b), to the extent that positivity resonance builds consequential personal and social resources, genuine affiliative smiles may have evolved to spur positive psychosocial development and improved physical health in individuals, relationships, and indeed, whole communities. Casting love as a micro moment of positivity resonance, then, offers a detailed evolutionary perspective on how genuine smiles can seed the life-enhancing states of positivity resonance and thus do good, both within the body and within society.

Conclusions

Love, defined as micro moments of positivity resonance, may thus be the most generative and consequential of all positive emotions. By virtue of being a single state, distributed across and reverberating between two or more brains and bodies at once, love's ability to broaden mind-sets and build resources may have substantially greater reach. Love, then, is not simply another positive emotion. Rather, it is the momentary phenomenon through which we feel and become part of something larger than ourselves. Meaning in life may thus emerge not from the grand and unrealistic utopian ideals of "happily-ever-after" love, but from what art historian Nicholas Bourriaud (1998) calls the "day-to-day micro-utopias" of shared positivity.

Seeing love as positivity resonance also blurs the boundaries that surround the concept of emotion. Many, if not most, scientific descriptions of emotions locate these affective phenomena within individuals, confined within one person's mind and skin. By contrast, the concept of positivity resonance aligns with perspectives offered within cultural psychology that position emotions as unfolding between and among people as they interact (e.g., Mesquita, 2001). Seeing emotions as properties of individuals may indeed be a myopic by-product of the Western tendency to perceptually extract focal objects from their contextual surround (e.g., Masuda & Nisbett, 2001). By contrast, positioning love as a dynamic process that unfurls across and unifies two or more interacting individuals offers parsimony to accounts of the social and societal functions of positive emotions.

Seeing love as positivity resonance also holds practical implications for how people might strengthen their relationships, families, and communities. Striving to improve these directly can be like telling a complete stranger "trust me" in the absence of any trustworthy actions. By contrast, knowing that relationships, families, and communities grow stronger to the extent that positivity resonates between and among people reveals the value of planning for and prioritizing positivity. Creating activities and safe contexts that allow real-time sensory connection and support the emergence of shared positive emotions becomes the pathway to build social bonds and community. This guidance may be especially valuable within contemporary urban cultures that propel people toward multitasking and technology-mediated social connections. As novelist Ursula Le Guin (1971) put it, "Love doesn't just sit there, like a stone; it has to be made, like bread; remade all the time, made new."

NOTES

1. Even so, scientific investigations of love have been stifled by controversy. It took courage and creativity, for instance, for social psychologists Ellen Berscheid and Elaine Hatfield to sustain their pioneering efforts to study romantic love in the face of what has come to be called "l'affaire Proxmire" (Reis, 2012). This refers to the 1974 debacle in which Wisconsin senator William Proxmire singled out Berscheid and Hatfield's NSF-sponsored research on love for his first of many Golden Fleece Awards, bestowed to highlight what he deemed to be outrageous and shamefully wasteful uses of federal tax dollars.
2. For simplicity I describe love-the-emotion as a property of dyads. Importantly, I see it as equally able to account for communal experiences of shared positivity, or what Haidt and colleagues refer to as an innate *hive psychology* that periodically propels humans to lose themselves enjoyably in a much larger social organism, like the crowd at a football game, music festival, or religious revival (Haidt, Seder, & Kesebir, 2008). Through physical copresence and behavioral synchrony, love-the-emotion can thus also spread from dyads to whole crowds or communities (e.g., Fowler & Christakis, 2008).

REFERENCES

Acevedo, B. P., Aron, A., Fisher, H. E., & Brown, L. L. (2011). Neural correlates of long-term intense romantic love. *Social Cognitive and Affective Neuroscience, 7*, 145–159.

Ainsworth, M. D. S. (1985). Attachments across the lifespan. *Bulletin of the New York Academy of Medicine, 61*, 792–812.

Ainsworth, M. D. S., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of attachment: A psychological study of the Strange Situation*. Hillsdale, NJ: Erlbaum.

Algoe, S. B., Fredrickson, B. L., & Gable, S. L. (2013). The social functions of the emotion of gratitude via expression. *Emotion, 13*, 605–609.

Aron, A., Aron, E. N., & Smollan, D. (1992). Inclusion of other in the Self Scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology, 63*, 516–612.

Aron, A., Melinat, E., Aron, E. N., Vallone, R. D., & Bator, R. J. (1997). The experimental generation of interpersonal closeness: A procedure and some preliminary findings. *Personality and Social Psychology Bulletin, 23*, 363.

Bartholomew, K., & Horowitz, L. M. (1991). Attachment styles among young adults: A test of a four-category model. *Journal of Personality and Social Psychology, 61*, 226–244.

Becker, D. V., Anderson, U. S., Mortensen, C. R., Neufeld, S. L., & Neel, R. (2011). The face in the crowd effect unconfounded: Happy faces, not angry faces, are more efficiently detected in single- and multiple-target visual search tasks. *Journal of Experimental Psychology: General, 140*, 637–659.

Beebe, B., Sorter, D., Rustin, J., & Knoblauch, S. (2003). A comparison of Meltzoff, Trevarthen, and Stern. *Psychoanalytic Dialogues, 13*, 777–804.

Berridge, K. C. (2007). The debate over dopamine's role in reward: The case for incentive salience. *Psychopharmacology, 191*, 391–431.

Berscheid, E. (2010). Love in the fourth dimension. *Annual Review of Psychology, 61*, 1–25.

Bourriaud, N. (1998). *Relational aesthetics*. Dijon, France: Less Presses du reel.

Bowlby, J. (1982). *Attachment and loss: Vol 1. Attachment*. New York: Basic Books. (Original work published 1969)

Brown, S. L., & Brown, R. M. (2006). Selective investment theory: Recasting the functional significance of close relationships. *Psychological Inquiry, 17*, 1–29.

Cacioppo, J. T., & Hawkley, L. C. (2009). Perceived social isolation and cognition. *Trends in Cognitive Sciences, 13*, 447–454.

Chida, Y., & Steptoe, A. (2008). Positive psychological well-being and mortality: A quantitative review of prospective observational studies. *Psychosomatic Medicine, 70*, 741–756.

Clark, M., & Mills, J. (1979). Interpersonal attraction in exchange and communal relationships. *Journal of Personality and Social Psychology, 37*, 12–24.

Clark, M. S., & Monin, J. K. (2006). Giving and receiving communal responsiveness as love. In R. J. Sternberg & K. Weis (Eds.), *The new psychology of love* (pp. 200–224). New Haven, CT: Yale University Press.

Cohn, M. A., & Fredrickson, B. L. (2006). Beyond the moment, beyond the self: Shared ground between selective investment theory and the broaden-and-build theory of positive emotions. *Psychological Inquiry, 17*, 39–44.

Cohn, M. A., Fredrickson, B. L., Brown, S. L., Mikels, J. A., & Conway, A. M. (2009). Happiness unpacked: Positive emotions increase life satisfaction by building resilience. *Emotion, 9*, 361–368.

Darwin, C. (1998). *The expression of the emotions in man and animals*. New York: Oxford University Press. (Original work published 1872)

Davidson, R. J. (2000). Affective style, psychopathology, and resilience: Brain mechanisms and plasticity. *American Psychologist, 55*, 1196–1214.

Diener, E., Sandvik, E., & Pavot, W. (1991). Happiness is the frequency, not the intensity, of positive versus negative affect. In F. Strack, M. Argyle, & N. Schwarz (Eds.), *Subjective well-being: An interdisciplinary perspective* (pp. 119–139). Elmsford, NY: Pergamon Press.

Ekas, N. V., Haltigan, J. D., & Messinger, D. S. (2013). The dynamic still-face effect: Do infants decrease bidding over time when parents are not responsive? *Developmental Psychology, 49*, 1027–1035.

Ekman, P., Davidson, R. J., & Friesen, W. V. (1990). The

Duchenne smile: Emotional expression and brain physiology II. *Journal of Personality and Social Psychology, 58*, 342–353.

Ellsworth, P. C., & Smith, C. A. (1988). Shades of joy: Patterns of appraisal differentiating pleasant emotions. *Cognition and Emotion, 2*, 301–331.

Farroni, T., Csibra, G., Simion, F., & Johnson, M. H. (2002). Eye contact detection in humans from birth. *Proceedings of the National Academy of Sciences of the United States of America, 99*, 9602–9605.

Fehr, B. (1988). Prototype analysis of the concepts of love and commitment. *Journal of Personality and Social Psychology, 55*, 557–579.

Fehr, B., & Russell, J. A. (1991). The concept of love viewed from a prototype perspective. *Journal of Personality and Social Psychology, 60*, 425–438.

Fehr, B., Sprecher, S., & Underwood, L. G. (2008). *The science of compassionate love: Theory, research, and applications.* New York: Wiley-Blackwell.

Feldman, R. (2007). Parent–infant synchrony and the construction of shared timing: Physiological precursors, developmental outcomes, and risk conditions. *Journal of Child Psychology and Psychiatry, 48*, 329–354.

Feldman, R., Gordon, I., & Zagoory-Sharon, O. (2010). The cross-generation transmission of oxytocin in humans. *Hormones and Behavior, 58*, 669–676.

Fisher, H. E., Aron, A. A., Mashek, D., Li, H., & Brown, L. L. (2002). Defining the brain systems of lust, romantic attraction, and attachment. *Archives of Sexual Behavior, 31*, 413–419.

Folkman, S. (1997). Positive psychological states and coping with severe stress. *Social Science and Medicine, 45*, 1207–1221.

Fowler, J. H., & Christakis, N. A. (2008). Dynamic spread of happiness in a large social network: Longitudinal analysis over 20 years in the Framingham Heart Study. *BMJ, 337*, a2338.

Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology, 2*, 300–319.

Fredrickson, B. L. (2009). *Positivity.* New York: Three Rivers Press.

Fredrickson, B. L. (2013a). *Love 2.0.* New York: Plume.

Fredrickson, B. L. (2013b). Positive emotions broaden and build. In E. Ashby Plant & P. G. Devine (Eds.), *Advances in experimental social psychology* (pp. 1–53). Burlington, VT: Academic Press.

Fredrickson, B. L., Cohn, M. A., Coffey, K. A., Pek, J., & Finkel, S. M. (2008). Open hearts build lives: Positive emotions, induced through loving-kindness meditation, build consequential personal resources. *Journal of Personality and Social Psychology, 95*, 1045–1062.

Gable, S. L., Gonzaga, G. C., & Strachman, A. (2006). Will you be there for me when things go right?: Supportive responses to positive event disclosures. *Journal of Personality and Social Psychology, 91*, 904–917.

Gervais, M., & Wilson, D. S. (2005). The evolution and functions of laughter and humor: A synthetic approach. *Quarterly Review of Biology, 80*, 395–430.

Gonzaga, G. C., Keltner, D., Londahl, E. A., & Smith, M. D. (2001). Love and the commitment problem in romantic relations and friendship. *Journal of Personality and Social Psychology, 81*, 247–262.

Haidt, J., Seder, P., & Kesebir, S. (2008). Hive psychology, happiness, and public policy. *Journal of Legal Studies, 37*, S133–S156.

Harlow, H. F. (1958). The nature of love. *American Psychologist, 13*, 673–685.

Hasson, U. (2010). I can make your brain look like mine. *Harvard Business Review, 88*, 32–33.

Hasson, U., Nir, Y., Levy, I., Fuhrmann, G., & Malach, R. (2004). Intersubject synchronization of cortical activity during natural vision. *Science, 303*, 1634–1640.

Hatfield, E., & Rapson, R. (1993). Love and attachment processes. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 595–604). New York: Guilford Press.

Hazan, C., & Shaver, P. (1987). Romantic love conceptualized as an attachment process. *Journal of Personality and Social Psychology, 52*, 511–524.

Heaphy, E. D., & Dutton, J. E. (2008). Positive social interactions and the human body at work: Linking organizations and physiology. *Academy of Management Review, 33*, 137–162.

Hegi, K. E., & Bergner, R. M. (2010). What is love?: An empirically-based essentialist account. *Journal of Social and Personal Relationships, 27*, 620–636.

Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine, 7*, e1000316.

Hove, M. J., & Risen, J. L. (2009). It's all in the timing: Interpersonal synchrony increases affiliation. *Social Cognition, 27*, 949–960.

Howell, R. T., Kern, M. L., & Lyubomirsky, S. (2007). Health benefits: Meta-analytically determining the impact of well-being on objective health outcomes. *Health Psychology Review, 1*, 1–54.

Isen, A. M. (1993). Positive affect and decision making. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 261–277). New York: Guilford Press.

Izard, C. E. (1977). *Human emotions.* New York: Plenum Press.

Kok, B. E., Coffey, K. A., Cohn, M. A., Catalino, L. I., Vacharkulksemsuk, T., Algoe, S. B., et al. (2013). How positive emotions build physical health: Perceived positive social connections account for the upward spiral between positive emotions and vagal tone. *Psychological Science, 24*, 1123–1132.

Laurenceau, J.-P., Barrett, L. F., & Pietromonaco, P. R. (1998). Intimacy as an interpersonal process: The importance of self-disclosure, partner disclosure, and perceived partner responsiveness in interpersonal exchanges. *Journal of Personality and Social Psychology, 74*, 1238–1251.

Lazarus, R. S. (1991). *Emotion and adaptation.* New York: Oxford University Press.

Le Guin, U. K. (1971). *The lathe of heaven: A novel.* New York: Scribner.

Maringer, M., Krumhuber, E. G., Fischer, A. H., & Niedenthal, P. M. (2011). Beyond smile dynamics: Mimicry and beliefs in judgments of smiles. *Emotion, 11*, 181–187.

Masuda, T., & Nisbett, R. E. (2001). Attending holistically versus analytically: Comparing the context sensitivity of Japanese and Americans. *Journal of Personality and Social Psychology, 81*, 922–934.

Meltzoff, A. N., & Moore, M. K. (1989). Imitation in newborns: Exploring the range of gestures imitated and the underlying mechanisms. *Developmental Psychology, 25*, 954–962.

Mesquita, B. (2001). Emotions in collectivist and individualist contexts. *Journal of Personality and Social Psychology, 80*, 68–74.

Mikulincer, M., Shaver, P. R., Sapir-Lavid, Y., & Avihou-Kanza, N. (2009). What's inside the minds of securely and insecurely attached people?: The secure-base script and its associations with attachment-style dimensions. *Journal of Personality and Social Psychology, 97*, 615–633.

Moskowitz, J. T. (2003). Positive affect predicts lower risk of AIDS mortality. *Psychosomatic Medicine, 65*, 620–626.

Niedenthal, P. M., Mermillod, M., Maringer, M., & Hess, U. (2010). The simulation of smiles (SIMS) model: Embodied simulation and the meaning of facial expression. *Behavioral and Brain Sciences, 33*, 417–480.

Oishi, S., Schimmack, U., Diener, E., Kim-Prieto, C., Scollon, C. N., & Choi, D.-W. (2007). The value-congruence model of memory for emotional experiences: An explanation for cultural differences in emotional self-reports. *Journal of Personality and Social Psychology, 93*, 897–905.

Owren, M. J., & Bachorowski, J. (2003). Reconsidering the evolution of nonlinguistic communication: The case of laughter. *Journal of Nonverbal Behavior, 27*, 183–200.

Reis, H. T. (2012). A history of relationship research in social psychology. In A. W. Kruglanski & W. Stroebe (Eds.), *Handbook of the history of social psychology* (pp. 363–382). New York: Psychology Press.

Reis, H. T., Clark, M. S., & Holmes, J. G. (2004). Perceived partner responsiveness as an organizing construct in the study of intimacy and closeness. In D. Mashek & A. Aron (Eds.), *Handbook of closeness and intimacy* (pp. 201–225). Mahwah, NJ: Erlbaum.

Rempel, J. K., & Burris, C. T. (2005). Let me count the ways: An integrative theory of love and hate. *Personal Relationships, 12*, 297–313.

Rice, E. L., Schenker, V. J., & Fredrickson, B. L. (2014). *Positive spontaneous thoughts about romance*. Unpublished raw data.

Schrammel, F., Pannasch, S., Graupner, S.-T., Mojzisch, A., & Velichkovsky, B. M. (2009). Virtual friend or threat?: The effects of facial expression and gaze interaction on psychophysiological responses and emotional experience. *Psychophysiology, 46*, 922–931.

Selcuk, E., & Ong, A. D. (2013). Perceived partner responsiveness moderates the association between received emotional support and all-cause mortality. *Health Psychology, 32*, 231–235.

Shaver, P., Schwartz, J., Kirson, D., & O'Connor, C. (1987). Emotion knowledge: Further exploration of a prototype approach. *Journal of Personality and Social Psychology, 52*, 1061–1086.

Shaver, P. R., Morgan, H. J., & Wu, S. (1996). Is love a "basic" emotion? *Personal Relationships, 3*, 81–96.

Siegel, D. (2001). Toward an interpersonal neurobiology of the developing mind: Attachment relationships, "mindsight," and neural integration. *Infant Mental Health Journal, 22*, 67–94.

Singer, I. (1984). *The nature of love: Vol. 1. From Plato to Luther* (2nd ed.). Chicago: University of Chicago Press.

Stephens, G. J., Silbert, L. J., & Hasson, U. (2010). Speaker–listener neural coupling underlies successful communication. *Proceedings of the National Academy of Sciences, 107*, 14425–14430.

Stephens, J. P., Heaphy, E., & Dutton, J. (2011). High quality connections. In K. Cameron & G. Spreitzer (Eds.), *The Oxford handbook of positive organizational scholarship* (pp. 385–399). New York: Oxford University Press.

Stern, D. (1985). *The interpersonal world of the infant*. New York: Basic Books.

Stern, D. (2008). The clinical relevance of infancy: A progress report. *Infant Mental Health Journal, 29*, 177–188.

Sternberg, R. J. (1986). A triangular theory of love. *Psychological Review, 93*, 119–135.

Tickle-Degnen, L., & Rosenthal, R. (1990). The nature of rapport and its nonverbal correlates. *Psychological Inquiry, 1*, 285–293.

Trevarthen, C. (1998). The concept and foundations of infant intersubjectivity. In S. Braten (Ed.), *Intersubjective communication and emotion in early ontogeny* (pp. 15–46). Cambridge, UK: Cambridge University Press.

Vacharkulksemsuk, T., & Fredrickson, B. L. (2012). Strangers in sync: Achieving embodied rapport through shared movements. *Journal of Experimental Social Psychology, 48*, 399–402.

Valdesolo, P., & DeSteno, D. (2011). Synchrony and the social tuning of compassion. *Emotion, 11*, 262–266.

Walle, E. A., & Campos, J. J. (2014). The development of infant detection of inauthentic emotion. *Emotion, 14*(3), 488–503.

Waugh, C. E., & Fredrickson, B. L. (2006). Nice to know you: Positive emotions, self-other overlap, and complex understanding in the formation of a new relationship. *Journal of Positive Psychology, 1*, 93–106.

Wiltermuth, S. S., & Heath, C. (2009). Synchrony and cooperation. *Psychological Science, 20*, 1–5.

CHAPTER 49

Sadness and Depression

Christian A. Webb and Diego A. Pizzagalli

Differentiating Sadness and Depression

The term "depression," in common parlance, is frequently used to describe the emotional experience of sadness. However, *clinical depression* refers to a specific psychiatric disorder (i.e., major depressive disorder [MDD]) characterized by a constellation of affective, behavioral, and cognitive symptoms, as well as significant impairments in functioning. According to the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013, pp. 160–161), a major depressive episode (MDE) is defined as experiencing at least five of the following symptoms for a minimum of 2 weeks (either symptom 1 or 2 must be present): (1) depressed mood; (2) diminished pleasure or interest (i.e., *anhedonia*); (3) significant change in weight or appetite; (4) insomnia or hypersomnia; (5) psychomotor agitation or retardation; (6) fatigue or loss of energy; (7) feelings of worthlessness or excessive or inappropriate guilt; (8) difficulties thinking, concentrating, or indecisiveness; and (9) recurrent thoughts of death, or suicidal ideation or actions.

As noted in the DSM-5 (American Psychiatric Association, 2013), "the mood in a major depressive episode is often described by the person as depressed, sad, hopeless, discouraged, or 'down in the dumps'" (p. 163). Although it may overlap with the depressed mood symptom of MDD, sadness—even if intense and prolonged—is not sufficient, in and of itself, to warrant a DSM diagnosis of depression. Indeed, sadness is a normative human emotion, typically experienced in response to the perception of loss or defeat (Beck & Alford, 2009; Ekman, 2007). Moreover, DSM criteria do not require sadness or a depressed mood to be present for a diagnosis of MDD. Like sadness, most MDEs are associated with stressful life events (often with themes of loss or defeat) as preceding, and arguably triggering, the onset of the episode (Hammen, 2005).

Evolutionary Accounts of Sadness and Depression

The apparent universality of basic emotions—including fear, anger, sadness, disgust, surprise, and joy/happiness—have led a number of scholars and evolutionary psychologists to theorize about the adaptive function of these emotions. According to Tooby and Cosmides (2008), emotions function as a "superordinate program" that

> direct the activities and interactions of the subprograms governing perception; attention; inference; learning; memory; goal choice; motivational priorities; categorization and conceptual frameworks; physiological reactions (such as heart rate, endocrine function, immune function); . . . affective coloration of events and stimuli; recalibration of probability estimates, situation assessments, values, and regulatory variables (e.g., self-esteem, . . . , relative value of alternative goal states, efficacy discount rate); and so on (p. 118)

The adaptive function of fear, for example, has been extensively discussed (e.g., see Sapolsky, 2004). Fear is typically triggered by the perception of imminent threat and is associated with a cascade of adaptive physiological "fight-or-flight" reactions (e.g., pupil dilation, increased heart rate, vasoconstriction). Ultimately, these biological processes facilitate and culminate in a survival-increasing behavioral, fight-or-flight response to the threat.

In contrast to the case of fear, a clear-cut evolutionary account of the adaptive function of sadness has proved more elusive. A consideration of the common situational triggers of sadness has informed ideas about what may be its adaptive function(s). The emotion of sadness is commonly triggered by perceptions of loss or defeat (Beck & Alford, 2009; Ekman, 2007). It has been argued that the state of sadness may facilitate deliberation, aid in the reevaluation of goals, and motivate individuals to change their life circumstances in adaptive ways in the face of such stressful or negative life events (Carver, 2004; Keller & Nesse, 2006; Tiedens & Linton, 2001). Moreover, the visible manifestation of sadness, in particular crying, may elicit compassion and aid from others (Nettle, 2004; Vingerhoets & Cornelius, 2001).

A bolder, and perhaps more controversial, claim is that depression itself is an evolutionary adaptation. The relatively high prevalence rate of MDD (see the section "Epidemiology of Depression") raises the following question: Given the myriad ways depression seems to reduce Darwinian fitness, why is it so prevalent and heritable? A number of researchers have argued that depression does serve an adaptive function, and that many diagnoses of MDD are erroneous and overpathologizing an adaptive state (e.g., see Andrews & Thomson, 2009; Horwitz & Wakefield, 2007). Indeed, the relatively high prevalence rate of DSM-defined MDD reported in nationally representative epidemiological studies is striking, and has inspired arguments regarding the adaptive function of what is currently classified as a disorder.

A range of theories have been proposed regarding the adaptive function of depression, including that depressive symptomatology (1) helps to promote the conservation of energy and resources, in particular reducing unproductive investment in unrealistic goals (e.g., Engel, 1980; Nesse, 2000); (2) facilitates the sustained analysis of the precipitant problem(s) (*analytical rumination hypothesis*; Andrews & Thomson, 2009) or aids in the analysis of complex social problems (*social navigation hypothesis*; Watson & Andrews, 2002); (3) reduces the risk of social losses and exclusion (*social risk hypothesis*; Allen & Badcock, 2003); (4) signals submissiveness in the face of a loss of status and facilitates the de-escalation of conflict (*social competition hypothesis*; Price, Sloman, Gardner, Gilbert, & Rohde, 1994); and (5) is associated with a suite of immunological and behavioral responses that reduce immune system vulnerability and risk of infection (Anders, Tanaka, & Kinney, 2013).

Depression is a complex and heterogeneous syndrome, and it is not always clear whether evolutionary theories are referring to sadness or clinical depression, and if the latter, what specific symptoms of depression. Indeed, distinctions have been made in the clinical literature between different subtypes of depressive symptom profiles (e.g., melancholic and atypical depression) and differences in the categories of stressors or events that trigger the episode (e.g., bereavement, seasonal affective disorder), as well as in vulnerability to different kinds of life stressors (e.g., sociotropic vs. autonomous individuals; Liu & Alloy, 2010). Yet, evolutionary accounts of depression often treat the disorder as a seemingly unitary construct. Some evolutionary theorists have attempted to parse the heterogeneity of depressive symptom profiles. For example, Keller and Nesse (2006) provided data indicating that different categories of negative events (e.g., social losses vs. failed efforts) trigger distinct patterns of depressive symptoms, which may be uniquely suited to the adaptive challenges specific to those triggering events (i.e., the *situation–symptom congruence hypothesis*).

Of course, the cognitive (e.g., distorted and entrenched pessimistic cognitions, consuming rumination, suicidal ideation), behavioral (e.g., suicidal actions, poor hygiene, social isolation, and withdrawal from daily activities), and affective (e.g., extreme anhedonia) symptoms associated with higher-severity cases of depressive symptomatology seem more challenging to label as adaptive. However, these may be exceptions to the rule—that is, sadness, and perhaps many cases of DSM-defined MDD, may indeed serve adaptive functions. However, more extreme cases may represent evolved mechanisms that have become dysregulated, as any evolved bodily system or organ is susceptible to malfunction. It will be important for future investigations of the possible adaptive function of depression to carefully consider the heterogeneity of depressive symptom presentations, and to devise meaningful tests of the various above-mentioned hypotheses.

Epidemiology of Depression

Prevalence

Epidemiological studies over the past three decades indicate that the point prevalence (i.e., the prevalence of the disorder at any one point in time) of MDD is approximately 2% in childhood and 5–8% in adulthood (Costello, Erkanli, & Angold, 2006; Kessler, Birnbaum, Shahly, Bromet, Hwang, et al., 2010). With regard to 12-month prevalence, the large, nationally representative National Comorbidity Survey—Replication (NCS-R) study reported that 6.7% of Americans met criteria for at least one MDE in the 12 months preceding the survey (Kessler, Chiu, Demler, & Walters, 2005). Estimates of the lifetime prevalence of MDD vary widely across studies, ranging from 6 (Weissman, Bruce, Leaf, Florio, & Holzer, 1991) to 25% (Lewinsohn, Hops, Roberts, Seeley, & Andrews, 1993). The NCS-R estimated the lifetime prevalence rate of MDD to be 16.6% (Kessler, Berglund, Demler, Jin, Merikangas, & Walters, 2005).

Age of Onset and Gender Differences

One of the striking findings regarding depression is the extent to which depression rates surge during adolescence. Cross-sectional studies suggest that the lifetime prevalence rate of depression is quite low in preadolescent school-age children (< 3%; e.g., Costello, Angold, Burns, Erkanli, Stangl, et al., 1996). However, the prevalence rate in older adolescents (15- to 18-year-olds) is significantly higher and similar to those found in adults (approximately 14%; Kessler, McGonagle, Zhao, et al., 1994). Of course, it is challenging to draw strong conclusions from cross-sectional studies regarding whether depression rates increase as a function of age (i.e., an *age effect*). Fortunately, prospective, longitudinal studies have been conducted that have tracked the prevalence rates of depression within the same sample as they age. Several longitudinal studies have confirmed that the prevalence rate of clinical depression is relatively low in childhood (i.e., 1–3%), but begins to increase during the transition from early to middle adolescence (i.e., ages 12–15) and rises significantly from middle to late adolescence (i.e., ages 15–18), reaching levels similar to those observed throughout adulthood (i.e., approximately 17%; e.g., Costello, Mustillo, Erkanli, Keller, & Angold, 2003; Hankin, Abramson, Moffitt, Silva, McGee et al., 1998; Reinherz, Giaconia, Lefkowitz, & Pakiz, 1993). In addition, during the transition from early to middle adolescence (i.e., ages 12–15), gender differences in depression rates emerge, with females beginning to report increasingly higher levels of depression than males (e.g., Hankin et al., 1998). By middle adolescence, females are twice as likely as males to report clinically significant depressive episodes and this 2:1 female-to-male ratio persists throughout adulthood.

Course

The course of depressive episodes is highly variable. However, the majority of individuals do recover within the first year (e.g., Keller, Lavori, Mueller, Endicott, Coryell, et al., 1992), with one study finding a median time to recovery of 6 weeks (Kendler, Walters, & Kessler, 1997). At the same time, a proportion of patients experience chronic, longer-term episodes. For example, the large, prospective National Institute of Mental Health's (NIMH) Collaborative Depression Study (CDS; Katz & Klerman, 1979) found that 12% of depressed individuals had not yet recovered at the 5-year follow-up (Keller et al., 1992), 7% were deemed unrecovered at the 10-year follow-up (Mueller, Keller, Leon, Solomon, Shea, et al., 1996), and 6% had yet to recover at the 15-year follow-up (Keller & Boland, 1998). In addition, among those who have experienced an MDE, rates of recurrence are exceedingly common, with approximately 80% having a recurrent episode (Kessler, Berglund, Demler, Jin, Koretz, et al., 2003). Moreover, data suggest that the risk of recurrence increases (by approximately 16%) with each successive episode (Boland & Keller, 2009). These findings highlight the importance of treatments not only reducing current depressive symptoms but also the risk of future depression relapse.

Cognitive Biases in Depression and Sadness

A growing body of research has uncovered a range of *cognitive biases* in depression, which influence various phases of information processing (e.g., biases in attention, interpretation, memory; Gotlib & Joormann, 2010). Indeed, cognitive-behavioral therapy (CBT), an empirically validated treatment for depression, is rooted in the cognitive model of depression (Beck, Rush, Shaw, & Emery, 1979), and in teaching patients the skills to identify and modify depressogenic biases in thinking and maladaptive information processing strategies. Below we review several of the major domains of cognitive biases in depression, and discuss the extent to which these biases are also observed in naturally occuring or induced sadness in nondepressed individuals.

Attentional Biases

Biased attention toward depressogenic stimuli represents one of the core elements of Beck's (2008) cognitive model of depression. A number of different paradigms have been employed to test whether depressed inviduals exhibit greater attentional biases toward negative information relative to healthy, nondepressed individuals. The most common paradigms are attentional allocation paradigms, such as the dot-probe task, the "emotional" Stroop task, and eye-tracking paradigms.

In the typical dot-probe task, pairs of stimuli (words or faces) are presented simultaneously. One of the stimuli is neutral, whereas the other is emotional (e.g., a sad or threat-related stimuli). A dot probe then replaces one of the preceding stimuli. Participants are asked to indicate the spatial location of the probe via button press. Response latencies to the probe are used as a measure of attentional bias. Specifically, a briefer latency in identifying the probe replacing the depressotypic stimuli is typically interpreted as reflecting early (automatic) attentional allocation to such stimuli. For example, Mogg, Bradley, and Williams (1995) administered a dot-probe task involving word pairs, half of which were presented supraliminally and half subliminally. The study found that depressed participants, relative to healthy participants, exhibited an attentional bias toward negative words, but only if the words were presented supraliminally. Subsequently, Bradley, Mogg, and Lee (1997) reported a similar mood-congruent attentional bias on the dot-probe task for both induced and naturally occuring dysphoria, but only when words were presented for 500 or 1,000 milliseconds (not in the 14 milliseconds masked exposure condition). The latter findings suggest that mood-congruent attentional biases may not be restricted to those who meet MDD criteria, but can be observed following sad mood induction in nondepressed individuals (but see Chepenik, Cornew, & Farah, 2007).

Attentional biases in depression are not restricted to word stimuli but also emerge for emotional faces. For example, Gotlib, Krasnoperova, Yue, and Joormann (2004) administered a pictorial variant of the dot-probe task involving the presentation of pairs of faces (sad, angry, happy, and neutral expressions) for 1,000 milliseconds. The authors found that depressed individuals displayed a specific attentional bias toward the sad—but not the happy or angry—faces. In summary, attentional bias findings in depression seem to typically emerge only under conditions in which the stimuli are presented supraliminally and for relatively longer periods of time.

In the emotional Stroop task, partipants are asked to name, as quickly as possible, the ink color of presented words, while ignoring the affectively laden meaning of the words (e.g., "sad," "down," "unworthy," "hopeless"). It is hypothesized that depressed invididuals will evidence greater response latency to depressotypic words compared with neutral words. Such effects have been argued to reflect the fact that attention is "grabbed" by the emotional word and thus distracts depressed participants from the task at hand (i.e., naming the ink color of the word).

A meta-analysis (Epp, Dobson, Dozois, & Frewen, 2012) revealed large emotional Stroop effects for negative stimuli in depressed participants compared to their nondepressed counterparts (Hedges's g = .98). It should be noted, however, that, although the largest group differences emerged for the negative stimuli, significant effects were also observed for neutral and even *positive* stimuli (i.e., a larger Stroop effect for depressed participants), arguing against a strong emotion-congruent bias (see Gotlib & Joorman, 2010; Williams, Mathews, & MacLeod, 1996). Fewer studies have examined the effect of naturally occurring or induced sadness on emotional Stroop performance, and findings are mixed. Although some studies have reported Stroop interference for sad words following sad mood induction (Gilboa-Schechtman, Revelle, & Gotlib, 2000), others have not (Perez, Rivera, Fuster, & Rodríguez, 1999).

Finally, eye-tracking technology has also been used in studies examining mood-congruent attentional biases in depression. For example, Eizenman et al. (2003) found that depressed individuals spent significantly more time attending to images with dysphoric themes (loss and sadness) in comparison to nondepressed controls. Interestingly, the study also found that the average glance duration for the dysphoric images was significantly longer for the depressed, relative to the healthy, group. Similarly, a subsequent study (Kellough, Beevers, Ellis, & Wells, 2008) found that depressed participants, relative to their nondepressed counterparts, spent more time attending to dysphoric images, as well as less time attending to pleasant images (see also Caseras, Garner, Bradley, & Mogg, 2007). A recent meta-analytic review of the eye-tracking literature reported that depressed individuals indeed display an increased maintenance of gaze on dysphoric (but not threat-related) stimuli in comparison to nondepressed participants (Armstrong & Olatunji, 2012). The latter findings suggest that depressed individuals may struggle to disengage from negative stimuli. In addition to preferential attention toward dyphoric stimuli, the results of the above meta-analysis also supported an "anhedonic" bias in depression, such that depressed participants were characterized by reduced orienting toward positive stimuli, as well as decreased maintenance of gaze toward positive stimuli. Future studies will be required to examine attential biases via eye tracking in nondepressed individuals undergoing a sad mood induction.

One important question is whether these attentional biases are simply correlates or consequences of depression, or if they index vulnerability and thus precede the onset of depressive episodes. According to Beck's model (Beck et al., 1979), biased attention toward negative, and away from positive, information fuels depressogenic cognitions and maladaptive schemas, which in turn render one vulnerable to depressive symptoms (particularly in the face of stressors). Interestingly, Joormann and colleagues found that individuals at risk of experiencing a future depressive episode by virtue of either having a history of depression (Joormann & Gotlib, 2007) or a mother with MDD (Joorman, Talbot, & Gotlib, 2007) exhibited attentional biases toward negative facial expressions. These findings suggest that attentional biases may be more than a mere symptom or "scar" of depression, and may reflect a risk factor for future depressive episodes and serve as a potential target of interventions aimed at improving attentional control and, ultimately, alleviating depressive symptoms (Siegle, Ghinassi, & Thase, 2007).

Memory Biases

Negative Information

Among the most consistently observed biases in depression are memory biases for mood-congruent information (Gotlib & Joormann, 2010; Mathews & MacLeod, 2005). A common pattern of findings is that nondepressed individuals exhibit a memory bias for positive stimuli (e.g., affectively valenced words), relative to negative (or neutral) stimuli. In contrast, depressed individuals typically show a recall bias for negatively valenced information (e.g., Bradley, Mogg, Millar, & White, 1995; Denny & Hunt, 1992). The effect also extends to memory for faces that differ in affective expression. For example, in a facial recognition task, Ridout, Astell, Reid, Glen, and O'Carroll (2003) found that depressed individuals displayed enhanced memory for sad faces relative to neutral or happy faces. In contrast, nondepressed individuals displayed the opposite memory bias, such that they had superior memory for happy, relative to sad or neutral, faces. It is important to note that there is also evidence of memory biases for mood-congruent information in healthy individuals following sad mood induction (e.g., Forgas, 2001; Chepenik et al., 2007). Indeed, Chepenik et al. (2007) assessed the effect of a sad mood induction in healthy individuals on performance on a range of cognitive tasks, and the strongest mood-congruent effect emerged on their memory bias task (no significant mood induction effects emerged on tasks tapping attentional biases or executive function).

More recently, Dillon, Dobbins, and Pizzagalli (2014) found that only healthy individuals showed significantly enhanced memory for rewarded stimuli relative to nonrewarded stimuli; depressed individuals show no such recall differences. Moreover, using experience sampling methodology to assess recall biases for mood states, Wenze, Gunthert, and German (2012) found that individuals with higher levels of depressive symptoms tended to have more negative mood recall bias and had *less* positive (i.e., more realistic) mood recall bias relative to those with lower levels of depressive symptoms.

Overgeneral Autobiographical Information

In addition to memory biases for negative information, studies indicate that depressed individuals have a tendency to recall overgeneral autobiographical memories, even when instructed to recall specific memories (see Williams et al., 2007, for a review). These results have emerged from a series of studies that have typically used the Autobiographical Memory Test (AMT; Williams & Broadbent, 1986; Williams et al., 2007) to assess the specificity of memory retrieval. Accordingly, when presented with positive and negative valenced words and asked to recall thematically related specific episodic memories, depressed individuals are more likely to recall generic summaries of events than healthy controls. This bias toward overgeneral memory retrieval in depression has been associated with deficits in problem solving and prolonged depressive episodes, as well as difficulties in imagining specific *future* events (Williams et al., 2007). It has been argued that overgeneral memory bias in depression may be related to functional avoidance (i.e., avoiding the threat of negative affect aroused from the recall of specific events), ruminative processes, and deficits in executive function (Williams et al., 2007). Interestingly, a study that trained dysphoric participants to be more concrete and specific in their thinking resulted in reductions in overgeneral thinking and, critically, in improvements in depressive syptoms and rumination (Watkins, Baeyens, & Read, 2009).

Biases in Predicting the Future

Event Forecasting

Not only is depression associated with biases in remembering the past, but there is also evidence linking depression to pessimistic biases in predicting both *future* events and affect. In his early writings, Aaron Beck argued that depressed individuals are characterized by pessimistic cognitions about one's future, as well as the self and world (Beck et al., 1979). Studies have found that depressed adults (e.g., Pyszczynski, Holt, & Greenberg, 1987; Strunk, Lopez, & DeRubeis, 2006) and children (e.g., Muris & van der Heiden, 2006) do indeed report more pessimistic cognitions about the future relative to their nondepressed counterparts. For example, in a sample of children, Muris and van der Heiden (2006) found that depressive symptoms were negatively associated with probability estimates of future positive events, but only when these events were about the self. Similarly, in an undergraduate sample, Pyszczynski et al. (1987) found that depressed participants expected fewer positive events and greater levels of negative events for themselves relative to others.

The latter findings are generally consistent with Beck's cognitive model of depression (Beck et al., 1979). However, the fact that depressed individuals hold pessimistic views of their future does not address whether these cognitions are *biased* relative to objective reality. One could argue, for example, that the reason depressed individuals predict greater negative, and fewer positive, outcomes in the future is not a cognitive bias or distortion per se, but rather reflects the simple fact that depressed individuals do indeed *experience* more negative, and fewer positive, events relative to their nondepressed peers. However, later studies found that pessimistic predictions about the future are biased relative to reality (e.g., Strunk & Adler, 2009; Strunk et al., 2006; Wenze et al., 2012). For example, Strunk et al. (2006) recruited a group of 153 subjects with a broad range of depressive symptoms and had them complete a battery of questionnaires at two time points, 1 month apart. At the first assessment, participants were asked to review a list of 40 varied life events: 20 desirable (e.g., "Will be invited to a party") and 20 undesirable (e.g., "Will get a parking or speeding ticket"). Participants were then asked to estimate the probability that each event would occur to them in the next 30 days. In order to assess predictive bias, at the end of the 30-day period, participants were asked to review the event list and report which of the events occurred to them. Individuals with relatively higher levels of depressive symptoms predicted that they would experience fewer positive outcomes during the study period. However, and most relevant to the question of predictive bias, higher levels of depressive symptoms were associated with greater pessimistic bias and inaccuracy in predicting future live events (see Strunk & Adler, 2009, for a replication). In contrast, research indicates that nondepressed individuals typically display an *optimistic bias* (i.e., a tendency to overestimate the likelihood of positive outcomes and downplay the likelihood of negative outcomes in the future; see Sharot, 2012). To our knowledge, no study has experimentally tested the effect of a sad mood induction on event forecasting.

Affective Forecasting

Evidence also indicates that pessimistic predictive biases may extend to other domains, including the prediction of future affective states (i.e., *affective forecasting*). Using experience sampling methodology, Wenze et al. (2012) found that individuals with greater levels of depression evidenced a more pessimistic negative mood prediction bias, but a less optimistic (i.e., more realistic) positive mood prediction bias. However, in contrast to the findings of Strunk and colleagues (Strunk & Adler, 2009; Strunk et al., 2006), depressive symptoms were not significantly associated with biases in future event prediction. The extent to which attentional and memory biases may fuel biases in the prediction of one's future (e.g., future events and affective states), and vice versa (e.g., pessimistic predictions of the future contributing to biased attention toward negative events and stimuli), is an interesting question needing research.

Neurobiology of Depression and Sadness: Functional Abnormalities

A burgeoning body of literature has described functional abnormalities in MDD, particularly in brain regions linked to reward processing and emotion processing/regulation. (Due to space limitation, we are unable to summarize other domains, and do not discuss structural abnormalities in depression, but see Bora, Fornito, Pantelis, & Yücel, 2012, for a review.)

Hyperreactivity to Negative Stimuli

In a recent meta-analytic review, Hamilton et al. (2012) aggregated studies comparing neural response to negative stimuli (e.g., sad faces and pictures) in depressed versus healthy participants. Relative to healthy individuals, those diagnosed with MDD exhibited greater neural response to negative stimuli in the amygdala, insula, and dorsal anterior cingulate cortex (dACC). These regions are prominent nodes within the so-called salience network, believed to play an important role in assessing the relevance of internal and external stimuli (Seeley et al., 2007). In addition, depressed individuals exhibited *decreased* response to negative stimuli in the dorsolateral prefrontal cortex (DLPFC), a hub of executive control. Taken together, increased reactivity in the salience network coupled with difficulties down-regulating negative affect (due to DLPFC hypoactivation) may reflect hyperreactivity to negative stimuli. Of note, activity in several of the above-mentioned regions normalizes following antidepressant treatment (i.e., decreased activity in the amygdala and insula, and increased activity in the DLPFC; see Delaveau et al., 2011).

Hyporeactivity to Positive Stimuli

Depression is also characterized by blunted reactivity to positive stimuli. Indeed, as noted above, one of the cardinal symptoms of depression is anhedonia (i.e., diminished pleasure or interest), and recent neuroimaging studies have revealed abnormalities across different temporal phases of reward processing, including the anticipation (*anticipatory phase*) and receipt (*consummatory phase*) of rewarding stimuli (Pizzagalli, 2014). MDD has been linked to reduced activity in reward-related brain regions in response to monetary rewards, positive words, and happy facial expressions, in particular in ventral (i.e., nucleus accumbens) and dorsal striatal (i.e., caudate, putamen) regions (Epstein, Pan, Kocsis, Yang, Butler et al., 2006; Forbes, Hariri, Martin, Silk, Moyles, et al., 2009; Pizzagalli, Holmes, Dillon, Goetz, Birk, et al., 2009; Surguladze, Brammer, Keedwell, Giampietro, Young, Travis, et al., 2005).

In addition to these consummatory deficits, blunted ventral and dorsal striatal activation has been observed during reward anticipation in MDD (Pizzagalli et al., 2009; Stoy et al., 2012). Interestingly, Stoy et al. (2012) found that ventral striatal hyporeactivity normalized following successful antidepressant treatment (see Dichter, Felder, Petty, Bizzell, Ernst, et al., 2009, for similar findings following successful psychotherapy). An important task for future research will be to elucidate whether such neural correlates are linked to depressed individuals' tendency to exhibit attentional biases toward negative, and away from positive, stimuli.

Sadness versus Depression

Overall, research indicates that there is partial overlap between the patterns of brain activation observed in MDD versus induced (or naturally occurring) sadness in healthy subjects, in particular, the presence of shared functional abnormalities in prefrontal and limbic regions (Aalto et al., 2002; Davidson, Pizzagalli, Nitschke, & Putnam, 2002; Mayberg et al., 1999). Paralleling findings in MDD, relatively reduced activity in the DLPFC has been observed in healthy participants following a sad mood induction (Mayberg et al., 1999). Moreover, as in depression, sadness in healthy participants has been associated with functional abnormalities in the ACC (Phan, Wager, Taylor, & Liberzon, 2002). Interestingly, in their meta-analysis of the functional neuroanatomy of emotions in healthy subjects, Phan et al. (2002) observed that, relative to other emotions, sadness was more strongly linked to modulation in the subgenual PFC (BA 25)—a region that has been strongly implicated in MDD and its treatment (Mayberg et al., 1999; Johansen-Berg, Gutman, Behrens, Matthews, Rushworth, et al., 2008).

Default Mode Network

In the above-mentioned neuroimaging studies, group comparisons were typically performed in response to emotional stimuli. Recent studies have revealed that an interconnected network of brain regions—including the medial prefrontal cortex (MPFC), posterior cingulate/retrosplenial cortex, and inferior parietal lobules, which have been collectively labeled the *default mode network* (DMN; Buckner, Andrews-Hanna, & Schacter, 2008; Whitfield-Gabrieli & Ford, 2012)—is *more* active during rest than during attention-demanding tasks. Relatively higher DMN activity has been linked to self-referential processes, including thinking about oneself, remembering one's past, and thoughts regarding one's future. Intriguingly, depressed individuals exhibit increased synchronicity within the DMN (Greicius, Flores, Menon, Glover, Solvason, et al., 2007) as well as reduced DMN suppression during task performance (Grimm et al., 2008; Pizzagalli, 2011; Sheline et al., 2009), suggesting potentiated (negative) self-referential processing as well as difficulty inhibiting spontaneous internal cognitions (e.g., rumination), which might prevent full engagement in the task at hand. Critically, relative dominance of DMN activity has been associated with higher levels of maladaptive rumination in MDD (Hamilton, Furman, Chang, Thomason, Dennis, et al., 2011). These findings are consistent with the notion that depression is characterized by preoccupation with spontaneous internal cognitions (rumination; "negative automatic thoughts" regarding self, future, and the world), and that individuals with MDD struggle to down-regulate these depressogenic and distracting thoughts during daily tasks that require their attention and focus.

Future Directions

Important progress has taken place over the last several decades in our understanding of depression. However, in comparison to the relatively less complex phenomenon of sadness, depression is a highly heterogeneous disorder, and is currently defined based on a cluster of symptoms and clinical course, rather than etiology or pathophysiology, which remain poorly understood. For example, it is still not entirely clear to what extent clinically significant MDD differs from normative sadness at the neurobiological level. MDD, as currently classified, likely encompasses a heterogeneous set of disorders with differing pathophysiologies (Pizzagalli, 2014), which consequently complicates efforts to uncover its etiology and underlying neurobiology. One promising approach to parsing this heterogeneity and gaining a better understanding of the etiology and pathophysiology of depression is to focus research on the examination of distinct, and more narrowly defined, endophenotypes of depression, such as anhedonia and, particularly relevant to the present review, cognitive (e.g., attentional and memory) biases (Hasler, Drevets, Manji, & Charney, 2004; Webb, Dillon, Pechtel, Goer, Murray, et al., 2016).

In addition, as evidenced in this review, the bulk of previous research in depression has been based on categorical comparisons of individuals meeting DSM criteria for MDD versus healthy controls. The NIMH, through its Research Domain Criteria (RDoC) initiative, is encouraging dimensional conceptual and analytic approaches to the investigation of MDD, as opposed to an overreliance on DSM-based categorical comparisons. Such a dimensional approach, which entails the consideration of the full range of depressive symptomatology (i.e., from no symptoms to high-severity cases), may yield important insights regarding the nature and etiology of the disorder. Moreover, such research may generate fruitful findings delineating the overlap and distinction between MDD and normative sadness. Although MDD, as currently defined (i.e., according to the DSM), shares minimal similarities with sadness, the empirical literature reviewed above suggests that there are important areas of overlap (e.g., with regard to functional neuroanatomy, cognitive biases and, arguably, evolutionary roots). Informative findings would likely emerge from additional research aimed at parsing the differences between sadness and MDD across different domains or "levels of analysis," including psychosocial (e.g., distinctions and overlap in cognitive biases/deficits and triggering events/stressors), behavioral (e.g., maladaptive patterns of behavior), and neurobiological (e.g., similarities and important differences in brain function and functional connectivity) levels.

With regard to clinical implications, a more in-depth understanding of the etiology of depression may ultimately inform efforts to improve treatment outcomes. For example, research on cognitive biases and the neural underpinning of depression can inform the development and testing of novel and targeted interventions for depression (e.g., see Siegle et al., 2007; Watkins et al., 2009, for the targeting of cognitive biases; see Holtzheimer et al., 2012, for deep brain stimulation of the subgenual PFC). Moreover, in an effort to minimize treatment nonresponse and maximize the efficacy of interventions for depression, it is also important for researchers to identify factors that contribute to worse outcomes. In addition to factors that predict better or poorer prognosis across treatments (i.e., a *prognostic* variable), it is particularly important to identify factors that predict better treatment response in one treatment versus another (i.e., a *prescriptive* variable), thus informing treatment selection. In other words, some patients may be better suited to a particular treatment based on their unique psychosocial, demographic, neurobiological, or clinical profile. For example, Fournier, DeRubeis, Shelton, Hollon, Amsterdam, et al. (2009) found that CBT was more effective than antidepressant medication for patients who were experiencing a relatively large number of life stressors, were married (or cohabitating), or unemployed. With regard to neural markers of differential treatment response, McGrath et al. (2013) recently found that glucose hypometabolism in the insula at pretreatment was associated with remission in the CBT but not the selective serotonin reuptake inhibitor (SSRI) escitalopram condition, whereas insula hypermetabolism was associated with the reverse pattern (i.e., better outcomes for escitalopram). Thus, in line with the pursuit of personalized medicine in psychiatry, future research on prescriptive predictors of symptom change may ultimately lead to critical information regarding which depression treatment is best suited for whom.

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References

Aalto, S., Naatanen, P., Wallius, E., Metsahonkala, L., Stenman, H., Niemi, P. M., et al. (2002). Neuroanatomical substrata of amusement and sadness: A PET activation study using film stimuli. *NeuroReport, 13*(1), 67–73.

Allen, N. B., & Badcock, P. B. T. (2003). The social risk hypothesis of depressed mood: Evolutionary, psychosocial, and neurobiological perspectives. *Psychological Bulletin, 129*(6), 887–913.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: Author.

Anders, S., Tanaka, M., & Kinney, D. K. (2013). Depression as an evolutionary strategy for defense against infection. *Brain, Behavior, and Immunity, 31*, 9–22.

Andrews, P. W., & Thomson, J. A. (2009). The bright side of being blue: Depression as an adaptation for analyzing complex problems. *Psychological Review, 116*(3), 620–654.

Armstrong, T., & Olatunji, B. O. (2012). Eye tracking of attention in the affective disorders: A meta-analytic review and synthesis. *Clinical Psychology Review, 32*(8), 704–723.

Beck, A. T. (2008). The evolution of the cognitive model of depression and its neurobiological correlates. *American Journal of Psychiatry, 165*(8), 969–977.

Beck, A. T., & Alford, B. A. (2009). *Depression: Causes and treatment*. Philadelphia: University of Pennsylvania Press.

Beck, A. T., Rush, J. A., Shaw, B. F., & Emery, G. (1979). *Cognitive therapy of depression*. New York: Guilford Press.

Boland, R., & Keller, M. (2009). Course and outcome of depression. In I. Gotlib & C. Hammen (Eds.), *Handbook of depression* (pp. 23–44). New York: Guilford Press.

Bora, E., Fornito, A., Pantelis, C., & Yücel, M. (2012). Gray matter abnormalities in major depressive disorder: A meta-analysis of voxel based morphometry studies. *Journal of Affective Disorders, 138*(1–2), 9–18.

Bradley, B. P., Mogg, K., & Lee, S. C. (1997). Attentional biases for negative information in induced and naturally occurring dysphoria. *Behaviour Research and Therapy, 35*(10), 911–927.

Bradley, B. P., Mogg, K., Millar, N., & White, J. (1995). Selective processing of negative information: Effects of clinical anxiety, concurrent depression, and awareness. *Journal of Abnormal Psychology, 104*(3), 532–536.

Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The brain's default network. *Annals of the New York Academy of Sciences, 1124*(1), 1–38.

Carver, C. S. (2004). Negative affects deriving from the Behavioral Approach System. *Emotion, 4*(1), 3–22.

Caseras, X., Garner, M., Bradley, B. P., & Mogg, K. (2007). Biases in visual orienting to negative and positive scenes in dysphoria: An eye movement study. *Journal of Abnormal Psychology, 116*(3), 491–497.

Chepenik, L. G., Cornew, L. A., & Farah, M. J. (2007). The influence of sad mood on cognition. *Emotion, 7*(4), 802–811.

Costello, E. J., Angold, A., Burns, B. J., Erkanli, A., Stangl, D. K., & Tweed, D. L. (1996). The Great Smoky Mountains Study of Youth: Functional impairment and serious emotional disturbance. *Archives of General Psychiatry, 53*, 1137–1143.

Costello, E. J., Erkanli, A., & Angold, A. (2006). Is there an epidemic of child or adolescent depression? *Journal of Child Psychology and Psychiatry, 47*, 1263–1271.

Costello, E. J., Mustillo, S., Erkanli, A., Keeler, G., & Angold, A. (2003) Prevalence and development of psychiatric disorders in childhood and adolescence. *Archives of General Psychiatry, 60*, 837–844.

Davidson, R. J., Pizzagalli, D., Nitschke, J. B., & Putnam, K. (2002). Depression: Perspectives from affective neuroscience. *Annual Review of Psychology, 53*, 545–574.

Delaveau, P., Jabourian, M., Lemogne, C., Guionnet, S., Bergouignan, L., & Fossati, P. (2011). Brain effects of antidepressants in major depression: A meta-analysis of emotional processing studies. *Journal of Affective Disorders, 130*(1–2), 66–74.

Denny, E. B., & Hunt, R. R. (1992). Affective valence and memory in depression: Dissociation of recall and fragment completion. *Journal of Abnormal Psychology, 101*(3), 575–580.

Dichter, G. S., Felder, J. N., Petty, C., Bizzell, J., Ernst, M., & Smoskin, M. J. (2009). The effects of psychotherapy on neural responses to rewards in major depression. *Biological Psychiatry, 66*(9), 886–897.

Dillon, D. G., Dobbins, I. G., & Pizzagalli, D. A. (2014). Weak reward source memory in depression reflects blunted activation of VTA/SN and parahippocampus. *Social Cognitive and Affective Neuroscience, 9*(10), 1576–1583.

Eizenman, M., Yu, L. H., Grupp, L., Eizenman, E., Ellenbogen, M., Gemar, M., et al. (2003). A naturalistic visual scanning approach to assess selective attention in major depressive disorder. *Psychiatry Research, 118*(2), 117–128.

Ekman, P. (2007). *Emotions revealed: Recognizing faces and feelings to improve communication and emotional life* (2nd ed.). New York: Macmillan.

Engel, G. L. (1980). The clinical application of the biopsychosocial model. *American Journal of Psychiatry, 137*(5), 535–544.

Epp, A. M., Dobson, K. S., Dozois, D. J. A., & Frewen, P. A. (2012). A systematic meta-analysis of the Stroop task in depression. *Clinical Psychology Review, 32*(4), 316–328.

Epstein, J., Pan, H., Kocsis, J. H., Yang, Y., Butler, T., et al. (2006). Lack of ventral striatal response to positive stimuli in depressed versus normal subjects. *American Journal of Psychiatry, 163*, 1784–1790.

Felder, J. N., Petty, C., Bizzell, J., Ernst, M., Smoski, M. J. (2009). The effects of psychotherapy on neural responses to rewards in major depression. *Biological Psychiatry*, 66, 886–897.

Forbes, E. E., Hariri, A. R., Martin, S. L., Silk, J. S., Moyles, D. L., et al. (2009). Altered striatal activation predicting real-world positive affect in adolescent major depressive disorder. *American Journal of Psychiatry, 166*, 64–73.

Forgas, J. P. (Ed.). (2001). *Handbook of affect and social cognition*. Mahwah, NJ: Erlbaum.

Fournier, J. C., DeRubeis, R. J., Shelton, R. C., Hollon, S. D., Amsterdam, J. D., & Gallop, R. (2009). Prediction of response to medication and cognitive therapy in the treatment of moderate to severe depression. *Journal of Consulting and Clinical Psychology, 77*(4), 775–787.

Gilboa-Schechtman, E., Revelle, W., & Gotlib, I. H. (2000). Stroop interference following mood induction: Emotionality, mood congruence, and concern relevance. *Cognitive Therapy and Research, 24*(5), 491–502.

Gotlib, I. H., & Joormann, J. (2010). Cognition and depression: Current status and future directions. *Annual Review of Clinical Psychology*, 6, 285–312.

Gotlib, I. H., Krasnoperova, E., Yue, D. L., & Joormann, J. (2004). Attentional biases for negative interpersonal stimuli in clinical depression. *Journal of Abnormal Psychology, 113*, 127–135.

Greicius, M. D., Flores, B. H., Menon, V., Glover, G. H., Solvason, H. B., Kenna, H., et al. (2007). Resting-state functional connectivity in major depression: abnormally increased contributions from subgenual cingulate cortex and thalamus. *Biological Psychiatry, 62*(5), 429–437.

Grimm, S., Boesiger, P., Beck, J., Schuepbach, D., Bermpohl, F., Walter, M., et al. (2008). Altered negative BOLD responses in the default-mode network during emotion processing in depressed subjects. *Neuropsychopharmacology, 34*(4), 932–943.

Hamilton, J. P., Etkin, A., Furman, D. J., Lemus, M. G., Johnson, R. F., & Gotlib, I. H. (2012). Functional neuroimaging of major depressive disorder: A meta-analysis and new integration of baseline activation and neural response data. *American Journal of Psychiatry, 169*(7), 693–703.

Hamilton, J. P., Furman, D. J., Chang, C., Thomason, M. E., Dennis, E., & Gotlib, I. H. (2011). Default-mode and task-positive network activity in major depressive disorder: Implications for adaptive and maladaptive rumination. *Biological Psychiatry, 70*(4), 327–333.

Hammen, C. (2005). Stress and depression. *Annual Review of Clinical Psychology, 1*, 293–319.

Hankin, B. L., Abramson, L. Y., Moffitt, T. E., Silva, P. A., McGee, R., & Angell, K. E. (1998) Development of depression from preadolescence to young adulthood: emerging sex differences in a 10-year longitudinal study. *Journal of Abnormal Psychology, 107*, 128–140.

Hasler, G., Drevets, W. C., Manji, H. K., & Charney, D. S. (2004). Discovering endophenotypes for major depression. *Neuropsychopharmacology, 29*(10), 1765–1781.

Holtzheimer, P. E., Kelley, M. E., Gross, R. E., Filkowski, M. M., Garlow, S. J., Barrocas, A., et al. (2012). Subcallosal cingulate deep brain stimulation for treatment-resistant unipolar and bipolar depression. *Archives of General Psychiatry, 69*(2), 150–158.

Horwitz, A. V., & Wakefield, J. C. (2007). *The loss of sadness: How psychiatry transformed normal sorrow into depressive disorder*. New York: Oxford University Press.

Johansen-Berg, H., Gutman, D. A., Behrens, T. E. J., Matthews, P. M., Rushworth, M. F. S., Katz, E., et al. (2008). Anatomical connectivity of the subgenual cingulate region targeted with deep brain stimulation for treatment-resistant depression. *Cerebral Cortex, 18*(6), 1374–1383.

Joormann, J., & Gotlib, I. (2007). Selective attention to emotional faces following recovery from depression. *Journal of Abnormal Psychology, 116*(1), 80–85.

Joormann, J., Talbot, L., & Gotlib, I. (2007). Biased processing of emotional information in girls at risk for depression. *Journal of Abnormal Psychology, 116*(1), 135–143.

Katz, M. M., & Klerman, G. L. (1979). Introduction: overview of the clinical studies program. *American Journal of Psychiatry, 136*(1), 49–51.

Keller, M. B., & Boland, R. J. (1998). Implications of failing to achieve successful long-term maintenance treatment of recurrent unipolar major depression. *Biological Psychiatry, 44*(5), 348–360.

Keller, M. B., Lavori, P. W., Mueller, T. I., Endicott, J., Coryell, W., Hirschfeld, R. M., & Shea, T. (1992). Time to recovery, chronicity, and levels of psychopathology in major depression: A 5-year prospective follow-up of 431 subjects. *Archives of General Psychiatry, 49*(10), 809–816.

Keller, M. C., & Nesse, R. M. (2006). The evolutionary significance of depressive symptoms: Different adverse situations lead to different depressive symptom patterns. *Journal of Personality and Social Psychology, 91*(2), 316–330.

Kellough, J. L., Beevers, C. G., Ellis, A. J., & Wells, T. T. (2008). Time course of selective attention in clinically depressed young adults: An eye tracking study. *Behaviour Research and Therapy, 46*(11), 1238–1243.

Kendler, K. S., Walters, E. E., & Kessler, R. C. (1997). The prediction of length of major depressive episodes: Results from an epidemiological sample of female twins. *Psychological Medicine, 27*(1), 107–117.

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Koretz, D., Merikangas, K. R., et al. (2003). The epidemiology of major depressive disorder: results from the National Comorbidity Survey Replication (NCS-R). *Journal of the American Medical Association, 289*(23), 3095–3105.

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62*(6), 593–602.

Kessler, R. C., Birnbaum, H. G., Shahly, V., Bromet, E., Hwang, I., McLaughlin, K. A., et al. (2010). Age differences in the prevalence and comorbidity of DSM-IV major depressive episodes: Results from the WHO World Mental Health Survey Initiative. *Depression and Anxiety, 27*(4), 351–364.

Kessler, R. C., Chiu, W. T., Demler, O., & Walters, E. E. (2005). Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62*(6), 617–627.

Kessler, R. C., McGonagle, K. A., Zhao, S., et al. (1994). Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: Results from the National Comorbidity Survey. *Archives of General Psychiatry, 51*, 8–19.

Lewinsohn, P. M., Hops, H., Roberts, R. E., Seeley, J. R., & Andrews, J. A. (1993). Adolescent psychopathology: I. Prevalence and incidence of depression and other DSM-III-R disorders in high school students. *Journal of Abnormal Psychology, 102*(1), 133.

Liu, R. T., & Alloy, L. B. (2010). Stress generation in depression: A systematic review of the empirical literature and recommendations for future study. *Clinical Psychology Review, 30*(5), 582–593.

Mathews, A., & MacLeod, C. (2005). Cognitive vulnerability to emotional disorders. *Annual Review of Clinical Psychology, 1*, 167–195.

Mayberg, H. S., Liotti, M., Brannan, S. K., McGinnis, S., Mahurin, R. K., Jerabek, P. A., et al. (1999). Reciprocal limbic-cortical function and negative mood: Converging PET findings in depression and normal sadness. *American Journal of Psychiatry, 156*(5), 675–682.

McGrath, C. L., Kelley, M. E., Holtzheimer, P. E., Dunlop, B. W., Craighead, W. E., Franco, A. R., et al. (2013). Toward a neuroimaging treatment selection biomarker for major depressive disorder. *JAMA Psychiatry, 70*(8), 821–829.

Mogg, K., Bradley, B. P., & Williams, R. (1995). Attentional bias in anxiety and depression: The role of awareness. *British Journal of Clinical Psychology, 34*(1), 17–36.

Mueller, T. I., Keller, M. B., Leon, A. C., Solomon, D. A., Shea, M. T., Coryell, W., & Endicott, J. (1996). Recovery after 5 years of unremitting major depressive disorder. *Archives of General Psychiatry, 53*(9), 794–799.

Muris, P., & van der Heiden, S. (2006). Anxiety, depression, and judgments about the probability of future negative and positive events in children. *Journal of Anxiety Disorders, 20*(2), 252–261.

Nesse, R. M. (2000). Is depression an adaptation? *Archives of General Psychiatry, 57*(1), 14–20.

Nettle, D. (2004). Evolutionary origins of depression: A review and reformulation. *Journal of Affective Disorders, 81*(2), 91–102.

Pérez, M. G., Rivera, R. M., Fuster, A. B., & Rodríguez, M. (1999). Attentional biases and vulnerability to depression. *Spanish Journal of Psychology, 2*, 11–19.

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *NeuroImage, 16*(2), 331–348.

Pizzagalli, D. A. (2011). Frontocingulate dysfunction in depression: Toward biomarkers of treatment response. *Neuropsychopharmacology, 36*(1), 183–206.

Pizzagalli, D. A. (2014). Depression, stress, and anhedonia: Toward a synthesis and integrated model. *Annual Review of Clinical Psychology, 10*, 393–423.

Pizzagalli, D. A., Holmes, A. J., Dillon, D. G., Goetz, E. L., Birk, J. L., et al. (2009). Reduced caudate and nucleus accumbens response to rewards in unmedicated subjects with major depressive disorder. *American Journal of Psychiatry, 166*, 702–710.

Price, J., Sloman, L., Gardner, R., Gilbert, P., & Rohde, P. (1994). The social competition hypothesis of depression. *British Journal of Psychiatry, 164*(3), 309–315.

Pyszczynski, T., Holt, K., & Greenberg, J. (1987). Depression, self-focused attention, and expectancies for positive and negative future life events for self and others. *Journal of Personality and Social Psychology, 52*(5), 994–1001.

Reinherz, H. Z., Giaconia, R. M., Lefkowitz, E. S., & Pakiz, B. (1993) Prevalence of psychiatric disorders in a community population of older adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry, 32*, 369–377.

Ridout, N., Astell, A., Reid, I., Glen, T., & O'Carroll, R. (2003). Memory bias for emotional facial expressions in major depression. *Cognition and Emotion, 17*(1), 101–122.

Sapolsky, R. M. (2004). *Why zebras don't get ulcers: An updated guide to stress, stress-related diseases, and coping.* New York: Owl.

Seeley, W. W., Menon, V., Schatzberg, A. F., Keller, J., Glover, G. H., Kenna, H., et al. (2007). Dissociable intrinsic connectivity networks for salience processing and executive control. *Journal of Neuroscience, 27*(9), 2349–2356.

Sharot, T. (2012). *The Optimism bias: Why we're wired to look on the bright side*. London: Hachette.

Sheline, Y. I., Barch, D. M., Price, J. L., Rundle, M. M., Vaishnavi, S. N., Snyder, A. Z., et al. (2009). The default mode network and self-referential processes in depression. *Proceedings of the National Academy of Sciences, 106*(6), 1942–1947.

Siegle, G., Ghinassi, F., & Thase, M. (2007). Neurobehavioral therapies in the 21st century: Summary of an emerging field and an extended example of cognitive control training for depression. *Cognitive Therapy and Research, 31*(2), 235–262.

Stoy, M., Schlagenhauf, F., Sterzer, P., Bermpohl, F., Hägele, C., Suchotzki, K., et al. (2012). Hyporeactivity of ventral striatum towards incentive stimuli in unmedicated depressed patients normalizes after treatment with escitalopram. *Journal of Psychopharmacology, 26*(5), 677–688.

Strunk, D. R., & Adler, A. D. (2009). Cognitive biases in three prediction tasks: A test of the cognitive model of depression. *Behaviour Research and Therapy, 47*(1), 34–40.

Strunk, D. R., Lopez, H., & DeRubeis, R. J. (2006). Depressive symptoms are associated with unrealistic negative predictions of future life events. *Behaviour Research and Therapy, 44*(6), 861–882.

Surguladze, S., Brammer, M. J., Keedwell, P., Giampietro, V., Young, A. W., Travis, M. J., et al. (2005). A differential pattern of neural response toward sad versus happy facial expressions in major depressive disorder. *Biological Psychiatry, 57*(3), 201–209

Tiedens, L. Z., & Linton, S. (2001). Judgment under emotional certainty and uncertainty: The effects of specific emotions on information processing. *Journal of Personality and Social Psychology, 81*(6), 973–988.

Tooby, J., & Cosmides, L. (2008). The evolutionary psychology of the emotions and their relationship to internal regulatory variables. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 114–137). New York: Guilford Press.

Vingerhoets, A. J. J. M., & Cornelius, R. R. (Eds.). (2001). *Adult crying: A biopsychosocial approach*. Hove, UK: Brunner-Routledge.

Watkins, E. R., Baeyens, C. B., & Read, R. (2009). Concreteness training reduces dysphoria: Proof-of-principle for repeated cognitive bias modification in depression. *Journal of Abnormal Psychology, 118*(1), 55.

Watson, P. J., & Andrews, P. W. (2002). Toward a revised evolutionary adaptationist analysis of depression: The social navigation hypothesis. *Journal of Affective Disorders, 72*(1), 1–14.

Webb, C. A., Dillon, D. G., Pechtel, P., Goer, F. K., Murray, L., Huys, Q. J., et al. (2016). Neural correlates of three promising endophenotypes of depression: Evidence from the EMBARC Study. *Neuropsychopharmacology, 41*(2), 454–463.

Weissman, M. M., Bruce, M. L., Leaf, P. J., Florio, L. P., & Holzer, C., III. (1991). Affective disorders. In L. N. Robins & D. A. Regier (Eds.), *Psychiatric disorders in America: The Epidemiologic Catchment Area Study* (pp. 53–80). New York: Free Press.

Wenze, S. J., Gunthert, K. C., & German, R. E. (2012). Biases in affective forecasting and recall in individuals with depression and anxiety symptoms. *Personality and Social Psychology Bulletin, 38*(7), 895–906.

Whitfield-Gabrieli, S., & Ford, J. M. (2012). Default mode network activity and connectivity in psychopathology. *Annual Review of Clinical Psychology, 8*, 49–76.

Williams, J. M., Barnhofer, T., Crane, C., Herman, D., Raes, F., Watkins, E., et al. (2007). Autobiographical memory specificity and emotional disorder. *Psychological Bulletin, 133*(1), 122–148.

Williams, J. M. G., & Broadbent, K. (1986). Autobiographical memory in suicide attempters. *Journal of Abnormal Psychology, 95*, 144–149.

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin, 120*(1), 3.

CHAPTER 50

EMPATHY

Jamil Zaki and Kevin Ochsner

In *The Western Illusion of Human Nature*, the anthropologist Marshall Sahlins (2008) chronicles a common idea uniting philosophers including Thucydides, Thomas Hobbes, and John Adams. According to Sahlins, these thinkers believed that social contracts are needed to restrain humans from expressing their antisocial "natural state," under which self-interest trumps all other concerns. This view of human nature has made its way into popular culture—via, for instance, the proclamation of *Wall Street*'s Gordon Gekko that "greed is good"—but it is not universal. Traditions throughout the world instead hold that people's identities are distributed, not only in their physical bodies but also across the persons about whom they care. Sahlins (2008) sums up the challenge these traditions pose to a self-oriented view of human nature: "What means 'self-interest' when both selves and interests are transpersonal relationships rather than the predicate of individuals?" (p. 43).

Increasingly, behavioral and neuroscientific research has weighed in on the side of this "transpersonal" view. Although people are physical islands, at a psychological level we are deeply intertwined. People commonly and powerfully share one another's internal states, and spend inordinate amounts of time thinking about others' experiences. The term "empathy" captures these phenomena, and more broadly describes the porous nature of emotions shared across interpersonal boundaries.

Defining Empathy and Its Components

We operationalize empathy as *the ability and tendency to share and understand others' internal states* (Zaki & Ochsner, 2012). This definition highlights the idea that empathy is a multifaceted construct comprising related but distinct components. Two of these processes have attracted the lion's share of empirical and theoretical attention over the last decades. The first of these is *experience sharing*, or the tendency of *perceivers* (individuals focusing on someone else) to take on the sensorimotor, visceral, and affective states of *targets* (individuals on whom perceivers focus). Early philosophical definitions often describe empathy solely in terms of experience sharing (Lipps, 1903; Smith, 1790/2002), and many theoretical models hold that this phenomenon constitutes empathy's central component (Gallese, 2007; Preston & de Waal, 2002). Regardless of one's stance on the centrality of experience sharing, a raft of empirical work demonstrates that people take on various kinds of states that they observe in others. For example, perceivers mimic others' bodily postures and facial movements (Chartrand & Lakin, 2013; Dimberg & Thunberg, 1998), experience autonomic arousal when they observe it in targets (Levenson & Ruef, 1992; Vaughan & Lanzetta, 1980), and take on targets' moods (Neumann & Strack, 2000).

Though experience sharing is a powerful empathic process, it is not the only one. A second, known as *mentalizing*, describes perceivers' explicit reasoning about targets' internal states using lay "theories" about how situations produce internal states (Gopnik & Wellman, 1992). For instance, most of us know that people can see things that are in front of, but not behind, them; we likewise generally believe that eating ice cream makes people happier than having a cavity drilled. When perceivers mentalize, they combine these intuitions with outward signs targets display (e.g., their facial expressions or actions) to draw inferences about targets' underlying emotions, intentions, and beliefs. Importantly, this form of mentalizing—the use of lay theories to decipher target cues—differs from the simpler process of merely accessing information about targets' states or traits, which can occur rapidly and spontaneously (Gilbert, Pelham, & Krull, 1989; Todorov & Uleman, 2002). The study of mentalizing finds its roots in developmental, ethological, and philosophical work on "theory of mind" (Flavell, 1999; Leslie, 1994; Premack & Woodruff, 1978). Since then, it has expanded to include social psychological investigations of the mechanisms underlying mentalizing (Ames, 2004; Epley, Keysar, Van Boven, & Gilovich, 2004) and computational models that specify the structure of perceivers' lay theories about targets (Baker, Saxe, & Tenenbaum, 2009; Ong, Zaki, & Goodman, 2015; Zaki, 2013).

Mentalizing and experience sharing relate to a third key component of empathy: *prosocial motivation*, through which individuals who share and understand targets' states often are compelled to help those targets (Batson, 2011; Zaki & Ochsner, 2012). We discuss this motivational component of empathy in more detail below.

TABLE 50.1. Comparison of Key Empathic Components

Experience sharing	Mentalizing
Development	
Rudimentary experience sharing in first weeks of life	Early signs toward end of first year/beginning of second year
Stable through first years of life	Develops over the course of early childhood, potentially in conjunction with other cognitive processes
Cognitive features	
Occurs rapidly and outside of awareness, and in the presence of concurrent tasks	Requires time, effort, and attention
Brain systems	
Neural resonance in regions associated with sensorimotor processing, visceral sensation, and affect	Regions of the so-called default network, including MPFC, TPJ, and STS
Disorders	
Psychopathy, conduct disorder, frontotemporal dementia	Autism spectrum disorders

Note. MPFC, medial prefrontal cortex; TPJ, temporoparietal junction; STS, superior temporal sulcus.

Independence of Empathic Processes

Many theories of empathy posit a strong boundary between experience sharing and mentalizing (Davis, 1994; Decety & Jackson, 2004; Hoffman, 1984; Singer, 2006; Uddin, Iacoboni, Lange, & Keenan, 2007), which often go by different but aligned terms such as "cognitive and affective empathy" (Shamay-Tsoory, Aharon-Peretz, & Perry, 2009) or "empathic concern" and "perspective taking" (Davis, 1983). As we (Zaki, 2013; Zaki & Ochsner, 2011b, 2012) have pointed out, these processes are impressively dissociable along a number of dimensions, which can be used to organize research on empathy from various psychological subdisciplines (see Table 50.1 for a summary of these dissociations).

Development

The first "wedge" that separates experience sharing and mentalizing is each process's developmental trajectory. Although somewhat sparse, existing evidence suggests that experience sharing, as compared with mentalizing, (1) comes online earlier in ontogeny and (2) remains more stable over the course of development.

Almost immediately after birth, neonates mimic facial movements such as tongue protrusions (Anisfeld, 1991; Meltzoff & Moore, 1977), consistent with a readily triggered link between perception of an action and the "sharing" of that action through imitation. Soon thereafter, infants display other signs of experience sharing. For instance, in the first week of life, infants express distress upon hearing the sound of another infant's cries (Sagi & Hoffman, 1976), but not when played the sound of their own cries (Martin & Clark, 1982). Ten-week-old infants broaden their imitative palette, responding congruently to adults' emotional facial expressions (Haviland &

Lelwica, 1987). Theorists such as Hoffman (2001) frame this type of experience sharing as the most primitive beginnings of later-developing concern for others. Interestingly, affect sharing also appears relatively stable in early development, as assessed through a small but growing number of longitudinal studies of children's naturalistic responses to feigned or videotaped pain in others (Davidov, Zahn-Waxler, Roth-Hanania, & Knafo, 2013). For instance, Knafo, Zahn-Waxler, Van Hulle, Robinson, and Rhee (2008) documented stable levels of experience sharing in the second year of life, and more recently Roth-Hanania, Davidov, and Zahn-Waxler (2011) demonstrated that this stability stretches even into the first year of life.

By comparison, mentalizing appears a more hard-fought developmental prize. Until a decade or so ago, research on theory of mind—which focused largely on children's understanding of targets' false beliefs—suggested that mentalizing came online between children's third and fourth birthday (Flavell, 1999). This trajectory was so consistent that some theorists assumed that it reflected the activation of a neurodevelopmental "module" for understanding others (Leslie, Friedman, & German, 2004). A major problem with this work, however, is that it often relied on children's verbal reports about their understanding of social targets, thus artificially constraining mentalizing to postverbal children. Removing this constraint, for instance, by using looking time to assess preverbal children's expectations about others' beliefs, has revealed mentalizing capacity much earlier in development, near children's first birthday (Onishi & Baillargeon, 2005; Surian, Caldi, & Sperber, 2007). Critically, however, there remains no evidence that mentalizing comes online as early as experience sharing.

Mentalizing also exhibits a more continuous trajectory across early development than experience sharing. For instance, although Roth-Hanania et al. (2011) documented stable levels of experience sharing between the ages of 6 and 18 months, they found that "hypothesis testing," or children's cognitive assessment of the reason for a target's pain, continued developing over that period. Further, the development of mentalizing abilities coincides with the advent of other "top-down" cognitive abilities such as response inhibition (Carlson & Moses, 2001; Wellman, Cross, & Watson, 2001), again suggesting that—unlike experience sharing—mentalizing develops only after some of its basic psychological "building blocks" fall into place.

Automaticity

A second difference between experience sharing and mentalizing is their level of behavioral automaticity. Experience sharing and mimicry can occur rapidly (Dimberg & Thunberg, 1998) and outside of awareness (Neumann & Strack, 2000). By contrast, mentalizing can be disrupted by the absence of attention and time. Interestingly, failures in mentalizing often reflect perceivers' incorrect assumption that their experiences are shared by social targets. For instance, when distracted or placed under time pressure, perceivers often wrongly infer that targets share their (perceivers') knowledge, beliefs, and emotions (Gilovich, Medvec, & Savitsky, 2000; Keysar, Barr, Balin, & Brauner, 2000). Under this model, mentalizing requires an "anchoring and adjustment" process in which perceivers begin with the egocentric assumption that they share states with targets, and effortfully correct that assumption in order to properly understand targets through mentalizing.[1]

Brain Systems

Experience sharing and mentalizing also diverge based on the neural systems underlying each process. Since the discovery of so-called mirror neurons over two decades ago (di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Rizzolatti & Sinigaglia, 2010), the neuroscience of experience sharing has been dominated by a simple but powerful insight: When observing targets experiencing motor, sensory, and affective states, perceivers exhibit patterns of brain activity similar to those they would evince if experiencing those states themselves. This property—which we term "neural resonance"—characterizes activity across a number of brain regions, including those involved in motor actions (Iacoboni et al., 1999), somatosensation (Keysers, Kaas, & Gazzola, 2010), and affective states such as pain, disgust, and reward (Lamm, Decety, & Singer, 2011; Morelli, Sacchet, & Zaki, 2015; Wicker et al., 2003; Zaki, Lopez, & Mitchell, 2014; Zaki & Ochsner, 2011a).

In our view, neural resonance reflects a more general property of the brain: embodied, or "grounded" cognition. Numerous demonstrations suggest that cognitive representations and linguistic descriptions of internal states produce patterns of brain activity consistent with sensorimotor and visceral representations (Barrett & Satpute, 2013; Barsalou, 2008). For instance, remembering or imagining visual percepts produces activity in the visual cortex (Kosslyn & Ochsner, 1994; Wheeler, Petersen, & Buckner, 2000). Likewise, linguistic terms associated with movements (e.g., "bite" or "kick") produces activity in patches of the motor cortex associated with those movements. It stands to reason, then, that such mechanisms should also apply to the observation of states in others. Such "perception–action coupling" (Dijksterhuis & Bargh, 2001; Preston & de Waal, 2002) thus likely connects experience sharing to other forms of grounded cognition.

Mentalizing exhibits a very different neural profile: typically engaging midline cortical structures such as the medial prefrontal cortex (MPFC) and posterior cingulate cortex, as well as the lateral temporal and inferior parietal cortex, and the temporoparietal junction (TPJ; Mitchell, 2009; Saxe, 2006; Zaki & Ochsner, 2012). At least some evidence indicates that regions within this network are engaged by dissociable features of mentalizing. For instance, the MPFC appears broadly responsive to information about mental states, whereas the TPJ responds more selectively to inferences about others' false beliefs (Saxe & Powell, 2006). This could reflect the TPJ's broader role in orienting to new and unexpected information (Corbetta, Patel, & Shulman, 2008; Mitchell, 2008), or holding multiple representations in mind simultaneously.

Interestingly, brain activity related to mentalizing also characterizes a number of other psychological phenomena, including autobiographical memory, prospection into the future, and mental navigation (Spreng, Mar, & Kim, 2009). These data speak to common mechanisms, such as the need to project one's self out of the "here and now" and imagine distal times, places, or perspectives. These phenomena likely share common psychological features—for instance, the need to reason about probabilistic or "fuzzy" outcomes—that unite them with mentalizing (Buckner & Carroll, 2007).

Further, the set of brain regions associated with mentalizing and other forms of self-projection differs from other systems in the brain in that it is stably active at rest. As such, this system is often referred to as the brain's "default network" (Raichle et al., 2001). The default network comprises multiple subsystems, some of which appear maximally relevant to mentalizing (Andrews-Hanna, Reidler, Sepulcre, Poulin, & Buckner, 2010). However, the overlap of this network with regions implicated in mentalizing and self-projections provides intriguing evidence that individuals at rest might tend to engage in these forms of thinking, including consideration of others' minds (Mason et al., 2007).

Critically, the systems of brain regions engaged by experience sharing and mentalizing are almost entirely nonoverlapping. This dissociation is evident not just across studies but also within studies. For instance, orienting perceivers toward lower-level motor and sensory features of targets' experience engages areas associated with experience sharing, whereas orienting them toward targets' high-level intentions produces engagement in brain areas associated with mentalizing (Spunt, Falk, & Lieberman, 2010; Spunt & Lieberman, 2012; Wheatley, Milleville, & Martin, 2007). Likewise, damage to structures associated with neural resonance produces impairments in experience sharing, whereas damage to regions associated with self-projection (such as the MPFC) produce impairments in mentalizing (Shamay-Tsoory et al., 2009). Together, these data once again suggest a powerful separation among empathic subprocesses.

Disorders

A final way in which mentalizing and experience sharing dissociate is through their differing profiles of dysfunction in psychiatric illness. The most famous such dissociation, highlighted by Blair (2005, 2008), separates autism spectrum disorders (ASDs) from psychopathy. Individuals with ASD exhibit circumscribed difficulties in mentalizing, accompanied by altered patterns of activity in brain systems associated with this empathic subprocess (Philip et al., 2011). They also exhibit reduced spontaneous mimicry, blunted engagement of relevant musculature, reduced mu-supression (an electroencephalogram [EEG] signal associated with motor resonance), and reduced mirror neuron system activity when observing target actions (Dapretto et al., 2006; McIntosh, Reichmann-Decker, Winkielman, & Wilbarger, 2006; Oberman, Ramachandran, & Pineda, 2008), indicating a reduction in low-level sharing of motor intentions. Interestingly, however, these abnormalities are not consistently accompanied by deficits in affect sharing. Instead, children and adults with ASD often exhibit typical levels of distress and concern in the presence of target suffering, and demonstrate typical levels of neural resonance for affective states such as pain (Hadjikhani et al., 2014).

By contrast, individuals with psychopathy are often able to understand others' states, but fail to share those states or exhibit typical levels of neural resonance (Meffert, Gazzola, den Boer, Bartels, & Keysers, 2013), producing a behavioral pattern of callous disregard for others' well-being. In fact, the ability to mentalize while unfettered by experience sharing can be a recipe for socially manipulative behavior. For instance, individuals high in "narcissistic exploitativeness," who self-report a tendency to use others for personal gain, exhibit higher than average levels of interpersonal accuracy, consistent with intact and even superior mentalizing ability (Konrath, Corneille, Bushman, & Luminet, 2013).

Summary

These data support the idea that empathy, rather than being a monolithic phenomenon, instead constitutes a constellation of psychological processes, including mentalizing and experience sharing. These processes are impressively separable, based on their developmental trajectories, cognitive features, underlying neural systems, and pattern of dysfunction in disordered populations. That said, the holistic experience of empathy, and the behavior it produces, likely involves a densely intermingled deployment of both processes. It is to this idea that we now turn.

Nonindependence of Empathic Processes

Cases in which psychological processes *can be* dissociated can tempt readers into the inference that those processes are *always* independent. This type of logic is often wrong, however, and the case of empathy is no different. Despite the splits between experience sharing and mentalizing we describe above, measuring empathy in realistic contexts and examining its most important "downstream" consequences reveals that these processes are deeply interconnected.

Naturalism

As with so much of psychology (Neisser, 1976; Rozin, 2001), the study of empathy reflects a tension between experimental control and naturalism (see also Zaki, 2013; Zaki & Ochsner, 2009, 2012). On the one hand, elucidating empathy's structure requires employing paradigms in which the different facets of empathy can be elicited and studied as cleanly and independently as possible. For instance, neuroscientists examining experience sharing often present subjects with decontextualized nonverbal displays of target affect (e.g., images of targets experiencing pain), and do not ask perceivers to draw explicit inferences about targets' experiences based on those cues. By contrast, studies of mentalizing typically ask perceivers to draw just such inferences, often based on "higher-level" social cues, such as written descriptions of the situation in which a target finds him- or herself. These methodological disparities make it unsurprising when previous studies isolate nonoverlapping areas associated with each empathic process. To wit, they are designed to do so.

However, the vast majority of empathic episodes outside the narrow context of the laboratory do not feature isolated "pieces" of social information. Instead, perceivers most often encounter cues that are multimodal (occurring over multiple informational channels), dynamic (changing over time), and contextually embedded (such that interpreting one cue requires processing of other, concurrent or temporally antecedent, social information). Recently, a spate of neuroscientific studies of empathy has employed more *naturalistic* social stimuli that contain these features (e.g., videos of targets explaining their experiences or live interactions between perceivers and targets). These studies have consistently revealed concurrent engagement of brain regions associated with both mentalizing and experience sharing (Redcay et al., 2010; Schilbach et al., 2013; Zaki, Weber, Bolger, & Ochsner, 2009), as well as connectivity across the brain networks supporting both processes (Lombardo et al., 2010; Zaki, Ochsner, Hanelin, Wager, & Mackey, 2007). Together, such data suggest that although empathic processes are separable, in everyday situations empathy likely comprises an interactive deployment of both processes (Keysers & Gazzola, 2007; Shamay-Tsoory, 2011; Uddin et al., 2007).

Accuracy

Another way to probe interactions between empathic subprocesses is by examining the predictors of empathy's "downstream" consequences. Here, we discuss one such consequence: perceivers' ability to accurately infer targets' internal states (Funder, 1995; Ickes, 1997). Accuracy in social contexts allows individuals to effectively interact with others—whether those interactions entail coordinated cooperation or outsmarting others in competitive settings (Byrne & Whiten, 1988; Tomasello, 2000)—and predicts adaptive outcomes in a number of contexts, such as the success of close relationships and positive adjustment in adolescents (Gleason, Jensen-Campbell, & Ickes, 2009; Verhofstadt, Buysse, Ickes, Davis, & Devoldre, 2008).

As with naturalistic empathic settings, accuracy appears not to be scaffolded by *either* experience sharing or mentalizing, but rather by a combination of both processes (Zaki & Ochsner, 2011b). Intuitively, the connection between mentalizing and accurate social inferences appears clear; after all, accuracy often requires "thinking through" what a perceiver likely feels given his or her displays and context, given sufficient time and attentional resources (Epley et al., 2004; Keysar et al., 2000). Neuroimaging investigations likewise reveal that brain areas associated with mentalizing track the complexity (Hampton, Bossaerts, & O'Doherty, 2008) and accuracy (Zaki et al., 2009) of inferences about others.

However, intuitive processes, including experience sharing, also scaffold interpersonal accuracy, in some cases more quickly and efficiently than mentalizing. As discussed above, perceivers quickly take on targets' facial expressions, postures, and moods. Such sharing, in turn, allows perceivers to "read out" their own internal states as cues about what targets might be feeling. And indeed, mimicry—whether it is measured or manipulated across individuals—tracks reaction time and accuracy in interpreting nonverbal emotion cues such as facial expressions (Blairy, Herrerea, & Hess, 1999; Hess & Blairy, 2001; Neal & Chartrand, 2011).

We have used neuroimaging to further examine the role of experience sharing and mentalizing in supporting accurate inferences, using an empathic accuracy paradigm (Ickes, 1997; Zaki & Ochsner, 2011b). In our protocol, perceivers were scanned using functional magnetic resonance imaging (fMRI) while they viewed videos of targets describing emotional autobiographical events. Critically, targets had previously viewed videos of themselves describing these events and used a rating dial to continuously report how positively or negatively they had felt at each moment while talking. Perceivers then used the same rating scale to infer how they believed targets felt, allowing us to use time series correlations between perceiver guesses and target self-reports as quantitative measures of accuracy. This approach revealed that areas in the so-called mirror neuron system, associated with mimicry and shared experience, as well as areas classically associated with mentalizing, both tracked the accuracy of perceivers' inferences on a video-by-video basis (Zaki et al., 2009).

It is important to note that although both mentalizing and experience sharing both support accuracy, they might do so more or less depending on the context. For instance, experience sharing affords a powerful window into targets' internal states, but only to the extent that perceivers believe their own minds are reasonable templates through which to understand targets. Similarity often determines whether or not this is the case. For instance, if a Bostonian perceiver and a New Yorker target both attend the Democratic National Convention, the perceiver's own states are probably useful in understanding how the target will feel about politics, but not about baseball (where the vicious Yankees–Red Sox rivalry likely divides them).

Both behavioral and neuroimaging approaches confirm the bounded nature of perceivers' tendency to deploy experience sharing, and the utility of doing so. For instance, perceivers who are similar to targets along important dimensions (e.g., political orientation) or share relatively minimal group assignments (e.g., based on preference for a television show) assume that their own preferences and mental states track targets' own (Ames & Kammrath, 2004). Likewise, perceivers who are similar to, but not dissimilar from, targets deploy neural resonance when watching targets perform movements (Aziz-Zadeh, Sheng, Liew, & Damasio, 2011), thinking about target preferences (Jenkins, Macrae, & Mitchell, 2008; Mitchell, Macrae, & Banaji, 2006), and observing targets' affective states (Mobbs et al., 2009; Singer et al., 2006; Xu, Zuo, Wang, & Han, 2009). Perceivers' "tuning" of experience sharing based on similarity further appears to be an adaptive strategy: perceivers' use of their own states to understand targets improves accuracy only when overall perceiver–target similarity is high (Hodges, Kiel, Kramer, Veach, & Villanueva, 2010; Neyer, Banse, & Asendorpf, 1999).

Overall, these data support two key points: (1) accuracy demonstrates the joint utility of both experience sharing and mentalizing in accurately understanding others; and (2) each of these processes' relationship to accuracy depends on contextual factors, such as overall similarity between targets and perceivers.

Prosocial Motivation as Both a Component and a Consequence of Empathy

Psychological phenomena are typically not idle, but rather serve important adaptive behaviors. Put more succinctly, thinking is for doing (Fiske, 1992). Empathy is no exception, and instead supports humans' vital cooperative and generous behavior through *prosocial motivation*, or perceivers' desire to help one another. Interestingly, researchers have described prosocial motivation both as a *component* of empathy, akin to experience sharing and mentalizing (Davis, 1994; Batson, 2011; Zaki & Ochsner, 2012, and as a *consequence* of these other two processes (Tomasello, Carpenter, Call, Behne, & Moll, 2005). We believe these two approaches dovetail nicely: prosocial motivation can be considered a component of empathy that flows from mentalizing and experience sharing. This is because individuals who vicariously share and also understand others' states should naturally come to care about targets' states. Interestingly, experience sharing and mentalizing might comprise dissociable routes to prosocial behavior, and it is to this idea that we now turn.

As has been recognized at least since Adam Smith's (1790/2002) *The Theory of Moral Sentiments*, experience sharing can produce powerful and even instinctive prosocial motivation (Zaki & Mitchell, 2013). Consider a perceiver who witnesses a friend in pain and has the option of helping that friend through a personally costly prosocial act. To the extent that the perceiver experiences self–other overlap with that target, the target's pain will produce vicarious distress in the perceiver. In many cases, such shared affect renders the psychological burden (in the form of shared pain) of *not helping* the target greater than that of helping.

Classic and contemporary work has leveraged knowledge about conditioning to demonstrate that (1) perceivers can be conditioned to fear or enjoy neutral stimuli that are paired with punishment or rewards delivered not to the perceiver him- or herself, but to a social target (Berger, 1962; Olsson & Phelps, 2007; Vaughan & Lanzetta, 1980); and (2) both humans and monkeys can be instrumentally conditioned to repeat a response simply because it decreases a target's suffering (Wechkin, Masserman, & Terris, 1964; Weiss, Buchanan, Altstatt, & Lombardo, 1971). Connecting these two ideas, Krebs (1975) demonstrated that individuals who displayed the strongest physiological reactions to others' distress (a proxy for the experience of shared affect) also were most willing to provide costly help to those targets. Cialdini and colleagues built on this model by documenting cases in which perceivers' sense of overlap with social targets predicts the costs they are willing to incur to help those targets (Cialdini, Brown, Lewis, Luce, & Neuberg, 1997; Cialdini & Kenrick, 1976; Cialdini et al., 1987). More recently, neuroscientists have documented cases in which self–other overlap measured through neural resonance predicts prosocial behavior. For instance, perceivers' engagement of brain areas associated with distress while seeing targets' misfortune (Hein, Silani, Preuschoff, Batson, & Singer, 2010), and with reward while observing targets' gains (Harbaugh, Mayr, & Burghart, 2007; Hare, Camerer, Knoepfle, & Rangel, 2010; Zaki et al., 2013), both predict individuals' willingness to later help those targets.

Mentalizing has also long been connected with prosocial motivation. Batson and others (Batson, 1991, 2011; Tomasello et al., 2005) have argued that prosociality fundamentally relies not only on individuals' sense of psychological overlap with each other, but also on perceivers' ability to represent the content of targets' minds through mentalizing. This idea is supported by evidence that explicit instructions to mentalize about targets increases perceivers' subsequent prosocial behaviors (Batson, Early, & Salvarani, 1997; Sturmer, Snyder, & Omoto, 2005). By contrast, dehumanization—people's unfortunate tendency to deny complex mental states to targets from other social groups—results in "sparse" inferences about outgroup targets' minds (Waytz, Gray, Epley, & Wegner, 2010), reductions in brain activity associated with mentalizing (Harris & Fiske, 2007), and reduced prosociality (Cuddy, Rock, & Norton, 2007). Finally, mentalizing-related brain activity during an impression formation task predicts later prosociality toward targets (Waytz, Zaki, & Mitchell, 2012), further suggesting that explicit consideration of targets' minds scaffolds our tendency to help.

The foregoing evidence thus points to two mechanisms underlying prosociality, which connect with experience sharing and mentalizing, respectively. As with accuracy, these data highlight the idea that downstream consequences of empathy cannot be reduced to a single empathic process, but rather require understanding how empathic components interact and combine.

The relationship among mentalizing, experience sharing, and prosocial motivation, though powerful, is by no means simple or monotonic. For instance, although experience sharing often compels perceivers to help targets, it can do so in ways that are demonstrably suboptimal. This is because experience sharing is most often elicited by the perception of clear (i.e., nonambiguous), nonverbal cues about individuals' joy or suffering (e.g., facial expressions). As such, this process can skew perceivers toward helping only when they have direct access to such cues. This produces a number of biases, such as perceivers' tendency to feel more empathy for the suffering of one person than the suffering of a group (the "identifiable victim effect"; Small & Loewenstein, 2003). These biases have spurred some theorists to argue that experience sharing constitutes an unreliable source of moral and prosocial behavior (Bloom, 2013; Prinz, 2011).

Mentalizing likewise has a complex relationship with prosociality. Consider the case of intergroup interactions. In some instances, taking the perspective of an outgroup target can increase perceivers' prosociality (Sturmer et al., 2005). However, in more fraught intergroup contexts, mentalizing with targets can promote *antisocial* behavior or attitudes. For instance, perceivers who mentalize about a target with whom they are competing may realize that target is likely to take advantage of them, and preempt their own losses by first acting antisocially themselves (Epley, Caruso, & Bazerman, 2006; Pierce, Kilduff, Galinsky, & Sivanathan, 2013). For individuals from low-power groups entangled in conflict (e.g., Palestinians), mentalizing about higher-power conflict groups (e.g., Israelis) can likewise intensify, not soften, their conflict-related negative attitudes (Bruneau & Saxe, 2012). Together, these data suggest that both experience sharing and mentalizing can support prosociality, but by no means always do so.

New Directions in Empathy Research

Having sketched the basic mechanisms underlying empathy and their interactions with one another, we now turn to two emerging, interconnected themes we see as important to the future of empathy research and theory.

The Motivated Nature of Empathy

One common assumption about empathy, and experience sharing in particular, is that it is deployed automatically in the presence of target emotions, and generally "happens to" perceivers. This view also constitutes a common thread uniting early and contemporary theories of empathy (see Zaki, 2014, for a review). Automatic models draw support from many demonstrations (some described above) that experience sharing and mimicry indeed occur quickly and outside of awareness. Any of us who have been unlucky enough to witness someone suffer a horrible injury, for instance, can attest to the seemingly unstoppable nature of vicarious distress. However, the fact that a process can be deployed automatically does not mean that perceivers have no recourse to alter empathic episodes based on their desires and motives.

Instead, ample evidence suggests that—as with emotions more generally (Tamir, 2009)—people have strong motives surrounding their experience of empathy.[2] For instance, perceivers often want to *avoid* empathy when it promises to be painful or costly, or when they interact with outgroup targets, or to *approach* empathy when it facilitates important social goals like relationship formation and maintenance. Also like with other emotions, perceivers carry out their motives to feel or not feel empathy through a number of regulatory strategies (Ochsner & Gross, 2005). For instance, if a perceiver anticipates that interacting with a target (e.g., a terminally ill patient) will provoke painful amounts of empathy, he or she can avoid that target altogether, in an interpersonal analogue of "situation selection" (Gross, 2002). Likewise, perceivers often cannily change their perception of targets' affective states, for instance, by reducing their attention to or reappraising the suffering of outgroup targets, thus making it easier to harm those targets (see Zaki, 2014, for a systematic review of empathic regulatory strategies).

Acknowledging empathy's motivated nature extends prior models, for instance, suggesting that some cases of empathic failure (e.g., in clinical populations and intergroup contexts) do not necessarily signal *inabilities* to empathize, but rather reduced motivation to do so. This further suggests that intervention approaches aiming to increase empathy should focus not only on training empathic skills, but also on changing perceivers' motives to feel empathy, for instance, by emphasizing social norms or personal values that encourage empathy (Arieli, Grant, & Sagiv, 2013; Tarrant, Dazeley, & Cottom, 2009). In a recent, allied approach, Schumann, Zaki, and Dweck (2014) induced individuals to believe either that empathy is a stable and unchangeable trait (an *entity mind-set*), or that empathy varies as a function of effort (an *incremental mind-set*). In prior research, incremental, as compared with entity, mind-sets increase individuals' motivation to expend effort under challenging situations (Dweck, 2006). Consistent with a motivated approach to empathy, incremental mind-sets likewise increased perceivers' willingness to engage with targets under challenging circumstances, for instance, when empathy promised to be affectively painful, or when perceivers encountered outgroup targets. In the future, motivated models should complement automatic views to build scientific understanding of when empathy fails and how it can be increased.

There Is No Ideal "Set Point" for Empathic Experience

A second evolving idea in the world of empathy research concerns the assumption that empathy is always desirable. People by and large believe that empathy ranks among other positive traits (on par with, e.g., friendliness or intelligence) in qualifying someone as a good person (Schumann et al., 2014). And indeed, empathy provides a vital emotional underpinning for all manner of adaptive social behavior. However, this does not imply that empathy is always a positive force, either for social perceivers or targets. This is especially true when empathic components are divorced from one another. As described above, psychopathy and intergroup competition mark two cases in which perceivers who deploy mentalizing in the absence of experience sharing can use their understanding of targets to cajole, manipulate, or even maximally harm other people (Konrath et al., 2013; Nozaki & Koyasu, 2013). Likewise, experience sharing can often backfire, for instance, allowing perceivers in competitive interactions to be taken advantage of (Gilin, Maddux, Carpenter, & Galinsky, 2013).

In addition to not always aiding interpersonal interactions, empathy can also be emotionally exhausting for perceivers. Imagine, for instance, walking down a Manhattan street while vicariously experiencing the affective states of everyone around you. This state of affairs would become unsustainable in minutes. Many people in careers that require common contact with others' suffering exemplify how difficult empathy can be for perceivers. Although it has yet to be studied rigorously, caretakers, clinicians, and medical professionals report widespread "empathy fatigue," or a sense of being overwhelmed by others' suffering (Figley, 1995, 2002).

We believe that the potentially deleterious effects of empathy should receive more attention in both basic and applied research. Consider the growing movement of interventions aimed at modulating empathy. Almost all such interventions seek to increase individuals' empathic responses, using methods derived from theory, religious practices, and/or basic science (Gordon, 2009; Weng et al., 2013). Such efforts are crucially important, but should be complemented by efforts to modulate empathic experience in other ways. In particular, we believe that perceivers could benefit from training in how to *regulate* empathy, increasing it when it is needed but also decreasing it when it proves overwhelming or maladaptive. Such regulation will be served by understanding that empathy—although a vital and powerful affective force—does not have an ideal set point.

Relationships between Empathy and Other Emotional States

One deep but unanswered question surrounds the extent to which empathy resembles—or can be reduced to—other, "intrapersonal" emotions. At first blush, experiencing an emotion one's self and observing that emotion in someone else appear dissociable in at least two ways. First, emotion experience, but not observation, appears to include *components*—such as visceral arousal—that can only be experienced in the first person. If this is the case, empathic experiences should require an inferential step that personal emotion does not. Second, personal emotion and empathy appear responsive to different *sources*: one's own experiences in the case of personal emotion versus a social target's emotion in the case of empathy. As Hoffman (1984) put it, empathy represents an emotional reaction in a perceiver that is more appropriate to a target's experience than to the perceiver's own. These apparent distinctions play into the relatively distinct treatment that emotion *experience* and emotion *perception* have received in existing research and theory.

Upon closer examination, however, these distinctions break down. Like other distinctions between self- and other-perception (Bem, 1967; Nisbett & Wilson, 1977), personal emotion might not feature privileged insight into one's own internal states. Indeed, appraisal and conceptual act theories hold that emotional experience occurs through a process of interpretation, through which people apply concepts to decipher core affective cues such as arousal (Barrett, 2013; Scherer, Schorr, & Johnstone, 2001). Similar processes characterize perception of others' emotions (Barrett, Lindquist, & Gendron, 2007; Nook, Lindquist, & Zaki, 2015) and empathy more broadly. In fact, experience sharing and mentalizing tightly parallel core affect and conceptualization as laid out in Barrett's conceptual act theory (Barrett, 2013). In particular, experience sharing provides initial affective and visceral inputs, which perceivers combine with conceptual information they glean through mentalizing to draw inferences about targets' states. In addition to its basic structure, empathy shares parallels with personal emotions in domains of motives and regulation. As described above, individuals desire to feel (or not feel) empathy just as they do with other emotional states (Tamir, 2009; Zaki, 2014), and likewise regulate empathic states in ways that parallel so-called intrapersonal emotion regulation (Ochsner & Gross, 2005; Zaki & Williams, 2013).

Broadly, empathy shares many features with other forms of emotion, but existing work has yet to directly compare the structure of personal emotional experiences with that of interpersonal affect. This will be an exciting and—we hope—synthetic direction for future research.

Conclusions

The study of empathy represents a centuries-old tradition that nonetheless continues changing rapidly through the advent of both new techniques and ideas. Further uncovering the cognitive and affective structure of this phenomenon will be crucial to understanding the ways in which interpersonal affect shapes social interactions.

Notes

1. The use of self-projection does not, of course, *always* lead perceivers astray. For instance, when perceivers and targets are highly similar, perceivers are more likely to project their own states onto targets (Ames, 2004), and more likely to accurately understand targets by doing so (Neyer et al., 1999). This type of projection, however, is less robust to context than mentalizing.
2. Importantly, motives—and the way they are carried out—operate at both explicit and implicit levels, and individuals often experience and act on even nonconscious motives (Gyurak, Gross, & Etkin, 2011; Williams, Bargh, Nocera, & Gray, 2009).

References

Ames, D. (2004). Inside the mind reader's tool kit: Projection and stereotyping in mental state inference. *Journal of Personality and Social Psychology, 87*(3), 340–353.

Ames, D., & Kammrath, L. (2004). Mind-reading and metacognition: Narcissism, not actual competence, predicts self-estimated ability. *Journal of Nonverbal Behavior, 28*(3), 187–209.

Andrews-Hanna, J. R., Reidler, J. S., Sepulcre, J., Poulin, R., & Buckner, R. L. (2010). Functional-anatomic fractionation of the brain's default network. *Neuron, 65*(4), 550–562.

Anisfeld, M. (1991). Neonatal imitation. *Developmental Review, 11*(1), 60–97.

Arieli, S., Grant, A. M., & Sagiv, L. (2013). Convincing yourself to care about others: An intervention for enhancing benevolence values. *Journal of Personality, 82*, 1.

Aziz-Zadeh, L., Sheng, T., Liew, S. L., & Damasio, H. (2011). Understanding otherness: The neural bases of action comprehension and pain empathy in a congenital amputee. *Cerebral Cortex, 22*(4), 811–819.

Baker, C. L., Saxe, R., & Tenenbaum, J. B. (2009). Action understanding as inverse planning. *Cognition, 113*(3), 329–349.

Barrett, L. F. (2013). Psychological construction: The Darwinian approach to the science of emotion. *Emotion Review, 5*(4), 379–389.

Barrett, L. F., Lindquist, K. A., & Gendron, M. (2007). Language as context for the perception of emotion. *Trends in Cognitive Sciences, 11*(8), 327–332.

Barrett, L. F., & Satpute, A. B. (2013). Large-scale brain networks in affective and social neuroscience: Towards an integrative functional architecture of the brain. *Current Opinion in Neurobiology, 23*(3), 361–372.

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Clinical Psychology, 59*, 617–645.

Batson, C. D. (1991). *The altruism question: Toward a social–psychological answer.* Hillsdale, NJ: Erlbaum.

Batson, C. D. (2011). *Altruism in humans.* New York: Oxford University Press.

Batson, C. D., Early, S., & Salvarani, G. (1997). Perspective taking: Imagining how another feels versus imaging how you would feel. *Personality and Social Psychology Bulletin, 23*(7), 751–758.

Bem, D. (1967). Self-perception: An alternative interpretation of cognitive dissonance phenomena. *Psychological Review, 74,* 183–200.

Berger, S. M. (1962). Conditioning through vicarious instigation. *Psychological Review, 69*(5), 450.

Blair, R. J. (2005). Responding to the emotions of others: Dissociating forms of empathy through the study of typical and psychiatric populations. *Consciousness and Cognition, 14*(4), 698–718.

Blair, R. J. (2008). Fine cuts of empathy and the amygdala: Dissociable deficits in psychopathy and autism. *Quarterly Journal of Experimental Psychology (Colchester), 61*(1), 157–170.

Blairy, S., Herrerea, P., & Hess, U. (1999). Mimicry and the judgement of emotional facial expressions. *Journal of Nonverbal Behavior, 23*(1), 5–41.

Bloom, P. (2013, May 20). The baby in the well: The case against empathy. *The New Yorker*, 20.

Bruneau, E. G., & Saxe, R. (2012). The power of being heard: The benefits of "perspective-giving" in the context of intergroup conflict. *Journal of Experimental Social Psychology, 48*(4), 855–866.

Buckner, R. L., & Carroll, D. C. (2007). Self-projection and the brain. *Trends in Cognitive Science, 11*(2), 49–57.

Byrne, R., & Whiten, A. (1988). *Machiavellian intelligence: Social expertise and the evolution of intellect in monkeys, apes, and humans*. Oxford, UK: Oxford University Press.

Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development, 72*(4), 1032–1053.

Chartrand, T. L., & Lakin, J. L. (2013). The antecedents and consequences of human behavioral mimicry. *Annual Review of Psychology, 64*, 285–308.

Cialdini, R. B., Brown, S. L., Lewis, B. P., Luce, C., & Neuberg, S. L. (1997). Reinterpreting the empathy–altruism relationship: When one into one equals oneness. *Journal of Personality and Social Psychology, 73*(3), 481–494.

Cialdini, R. B., & Kenrick, D. T. (1976). Altruism as hedonism: A social development perspective on the relationship of negative mood state and helping. *Journal of Personality and Social Psychology, 34*(5), 907.

Cialdini, R. B., Schaller, M., Houlihan, D., Arps, K., Fultz, J., & Beaman, A. L. (1987). Empathy-based helping: Is it selflessly or selfishly motivated? *Journal of Personality and Social Psychology, 52*(4), 749–758.

Corbetta, M., Patel, G., & Shulman, G. L. (2008). The reorienting system of the human brain: From environment to theory of mind. *Neuron, 58*(3), 306–324.

Cuddy, A., Rock, M., & Norton, M. (2007). Aid in the aftermath of Hurricane Katrina. *Group Processes and Intergroup Relations, 10*(1), 107–118.

Dapretto, M., Davies, M. S., Pfeifer, J. H., Scott, A. A., Sigman, M., Bookheimer, S. Y., et al. (2006). Understanding emotions in others: Mirror neuron dysfunction in children with autism spectrum disorders. *Nature Reviews Neuroscience, 9*(1), 28–30.

Davidov, M., Zahn-Waxler, C., Roth-Hanania, R., & Knafo, A. (2013). Concern for others in the first year of life: Theory, evidence, and avenues for research. *Child Development Perspectives, 7*(2), 126–131.

Davis, M. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology, 44*(1), 113–126.

Davis, M. (1994). *Empathy: A social psychological approach*. New York: Westview Press.

Decety, J., & Jackson, P. L. (2004). The functional architecture of human empathy. *Behavioral and Cognitive Neuroscience Reviews, 3*(2), 71–100.

di Pellegrino, G., Fadiga, L., Fogassi, L., Gallese, V., & Rizzolatti, G. (1992). Understanding motor events: A neurophysiological study. *Experimental Brain Research, 91*(1), 176–180.

Dijksterhuis, A., & Bargh, J. (2001). The perception–behavior expressway: Automatic effects of social perception on social behavior. *Advances in Experimental Social Psychology, 33*, 1–40.

Dimberg, U., & Thunberg, M. (1998). Rapid facial reactions to emotional facial expressions. *Scandinavian Journal of Psychology, 39*(1), 39–45.

Dweck, C. S. (2006). *Mindset: The new psychology of success*: New York: Random House.

Epley, N., Caruso, E., & Bazerman, M. (2006). When perspective taking increases taking: Reactive egoism in social interaction. *Journal of Personality and Social Psychology, 91*(5), 872–889.

Epley, N., Keysar, B., Van Boven, L., & Gilovich, T. (2004). Perspective taking as egocentric anchoring and adjustment. *Journal of Personality and Social Psychology, 87*(3), 327–339.

Figley, C. R. (1995). Compassion fatigue: Toward a new understanding of the costs of caring.

Figley, C. R. (2002). Compassion fatigue: Psychotherapists' chronic lack of self care. *Journal of Clinical Psychology, 58*(11), 1433–1441.

Fiske, S. T. (1992). Thinking is for doing: Portraits of social cognition from Daguerreotype to laserphoto. *Journal of Personality and Social Psychology, 63*(6), 877–889.

Flavell, J. (1999). Cognitive development: Children's knowledge about other minds. *Annual Review of Psychology, 50*, 21–45.

Funder, D. C. (1995). On the accuracy of personality judgment: A realistic approach. *Psychological Review, 102*(4), 652–670.

Gallese, V. (2007). Before and below "theory of mind": Embodied simulation and the neural correlates of social cognition. *Philosophical Transactions of the Royal Society B: Biological Sciences, 362*(1480), 659–669.

Gilbert, D., Pelham, B., & Krull, D. (1989). On cognitive busyness: When person perceivers meet persons perceived. Journal of Personality and Social Psychology, 54(5), 733–740.

Gilin, D., Maddux, W. W., Carpenter, J., & Galinsky, A. D. (2013). When to use your head and when to use your heart: The differential value of perspective-taking versus empathy in competitive interactions. *Personality and Social Psychology Bulletin, 39*(1), 3–16.

Gilovich, T., Medvec, V. H., & Savitsky, K. (2000). The spotlight effect in social judgment: An egocentric bias in estimates of the salience of one's own actions and appearance. *Journal of Personality and Social Psychology, 78*, 211–222.

Gleason, K., Jensen-Campbell, L., & Ickes, W. (2009). The role of empathic accuracy in adolescents' peer relations and adjustment. *Personality and Social Psychology Bulletin, 35*(8), 991–1011.

Gopnik, A., & Wellman, H. (1992). Why the child's theory of mind really is a theory. *Mind and Language, 7*(1–2), 145–171.

Gordon, M. (2009). *Roots of empathy: Changing the world child by child*. New York: Workman.

Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology, 39*(3), 281–291.

Gyurak, A., Gross, J. J., & Etkin, A. (2011). Explicit and implicit emotion regulation: A dual-process framework. *Cognition and Emotion, 25*(3), 400–412.

Hadjikhani, N., Zürcher, N., Rogier, O., Hippolyte, L., Lemonnier, E., Ruest, T., et al. (2014). Emotional contagion for pain is intact in autism spectrum disorders. *Translational Psychiatry, 4*(1), e343.

Hampton, A. N., Bossaerts, P., & O'Doherty, J. P. (2008). Neural correlates of mentalizing-related computations during strategic interactions in humans. *Proceedings of the National Academy of Sciences USA, 105*(18), 6741–6746.

Harbaugh, W. T., Mayr, U., & Burghart, D. R. (2007). Neural responses to taxation and voluntary giving reveal motives for charitable donations. *Science, 316*(5831), 1622–1625.

Hare, T. A., Camerer, C. F., Knoepfle, D. T., & Rangel, A. (2010). Value computations in ventral medial prefrontal cortex during charitable decision making incorporate input from regions involved in social cognition. *Journal of Neuroscience, 30*(2), 583–590.

Harris, L. T., & Fiske, S. T. (2007). Social groups that elicit disgust are differentially processed in mPFC. *Social Cognitive and Affective Neuroscience, 2*(1), 45–51.

Haviland, J. M., & Lelwica, M. (1987). The induced affect response: 10-week-old infants' responses to three emotion expressions. *Developmental Psychology, 23*(1), 97.

Hein, G., Silani, G., Preuschoff, K., Batson, C. D., & Singer, T. (2010). Neural responses to ingroup and outgroup members' suffering predict individual differences in costly helping. *Neuron, 68*(1), 149–160.

Hess, U., & Blairy, S. (2001). Facial mimicry and emotional contagion to dynamic emotional facial expressions and their influence on decoding accuracy. *International Journal of Psychophysiology, 40*(2), 129–141.

Hodges, S. D., Kiel, K. J., Kramer, A. D. I., Veach, D., & Villanueva, B. R. (2010). Giving birth to empathy: The effects of similar experience on empathic accuracy, empathic concern, and perceived empathy. *Personality and Social Psychology Bulletin, 36*(3), 398–409.

Hoffman, M. (1984). Interaction of affect and cognition in empathy. In C. Izard, J. Kagan, & R. Zajonc (Eds.), *Emotions, cognition, and behavior* (pp. 103–131). Cambridge, UK: Cambridge University Press.

Hoffman, M. (2001). *Empathy and moral development: Implications for caring and justice*. Cambridge, UK: Cambridge University Press.

Iacoboni, M., Woods, R. P., Brass, M., Bekkering, H., Mazziotta, J. C., & Rizzolatti, G. (1999). Cortical mechanisms of human imitation. *Science, 286*(5449), 2526–2528.

Ickes, W. (1997). *Empathic accuracy*. New York: Guilford Press.

Jenkins, A. C., Macrae, C. N., & Mitchell, J. P. (2008). Repetition suppression of ventromedial prefrontal activity during judgments of self and others. *Proceedings of the National Academy of Sciences USA, 105*(11), 4507–4512.

Keysar, B., Barr, D. J., Balin, J. A., & Brauner, J. S. (2000). Taking perspective in conversation: The role of mutual knowledge in comprehension. *Psychological Science, 11*(1), 32–38.

Keysers, C., & Gazzola, V. (2007). Integrating simulation and theory of mind: From self to social cognition. *Trends in Cognitive Science, 11*(5), 194–196.

Keysers, C., Kaas, J. H., & Gazzola, V. (2010). Somatosensation in social perception. *Nature Reviews Neuroscience, 11*(6), 417–428.

Knafo, A., Zahn-Waxler, C., Van Hulle, C., Robinson, J. L., & Rhee, S. H. (2008). The developmental origins of a disposition toward empathy: Genetic and environmental contributions. *Emotion, 8*(6), 737.

Konrath, S., Corneille, O., Bushman, B. J., & Luminet, O. (2013). The relationship between narcissistic exploitativeness, dispositional empathy, and emotion recognition abilities. *Journal of Nonverbal Behavior, 38*, 129–143.

Kosslyn, S. M., & Ochsner, K. N. (1994). In search of occipital activation during visual mental imagery. *Trends in Neurosciences, 17*(7), 290–292.

Krebs, D. (1975). Empathy and altruism. *Journal of Personality and Social Psychology, 32*(6), 1134.

Lamm, C., Decety, J., & Singer, T. (2011). Meta-analytic evidence for common and distinct neural networks associated with directly experienced pain and empathy for pain. *Neuroimage, 54*(3), 2492–2502.

Leslie, A. M. (1994). Pretending and believing: Issues in the theory of ToMM. *Cognition, 50*(1–3), 211–238.

Leslie, A. M., Friedman, O., & German, T. P. (2004). Core mechanisms in "theory of mind." *Trends in Cognitive Science, 8*(12), 528–533.

Levenson, R. W., & Ruef, A. M. (1992). Empathy: A physiological substrate. *Journal of Personality and Social Psychology, 63*(2), 234–246.

Lipps, T. (1903). Einfühlung, innere Nachahmung, und Organempfindungen. *Archiv für Psychologie, 1*, 185–204.

Lombardo, M. V., Chakrabarti, B., Bullmore, E. T., Wheelwright, S. J., Sadek, S. A., Suckling, J., et al. (2010). Shared neural circuits for mentalizing about the self and others. *Journal of Cognitive Neuroscience, 22*(7), 1623–1635.

Martin, G. B., & Clark, R. D. (1982). Distress crying in neonates: Species and peer specificity. *Developmental Psychology, 18*(1), 3.

Mason, M. F., Norton, M. I., Van Horn, J. D., Wegner, D. M., Grafton, S. T., & Macrae, C. N. (2007). Wandering minds: The default network and stimulus-independent thought. *Science, 315*(5810), 393–395.

McIntosh, D. N., Reichmann-Decker, A., Winkielman, P., & Wilbarger, J. L. (2006). When the social mirror breaks: Deficits in automatic, but not voluntary, mimicry of emotional facial expressions in autism. *Developmental Science, 9*(3), 295–302.

Meffert, H., Gazzola, V., den Boer, J. A., Bartels, A. A., & Keysers, C. (2013). Reduced spontaneous but relatively normal deliberate vicarious representations in psychopathy. *Brain, 136*(8), 2550–2562.

Meltzoff, A. N., & Moore, M. K. (1977). Imitation of facial and manual gestures by human neonates. *Science, 198*(4312), 75–78.

Mitchell, J. P. (2008). Activity in right temporo-parietal junction is not selective for theory-of-mind. *Cerebral Cortex, 18*(2), 262–271.

Mitchell, J. P. (2009). Inferences about mental states. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1521), 1309–1316.

Mitchell, J. P., Macrae, C. N., & Banaji, M. R. (2006). Dissociable medial prefrontal contributions to judgments of similar and dissimilar others. *Neuron, 50*(4), 1–9.

Mobbs, D., Yu, R., Meyer, M., Passamonti, L., Seymour, B., Calder, A. J., et al. (2009). A key role for similarity in vicarious reward. *Science, 324*(5929), 900.

Morelli, S. A., Sacchet, M. D., & Zaki, J. (2015). Common and distinct neural correlates of personal and vicarious reward: A quantitative meta-analysis. *NeuroImage, 112*, 244–253

Neal, D. T., & Chartrand, T. L. (2011). Embodied emotion perception: Amplifying and dampening facial feedback modulates emotion perception accuracy. *Social Psychological and Personality Science, 2*(6), 673–678.

Neisser, U. (1976). *Cognition and reality: Principles and implications of cognitive psychology.* San Francisco: Freeman.

Neumann, R., & Strack, F. (2000). "Mood contagion": The automatic transfer of mood between persons. *Journal of Personality and Social Psychology, 79*(2), 211–223.

Neyer, F., Banse, R., & Asendorpf, J. (1999). The role of projection and empathic accuracy in dyadic perception between older twins. *Journal of Social and Personal Relationships, 16*(4), 419–442.

Nisbett, R., & Wilson, T. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84*(3), 231–259.

Nook, E. C., Lindquist, K. A., & Zaki, J. (2015). A new look at emotion perception: Concepts speed and shape facial emotion recognition. *Emotion, 15*(5), 569–578.

Nozaki, Y., & Koyasu, M. (2013). The relationship between trait emotional intelligence and interaction with ostracized others' retaliation. *PLoS ONE, 8*(10), e77579.

Oberman, L. M., Ramachandran, V. S., & Pineda, J. A. (2008). Modulation of mu suppression in children with autism spectrum disorders in response to familiar or unfamiliar stimuli: The mirror neuron hypothesis. *Neuropsychologia, 46*(5), 1558–1565.

Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Science, 9*(5), 242–249.

Olsson, A., & Phelps, E. A. (2007). Social learning of fear. *Nature Reviews Neuroscience, 10*(9), 1095–1102.

Ong, D., Zaki, J., & Goodman, N. (2015). Affective cognition: Exploring lay theories of emotion. *Cognition, 143*, 141–162.

Onishi, K. H., & Baillargeon, R. E. (2005). Do 15-month-old infants understand false beliefs? *Science, 308*(5719), 255–258.

Philip, R. C., Dauvermann, M. R., Whalley, H. C., Baynham, K., Lawrie, S. M., & Stanfield, A. C. (2011). A systematic review and meta-analysis of the fMRI investigation of autism spectrum disorders. *Neuroscience and Biobehavioral Reviews, 36*(2), 901–942.

Pierce, J. R., Kilduff, G. J., Galinsky, A. D., & Sivanathan, N. (2013). From glue to gasoline: How competition turns perspective takers unethical. *Psychological Science, 24*(10), 1986–1994.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences, 1*, 515–526.

Preston, S. D., & de Waal, F. B. (2002). Empathy: Its ultimate and proximate bases. *Behavioral and Brain Sciences, 25*(1), 1–20, discussion 20–71.

Prinz, J. (2011). Against empathy. *Southern Journal of Philosophy, 49*(s1), 214–233.

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences USA, 98*(2), 676–682.

Redcay, E., Dodell-Feder, D., Pearrow, M. J., Mavros, P. L., Kleiner, M., Gabrieli, J. D., et al. (2010). Live face-to-face interaction during fMRI: A new tool for social cognitive neuroscience. *Neuroimage, 50*(4), 1639–1647.

Rizzolatti, G., & Sinigaglia, C. (2010). The functional role of the parieto-frontal mirror circuit: Interpretations and misinterpretations. *Nature Reviews Neuroscience, 11*(4), 264–274.

Roth-Hanania, R., Davidov, M., & Zahn-Waxler, C. (2011). Empathy development from 8 to 16 months: Early signs of concern for others. *Infant Behavior and Development, 34*(3), 447–458.

Rozin, P. (2001). Social psychology and science: Some lessons from Solomon Asch. *Personality and Social Psychology Review, 5*(1), 2–14.

Sagi, A., & Hoffman, M. L. (1976). Empathic distress in the newborn. *Developmental Psychology, 12*(2), 175.

Sahlins, M. (2008). *The Western illusion of human nature.* Chicago, IL: Prickly Paradigm Press.

Saxe, R. (2006). Uniquely human social cognition. *Current Opinion in Neurobiology, 16*(2), 235–239.

Saxe, R., & Powell, L. J. (2006). It's the thought that counts: Specific brain regions for one component of theory of mind. *Psychological Science, 17*(8), 692–699.

Scherer, K. R., Schorr, A., & Johnstone, T. (Eds.). (2001). *Appraisal processes in emotion.* New York: Oxford University Press.

Schilbach, L., Timmermans, B., Reddy, V., Costall, A., Bente, G., Schlicht, T., et al. (2013). Toward a second-person neuroscience. *Behavioural Brain Research, 36*(4), 393–414.

Schumann, K., Zaki, J., & Dweck, C. S. (2014). Addressing the empathy deficit: Beliefs about the malleability of empathy predict effortful responses when empathy is challenging. *Journal of Personality and Social Psychology, 107*(3), 475.

Shamay-Tsoory, S. G. (2011). The neural bases for empathy. *The Neuroscientist, 17*(1), 18–24.

Shamay-Tsoory, S. G., Aharon-Peretz, J., & Perry, D. (2009). Two systems for empathy: A double dissociation between emotional and cognitive empathy in inferior frontal gyrus versus ventromedial prefrontal lesions. *Brain, 132*(Part 3), 617–627.

Singer, T. (2006). The neuronal basis and ontogeny of empathy and mind reading: Review of literature and implications for future research. *Neuroscience and Biobehavioral Reviews, 30*(6), 855–863.

Singer, T., Seymour, B., O'Doherty, J. P., Stephan, K. E., Dolan, R. J., & Frith, C. D. (2006). Empathic neural responses are modulated by the perceived fairness of others. *Nature, 439*(7075), 466–469.

Small, D. A., & Loewenstein, G. (2003). Helping a victim or helping the victim: Altruism and identifiability. *Journal of Risk and Uncertainty, 26*(1), 5–16.

Smith, A. (2002). *The theory of moral sentiments.* Cambridge, UK: Cambridge University Press. (Original work published 1790)

Spreng, R. N., Mar, R. A., & Kim, A. S. (2009). The common neural basis of autobiographical memory, prospection, navigation, theory of mind, and the default mode: A quantitative meta-analysis. *Journal of Cognitive Neuroscience, 21*(3), 489–510.

Spunt, R. P., Falk, E. B., & Lieberman, M. D. (2010). Dissociable neural systems support retrieval of how and why action knowledge. *Psychological Science, 21*(11), 1593–1598.

Spunt, R. P., & Lieberman, M. D. (2012). An integrative model of the neural systems supporting the comprehension of observed emotional behavior. *NeuroImage, 59*(3), 3050–3059.

Sturmer, S., Snyder, M., & Omoto, A. M. (2005). Prosocial emotions and helping: The moderating role of group membership. *Journal of Personality and Social Psychology, 88*(3), 532–546.

Surian, L., Caldi, S., & Sperber, D. (2007). Attribution of beliefs by 13-month-old infants. *Psychological Science, 18*(7), 580–586.

Tamir, M. (2009). What do people want to feel and why?: Pleasure and utility in emotion regulation. *Current Directions in Psychological Science, 18*(2), 101–105.

Tarrant, M., Dazeley, S., & Cottom, T. (2009). Social categorization and empathy for outgroup members. *British Journal of Social Psychology, 48*(3), 427–446.

Todorov, A., & Uleman, J. S. (2002). Spontaneous trait inferences are bound to actors' faces: Evidence from a false recognition paradigm. *Journal of Personality and Social Psychology, 83*(5), 1051–1065.

Tomasello, M. (2000). *The cultural origin of human cognition*. Cambridge, MA: Harvard University Press.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences, 28*(5), 675–691, discussion 691–735.

Uddin, L. Q., Iacoboni, M., Lange, C., & Keenan, J. P. (2007). The self and social cognition: The role of cortical midline structures and mirror neurons. *Trends in Cognitive Science, 11*(4), 153–157.

Vaughan, K. B., & Lanzetta, J. T. (1980). Vicarious instigation and conditioning of facial expressive and autonomic responses to a model's expressive display of pain. *Journal of Personality and Social Psychology, 38*(6), 909–923.

Verhofstadt, L. L., Buysse, A., Ickes, W., Davis, M., & Devoldre, I. (2008). Support provision in marriage: The role of emotional similarity and empathic accuracy. *Emotion, 8*(6), 792–802.

Waytz, A., Gray, K., Epley, N., & Wegner, D. M. (2010). Causes and consequences of mind perception. *Trends in Cognitive Sciences, 14*(8), 383–388.

Waytz, A., Zaki, J., & Mitchell, J. (2012). Response of dorsomedial prefrontal cortex predicts altruistic behavior. *Journal of Neuroscience, 32*, 7646–7650.

Wechkin, S., Masserman, J. H., & Terris, W., Jr. (1964). Shock to a conspecific as an aversive stimulus. *Psychonomic Science, 1*(1–12), 47–48.

Weiss, R. F., Buchanan, W., Altstatt, L., & Lombardo, J. P. (1971). Altruism is rewarding. *Science, 171*(3977), 1262–1263.

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development, 72*(3), 655–684.

Weng, H., Fox, A., Schackman, A., Stodoloa, D., Caldwell, J., Olson, M., et al. (2013). Compassion training alters altruism and neural responses to suffering. *Psychological Science, 24*(7), 1171–1180.

Wheatley, T., Milleville, S. C., & Martin, A. (2007). Understanding animate agents: Distinct roles for the social network and mirror system. *Psychological Science, 18*(6), 469–474.

Wheeler, M. E., Petersen, S. E., & Buckner, R. L. (2000). Memory's echo: Vivid remembering reactivates sensory-specific cortex. *Proceedings of the National Academy of Sciences USA, 97*(20), 11125–11129.

Wicker, B., Keysers, C., Plailly, J., Royet, J. P., Gallese, V., & Rizzolatti, G. (2003). Both of us disgusted in my insula: The common neural basis of seeing and feeling disgust. *Neuron, 40*(3), 655–664.

Williams, L. E., Bargh, J. A., Nocera, C. C., & Gray, J. R. (2009). The unconscious regulation of emotion: Nonconscious reappraisal goals modulate emotional reactivity. *Emotion, 9*(6), 847.

Xu, X., Zuo, X., Wang, X., & Han, S. (2009). Do you feel my pain?: Racial group membership modulates empathic neural responses. *Journal of Neuroscience, 29*(26), 8525–8529.

Zaki, J. (2013). Cue integration: A common framework for physical perception and social cognition. *Perspect Psychological Science, 8*(3), 296–312.

Zaki, J. (2014). Empathy: A motivated account. *Psychological Bulletin, 140*(6), 1608–1647.

Zaki, J., Lopez, G., & Mitchell, J. (2014). Activity in ventromedial prefrontal cortex covaries with revealed social preferences: Evidence for person-invariant value. *Social Cognitive and Affective Neuroscience, 9*(4), 464–469.

Zaki, J., & Mitchell, J. P. (2013). Intuitive prosociality. *Current Directions in Psychological Science, 22*(6), 466–470.

Zaki, J., & Ochsner, K. (2009). The need for a cognitive neuroscience of naturalistic social cognition. *Annals of the New York Academy of Sciences, 1167*(1), 16–30.

Zaki, J., & Ochsner, K. (2011a). You, me, and my brain: Self and other representations in social cognitive neuroscience. In A. Todorov, S. T. Fiske, & D. Prentice (Eds.), *Social neuroscience: Toward understanding the underpinnings of the social mind* (pp. 26–48). New York: Oxford University Press.

Zaki, J., & Ochsner, K. (2011b). Reintegrating accuracy into the study of social cognition. *Psychological Inquiry, 22*(3), 159–182.

Zaki, J., & Ochsner, K. (2012). The neuroscience of empathy: Progress, pitfalls, and promise. *Nature Reviews Neuroscience, 15*(5), 675–680.

Zaki, J., Ochsner, K. N., Hanelin, J., Wager, T., & Mackey, S. C. (2007). Different circuits for different pain: Patterns of functional connectivity reveal distinct networks for processing pain in self and others. *Social Neuroscience, 2*(3–4), 276–291.

Zaki, J., Weber, J., Bolger, N., & Ochsner, K. (2009). The neural bases of empathic accuracy. *Proceedings of the National Academy of Sciences USA, 106*(27), 11382–11387.

Zaki, J., & Williams, W. C. (2013). Interpersonal emotion regulation. *Emotion, 13*(5), 803–810.

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