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EMOTION

A Short History of Psychological Perspectives on Emotion

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Abstract

This chapter presents a short history of psychological theory and research on emotion since the beginnings of psychology as an academic discipline in the last third of the 19th century. Using William James's theory of emotion as the starting point and anchor, the history of research on five main questions of emotion psychology is charted. These concern, respectively: (1) the causal generation of emotions; (2) the effects of emotion on subsequent cognition and behavior; (3) the nature of emotion; (4) the evolutionary and learning origins of the emotion system; and (5) the neural structures and processes involved in emotions.

A Short History of Psychological Perspectives on Emotion

Psychology as an independent academic discipline emerged during the last third of the 19th century (see e.g., Leahey, 2003). I have therefore chosen this period as the starting point of the present, short history of psychological perspectives of emotion. However, readers should be aware that academic emotion psychology did not start from scratch. On the contrary, it build on a rich tradition of theorizing about emotions by philosophers, historians, and literary writers that dates back to the Ancient Greeks (see e.g., Strongman, 2003) and has remained influential up to the present (e.g., Arnold, 1960; Nussbaum, 2001).

When psychology became an independent discipline, it defined itself initially as the science of consciousness (of conscious mental states; e.g., Brentano, 1873; Wundt, 1896). Given that emotions are salient exemplars of conscious mental states, it is not surprising that the psychologists of consciousness also had a keen interest in the emotions. In fact, most of the basic types of psychological emotion theory discussed today were already present, at least in the outlines, in the psychology of consciousness. During the subsequent, behaviorist phase of psychology (about 1915-1960), and due in large part to its restrictive research doctrines, research on emotions subsided again (see e.g., Arnold, 1960), although behaviorists did make some important contributions to emotion psychology (e.g., research on the classical conditioning of fear; see Gray, 1975; LeDoux, 1998; Watson, 1919). Immediately after the so-called “cognitive revolution” of the early 1960ies, when behaviorism was replaced by cognitivism—a modern version of mentalism guided by the metaphor of information processing in computers—emotion research took up speed again, until in the 1990ies, it became a boom that also began to affect other scientific disciplines. Today, emotion is an important topic in nearly every subfield of psychology, as well as in many other disciplines ranging from biology to neurophysiology to computer science, linguistics and literary studies. Some already see the emergence of a new interdisciplinary research field, analogous to

cognitive science: *affective science*, the interdisciplinary study of emotions and related phenomena (Scherer, 2009).

One important reason for the recent surge of interest in emotions has been a re-evaluation of the adaptive utility of emotions. Traditionally, emotions have often been regarded as maladaptive (because, it was held, they interfere with rational thinking and decision-making; see e.g., Roberts, 2013). In contrast, during the past twenty or so years, emotions have increasingly come to be seen as overall adaptive (e.g., Feldman-Barrett & Salovey, 2002; Frijda, 1994). Some theorists even regard emotions as indispensable for adaptive behavior (e.g., Damasio, 1994). This changed view of the usefulness of emotions has also been an important motive for launching of the field of affective computing (Picard, 1997).

Five Questions of Emotion Psychology

The task of emotion psychology can be defined as the reconstruction, or “reverse engineering” of the structure and functioning of the human emotion system, including its relations to other subsystems of the mind (Reisenzein & Horstmann, 2006). The central subtasks of this task are to explain (Q1) how emotions are elicited, or generated; (Q2) what effects (in particular what adaptive, or functional effects) emotions have on subsequent cognitive processes and behavior; and related to both questions, (Q3) what emotions themselves are—how they are to be theoretically defined; what kinds of mental and computational states they are (Reisenzein, 2012). Answering Q1-Q3 amounts to reconstructing the blueprint of the emotion system. However, as already argued by McDougall (1908/1960; see also, Tooby & Cosmides, 1990), to achieve this goal it is helpful and even necessary, to address a further question that is also of independent interest, which concerns the origins of the emotion system; namely (Q4) which parts of the emotion system are inherited and which are acquired through learning. Finally, to help answer questions Q1-

Q4, it would be useful to know (Q5) how emotions are biologically realized or implemented, that is, which neural structures and processes underlie them.

A generally accepted theory of emotions that gives detailed answers to all these questions, or even just to the central questions Q1-Q3, still does not exist today. Nevertheless, progress has been made. In what follows, I will trace the history of the most important proposed answers to the five main questions of emotion psychology. As the starting point and anchor of my report, I will use a classical theory of emotion, which was proposed by one of the founding fathers of psychology, the psychologist and philosopher William James (1884; 1890; 1894). My reason for choosing James's theory of emotion for structuring this chapter is not that the theory has stood the test of time particularly well (see Reisenzein & Stephan, in press); but that it has been highly influential, is widely known, and is possibly the first emotion theory that tries to give answers—if partly only very sketchy answers—to all of the five main questions of emotion psychology. I will first describe James's answers to these questions and then discuss, in separate sections, what has been learned about them since James's time.

James's Theory of Emotion

The starting point of James's theory of emotion is the intuition, which I believe readers will confirm, that emotional experiences—experiences of joy, sorrow, anger, fear, pity or joy for another, pride, guilt etc. (see e.g., Ortony, Clore, & Collins, 1988)—have a special *phenomenal quality*; that is, it “is like” or “feels like” a special way to have them. James expressed this intuition with a metaphor that has since been adopted by many other emotion theorists: Emotional experiences have “warmth”; they are “hot” experiences in contrast to “cold” nonemotional mental states such as intellectual perceptions or thoughts, which James (1890/1950, p. 451) described as “purely cognitive in form, pale, colorless, destitute of emotional warmth”. In addition, introspection suggests that the experiential

quality of emotions is more or less different for different emotions (e.g., it feels different to be happy, angry, and afraid), and that each emotional quality can occur in different intensities (one can be a little, moderately or extremely happy, angry, afraid etc.).

James's main aim with his emotion theory was to explain this set of intuitions about emotional experience (Reisenzein & Döring, 2009). A central idea behind the explanation he offered was to notice that the description of emotions suggested by introspection—emotions are a unique group of related experiential qualities that can occur in different intensities—fitted the definition of *sensations* (e.g., of color, tone, or taste) (e.g., Wundt, 1896). Given the similarities between emotions and sensations, it seems natural to try to explain the phenomenal properties of emotions by assuming that they are a class of mental states analogous to sensations; or even, that they are a subgroup of sensations. This is the basic idea of the so-called *feeling theory of emotion*, which until today has remained—at least in a “cognitively diluted” version (see the section on the nature of emotion)—the main approach to explaining the phenomenal character of emotions (Reisenzein, 2012; Reisenzein & Döring, 2009).

Q3. What is an emotion? James himself opted for the radical version of feeling theory: He proposed that emotional feelings are not just *analogous to* sensations, but that they literally *are* a class of sensations on a par with sensations of color, taste, touch etc. Specifically, James argued, emotional feelings are the sensations of the bodily reactions that (he maintained) are always elicited by emotion-evoking events (see his answers to Q1 and Q4). Emotion-relevant bodily changes include facial and vocal expressions of emotion as well as emotional actions (e.g., running away in fear), but most important are physiological reactions, such as heart pounding and sweating. In fact, in a response to critics of his theory, James (1894) argued that only physiological reactions are necessary for emotions.

Q1. How are emotions elicited? According to how James initially (James, 1884; 1890/1950) described the process of emotion generation, the bodily changes experienced as emotions are elicited by perceptions or ideas of suitable objects in a reflex-like (i.e., direct and involuntary) manner. To use James's most famous example, imagine a wanderer in the wilderness who suddenly sees a bear in front of him, and feels terrified. According to James, the wanderer's feeling of fear is generated as follows: The perception of the bear elicits, in a reflex-like manner, a specific pattern of bodily reactions—that characteristic for fear (comprising among others an increase in heart rate, constriction of the peripheral blood vessels, sweating, and trembling; see James, 1890/1950, p. 446). The bodily changes are immediately registered by sense-organs located in the viscera, skin, and muscles, and communicated back to the brain, where they are presumably integrated into a holistic bodily feeling (James, 1894). This feeling is the experience of fear.

Q2. What are the effects (in particular the adaptive effects) of emotions on subsequent cognition and behavior? Given the evolutionary foundation of James's emotion theory (see Q4), it is interesting to learn that James was rather reserved about the adaptiveness of the bodily reactions elicited by emotional stimuli: Although he believed that some of them are adaptive, he claimed that this is by no means the case for all. Furthermore, the emotion itself (e.g., the feeling of fear) does not seem to have any function of its own; indeed, the assumption of James's theory that emotions are the effects rather than the causes of emotional behaviors seems at first sight to *preclude* any useful function for emotions. However, as McDougall (1908/1960) has pointed out, feelings of bodily changes could still play a role in the control of ongoing emotional behavior (see also, Laird, 2007). Furthermore, if one assumes that emotional feelings are based on physiological changes only (James, 1884), they could at least in principle motivate emotional actions (e.g., fleeing in the case of fear) (see Reisenzein & Stephan, in press).

Q4. Where do the emotion mechanisms come from—to which degree are they inherited versus learned? According to James, the bodily reactions that constitute the basis of emotional feelings are produced by inherited emotion mechanisms that developed in evolution, although they can be substantially modified by learning. As said, James assumed that at least some of the evolutionary emotion mechanisms came into existence because they helped to solve a recurrent adaptive problem (see Q2). For example, the program that generates the fear pattern of physiological responses could be so explained: it developed because it helped our forebears to prepare for rapid flight or defense in dangerous situations (McDougall, 1908/1960). Furthermore, James assumed that the “instinctive” bodily reactions can be naturally elicited only by a small set of inborn releasers. However, as a result of associative learning experiences—essentially what later came to be known as classical conditioning (Watson, 1919; LeDoux, 1998)—all kinds of initially neutral stimuli can become learned elicitors of the inborn emotional reactions (James, 1884; see also McDougall, 1908/1860). Likewise, the reaction patterns can themselves become modified, within limits, as the result of learning (James, 1890/1950; see Reisenzein & Stephan, in press).

Q5. What are the neural structures and processes underlying emotions? To show that his psychological emotion theory was compatible with the then available neurophysiological knowledge, James (1884) supplemented this theory with a sketch of the neural processes underlying the generation of emotions, resulting in what was perhaps the first neurophysiological model of emotion. According to James, at the neurophysiological level, the process of emotion generation can be described as follows: An object or event (e.g., an approaching bear) incites a sense organ (e.g., the eye). From there, afferent neural impulses travel to the sensory cortex, where they elicit a specific neural activation pattern which is the neurophysiological correlate of the perception of the object. Due to inherited or acquired neural connections, some sensory activation patterns (e.g., the pattern corresponding

to the perception of a bear) activate one of several evolutionary bodily reaction programs located in the motor cortex (e.g., the “fear” reaction program). As a consequence, efferent impulses are sent to the inner organs and muscles of the body, where they produce a complex, emotion-specific pattern of bodily changes (e.g., the fear pattern). These bodily changes are in turn registered by interoceptors in the viscera, skin, and muscles, whose signals are transmitted back to the sensory cortex, where they produce another neural activation pattern which is the neurophysiological correlate of an emotional feeling (e.g., fear). Hence, neurophysiologically speaking, emotions are simply special patterns of excitation in the sensory cortex, caused by feedback from the bodily changes reflexively elicited by emotional stimuli.

Let us now look at what has been learned since James’s times about the five questions of emotion psychology.

The Process of Emotion Generation

Worcester’s Critique

Shortly after it had been proposed, James’s theory of emotion came under heavy attack (see Gardiner, 1896). One of the objections raised concerned James’s suggestion that emotions are elicited by sense-perceptions in a reflex-like manner. Critics such as Worcester (1893) and Irons (1894) argued that this proposal conflicts with several well-known facts. Specifically, referring to James’s example of a wanderer who feels fear upon encountering a bear, Worcester pointed out that a well-armed hunter might feel joy rather than fear when sighting a bear, and that even an ordinary person might only feel curiosity if the bear were chained or caged. Worcester concluded from these cases that fear is not directly caused by sense-perceptions, but by certain thoughts to which these perceptions may give rise. Specifically, the wanderer feels afraid of the bear only if he believes that the bear may cause him bodily harm (Worcester, 1893, p. 287). In his response to Worcester’s objection, James

(1894) in effect conceded the point. Thereby, however, James accepted that at least in the typical case, emotions are caused by cognitive processes, specifically by appraisals of objects as relevant for one's well-being (Arnold, 1960; see the next section). However, neither James nor Worcester clarified the cognitive processes involved in the generation of different emotions in more detail.

In fact, though, this issue had already been investigated in considerable detail in the cognitive tradition of emotion theorizing dating back to Aristotle (350 b. c.). In 19th century introspective psychology, this tradition was represented, among others, by the cognitive emotion theories proposed by Alexius Meinong (1894) and Carl Stumpf (1899) (see Reisenzein, 2006; Reisenzein & Schönplflug, 1992). Unfortunately, however, these early cognitive emotion theories¹ became buried under the “behaviorist avalanche” (Leahey, 2003). It was only during the cognitive revolution of the early 1960ies that the cognitive tradition of emotion theorizing was rediscovered (and partly reinvented) in psychology. The two theorists most responsible for this development were Magda B. Arnold (1960) and Richard S. Lazarus (1966), the pioneers of cognitive emotion theory in post-behaviorist psychology.

The Arnold-Lazarus Theory

Whereas James regarded the *phenomenal character* of emotions—the fact that it feels a particular way to have emotions—as their most salient feature and that most in need of explanation, Arnold (1960) focused on another property of emotions that had already been

¹ In contemporary psychology, the term “cognitive emotion theory” is typically used to denote any emotion theory which assumes that cognitions—paradigmatically beliefs, in particular evaluative beliefs—are necessary conditions for emotions, even if they are only regarded as causally rather than constitutionally necessary for emotions. In contrast, in contemporary philosophy, the term “cognitive emotion theory” is typically used in a narrower sense to denote emotion theories which claim that emotions *are* cognitions (of a certain kind; typically evaluative beliefs) or *contain* such cognitions as components; implying not only that emotions are *intentional* (object-directed, or representational) mental states, but more specifically, that they are *cognitive* (information-providing) mental states (see Reisenzein & Döring, 2009).

emphasized by James's contemporaries Meinong (1894) and Stumpf (1899; see also Irons, 1894): the *object-directedness of emotions* (the technical philosophical term is *intentionality*). Like some other mental states—the paradigmatic examples in this case are beliefs and desires—emotions are directed at objects: If one is happy, sad, or afraid, one is at least in the typical case (according to Arnold, even always) happy about something, sad about something, or afraid of something; or so emotions present themselves to the subject. This *something* (which may not actually exist) is the intentional object of the emotion. For example, the object of fear of James's wanderer's—what he fears—is *that the bear might cause him bodily harm* (Worcester, 1893). As is the case for fear, the objects of most emotions are *states of affairs* (e.g., states, events, actions).

The object-directedness of emotions rather directly suggests that emotions presuppose cognitions of their objects (Meinong, 1906; Arnold, 1960). Arnold (1960) elaborated this idea by proposing that the cognitions required for an emotion directed at a state of affairs *p* are of two kinds: (a) *factual cognitions* about *p* (paradigmatically, these are beliefs concerning the existence and properties of *p*), and (b) an *evaluation* or *appraisal* of *p* as being good or bad for oneself. Paradigmatically, this appraisal is also a belief, namely an evaluative belief, the belief that *p* is good or bad for oneself (in fact, appraisals were originally called “value judgments” by Arnold & Gasson, 1954).² Hence, for example, to feel joy about *p* (e.g. that Smith was elected as president), Mary must (at minimum) believe that *p* is the case (or, as Arnold [1960a, p. 193] says, “is present”) and evaluate *p* as good for oneself. Analogously, to experience sorrow about *p*, Mary must believe that *p* is the case and evaluate *p* as bad for herself. Furthermore, under normal circumstances (i.e., if Mary is awake, attentive, not under

² However, Arnold (1960) subsequently argued that appraisals are a *special kind* of value judgments; in particular, she claimed, they are similar to sense-judgments in being “direct, immediate, nonreflexive, nonintellectual, instinctive, and intuitive”(p. 175). See also Kappas (2006).

the influence of emotion-dampening drugs etc.), the described cognitions are also sufficient for joy and sorrow to occur.

Although Arnold (1960) is not fully explicit on this point, it appears that she thought that the evaluation of an event as positive or negative is the outcome of a comparison of the event with one's goals or desires: Events are positive if they are goal-congruent (fulfill a desire) and negative if they are goal-incongruent (frustrate a desire). This view of the appraisal process can be found in explicit form in Lazarus (1966) and has been adopted by most subsequent appraisal theorists (Reisenzein, 2006). However, this theory of the appraisal process implies that emotions presuppose not only beliefs (i.e., informational mental states), but also desires (i.e., motivational mental states), even though the latter are only indirect causes of the emotions: they are the standards to which facts are compared to determine whether they are good or bad.³ The emotion itself, according to Arnold (and in contrast to James), is an experienced action tendency: a felt impulse to approach objects appraised as good, or to avoid objects appraised as bad.

So far I have only described Arnold's analysis of joy and sorrow. However, Arnold proposed that a parallel analysis is possible for all other emotions (at least all having states of affairs as objects). Like joy and sorrow, these other emotions presuppose factual and evaluative beliefs about their objects; however, these beliefs differ more or less for the different emotions. Arnold elaborated this idea by proposing that the cognitions underlying

³ An alternative version of cognitive emotion theory, the *belief-desire theory* of emotion, holds that emotions are *directly* caused by factual beliefs and desires, without intervening appraisals (evaluative beliefs). For example, according to this theory, Mary's joy about Smith's election as president is directly caused by the belief that Smith was elected, and the desire that he should be elected. Arguments for the belief-desire theory are summarized in Reisenzein (2009a; 2009b; see also Castelfranchi & Miceli, 2009, and Green, 1992). In this chapter, I follow the mainstream of cognitive emotion theory in psychology, i.e. appraisal theory. Those who find the belief-desire account more plausible should note that it is possible to reformulate (although with a corresponding change of meaning) most of appraisal theory in the belief-desire framework (see e.g., Adam, Herzog, & Longin, 2009; Steunebrink, Dastani, & Meyer, 2012; and Reisenzein, Hudlicka et al., 2013).

the different emotions vary on (at least) three dimensions of appraisal,⁴ two of which were already mentioned: *evaluation of the object* as good or bad for oneself (i.e., “appraisal” in the narrow meaning of the word); *presence-absence of the object*, and *the ease or difficulty to attain or avoid the object* or, as one can also say (with Lazarus, 1966), *coping potential*. As used by Arnold, *presence-absence* refers simultaneously to the subjective temporal location of a state of affairs and to the subjective certainty that it obtains; it contrasts subjectively present or past plus certain states of affairs with those that are subjectively future and still uncertain. *Coping potential* concerns the belief that the state of affairs in question (a) if still absent, is easy, difficult or impossible to attain (positive state) or avoid (negative state) or (b) if already present, is easy, difficult or impossible to keep (positive state), or to undo or adapt to (negative state). Note that this third appraisal dimension, like the second, refers to a factual belief. Different combinations of the possible values of the three appraisal dimensions give rise to different emotions. For example, according to Arnold (1960), joy is precisely speaking experienced if one believes that a positive state of affairs is present and can be easily maintained, whereas fear is experienced if one believes that a negative event might occur that one cannot prevent.

A very similar appraisal theory to that of Arnold was proposed by Lazarus (1966). As detailed in Reisenzein (2006), Lazarus essentially combined Arnold’s first two appraisal dimensions into a single process, which he called *primary appraisal*, and renamed Arnold’s third dimension *secondary appraisal*. However, even though Lazarus’s (1966) original appraisal theory (for an expanded and revised version, see Lazarus, 1991) therefore did not go much beyond Arnold’s, in contrast to Arnold he supported his theory by a series of laboratory experiments (see Lazarus, 1966). These experimental studies did much to make appraisal theory scientifically respectable in psychology.

⁴ Note that “appraisal” is here used in a broad sense that includes all emotion-relevant factual

More Recent Appraisal Theories

Since the 1960ies, the appraisal theory of emotion has become the dominant approach to the explanation of emotion generation in psychology. Over the years, however, the original version of the theory proposed by Arnold and Lazarus has been found wanting in various respects, and accordingly, improved appraisal theories have been proposed (e.g., Frijda, 1986; Ortony et al., 1988; Roseman, 1984; Scherer, 2001; Smith & Lazarus, 1990; for an overview, see Ellsworth & Scherer, 2003; and for a recent discussion, Moors, Ellsworth, Scherer, & Frijda, 2013). These newer appraisal theories share with the Arnold-Lazarus theory the basic assumption that emotions are products of factual and evaluative cognitions. However, unlike Arnold and Lazarus, they typically distinguish between different kinds of evaluations of the eliciting events (e.g., personally desirable/undesirable versus morally good/bad) and postulate additional, as well as partly different, factual appraisals (e.g., probability of the event, unexpectedness of the event, and responsibility for the event). Perhaps the most elaborated, as well as the most systematic of the newer appraisal theories was proposed by Ortony et al. (1988). Ortony et al. specify the cognitions underlying 11 positive and 11 emotions and argue with some plausibility that other emotions are subspecies of these 22 emotions. The OCC model, as it is often referred to, has become the most widely used psychological template for computational models of emotion generation. Other more recent appraisal theories, such as those proposed by Smith and Lazarus (1990), and Scherer (2001), also seek to describe the computational processes of emotion generation in greater detail than Arnold and Lazarus did. A common assumption of these “process models” of appraisal is that appraisal processes can occur in several different *modes*, in particular as *nonautomatic* and as *automatic* processes. Whereas nonautomatic appraisal processes are akin to conscious inference strategies, automatic appraisals are assumed to be unconscious

and evaluative cognitions. In a narrow meaning, “appraisal” refers to evaluations only.

and to be triggered fairly directly by the perception of eliciting events. Like other cognitive processes, initially nonautomatic, conscious appraisals can become automatized as a result of their repeated execution (e.g., Reisenzein, 2001). Automatic appraisals can explain why emotions frequently follow eliciting events rapidly.

Like the foundational appraisal theory of Lazarus (1966), the more recent appraisal theories have generated a sizable body of empirical research (e.g., Ellsworth & Scherer, 2003). Most of this research has been aimed at providing support for the assumption that different emotions are characterized by distinct patterns of appraisal composed from a limited set of dimensions. This assumption has been reasonably well supported (Ellsworth & Scherer, 2003). However, in my view the main reason for the success of appraisal theory has not been this and other empirical support for the theory, but the fact that it agrees well with implicit common-sense psychology, and has unmatched explanatory power (Reisenzein, 2006). Concerning the latter issue, it is simply hard to see *how else* than by assuming intervening cognitive processes of at least *approximately* the kind assumed in appraisal theories (or in the belief-desire theory of emotion, see Footnote 3), one could explain the following, basic facts of human emotions: (1) emotions are highly differentiated (there are many different emotions); (2) different individuals can react with entirely different emotions (e.g., joy versus sorrow) to the same objective events (e.g., the victory of a soccer team); (3) the same emotion (e.g., joy) can be elicited by events that have objectively nothing in common (e.g., the victory of a soccer team and the arrival of a friend); (4) the same concrete emotional reaction (e.g., joy about the arrival of a friend) can be caused by information acquired in widely different ways (e.g., when seeing the friend approach, when hearing his voice, when being told by others that he has arrived); and (5) if a person's appraisals of an event changes, then in most cases her emotions about that event change as well.

Can Emotions be “Noncognitively” Elicited?

Whereas the “cognitive path” to emotion described by cognitive emotion theories is generally acknowledged by today’s emotion psychologists, the question of the existence, or at least the practical importance of alternative, “noncognitive” paths to emotion has given rise to a protracted debate (e.g., Lazarus, 1982; Leventhal & Scherer, 1987; Storbeck & Clore, 2007; Zajonc, 1980). This so-called “cognition-emotion-debate” has suffered, among other things, from the failure to distinguish clearly between two different version of the hypothesis of “noncognitive” emotion generation: (a) the hypothesis that *certain kinds of emotion in the broad sense of the term*, such as sensory pleasures and displeasures or aesthetic feelings, are “noncognitively” caused; that is, do not presuppose beliefs and desires, but only nonpropositional and possibly even nonconceptual representations such as certain visual patterns or sounds; (b) the hypothesis that even *prototypical emotions* such as fear, anger or joy can be (and perhaps even, often are) noncognitively caused (e.g., that fear can be elicited by the sight of a dark moving form in the woods, without any mediating thoughts, as James [1890/1950] had claimed). Whereas the first hypothesis is plausible (Reisenzein, 2006), the second is more controversial: On closer inspection, the data that have been adduced to support this hypothesis turn out to be less convincing than is often claimed (see e.g., Reisenzein, 2009b). Most of these data concern fear. For example, it has been argued that noncognitive fear elicitation is demonstrated by studies which found that physiological reactions can be elicited by subliminally presented emotional stimuli (e.g., Öhman & Mineka, 2001; see Storbeck & Clore, 2007, for a review). However, it is also possible that these physiological reactions are mediated by automatized and unconscious appraisal processes (e.g., Siemer & Reisenzein, 2007).

The Effects of Emotions

In contrast to James, common-sense psychology assumes that emotions can have powerful effects on cognition and behavior. In fact, this belief is a main reason why emotions interest both lay people and scientists. As mentioned in the introduction, psychologists have traditionally emphasized the negative, maladaptive effects of emotions; however, during the past 20 years or so, the view has increasingly gained acceptance that, notwithstanding their occasional negative consequences, emotions are overall (i.e., across all relevant situations) adaptive. The adaptive effects of emotions are their (evolutionary) *functions*—the reasons why the emotion mechanisms came into existence in the first place (e.g., Mitchell, 1995). However, although emotion psychologists today largely agree that emotions are functional, there is still only partial agreement on what the functional effects of emotions consist of (for overviews, see e.g., Frijda, 1994; Hudlicka, 2011). In what follows, I describe three main proposed functions of emotions concerning which there is reasonable consensus as well as empirical support: the attention-directing, informational, and motivational function of emotions.

The attention-directing function of emotions

According to this hypothesis, a primary function of emotions is to shift the focus of attention to their eliciting events (or computationally speaking, to allocate central processing resources to the analysis of these events), or give them priority in information processing (e.g., Simon, 1967; Sloman, 1992; see also, Reisenzein, Meyer, & Niepel, 2012).

The informational function of emotions

The informational or epistemic function of emotions consists in providing adaptively useful information to other cognitive (sub-) systems, including other agents. This information presumably concerns (a) the results of (unconscious) appraisal processes (e.g., Schwarz & Clore, 2007) or the occurrence of changes in the person's belief-desire system (Reisenzein,

2009a) and/or (b) closely related to this, information about the value of objects and events, including actions and their consequences (e.g., Damasio, 1994; Meinong, 1894; Slovic, Finucane, Peters, & MacGregor, 2004). To illustrate, nervousness experienced when meeting a stranger might function to inform the decision-making system about the subconscious appraisal of the encounter as threatening. Similarly, a pleasant feeling experienced when considering a possible course of action could serve to signal the subconscious approval of the action and mark it as a good one to choose. Empirical evidence for these informational effects (and possibly functions) of emotions can be found in Schwarz and Clore (2007) and Slovic et al. (2005). Analogously, the nonverbal and verbal communication of emotions could serve to convey this information to other agents.

The motivational function of emotions

The motivational function of emotions consists of their adaptive effects on action goals. It has been argued that emotions serve both to re-prioritize existing goals or intentions, and generate to new ones (e.g., Frijda, 1986; Oatley & Johnson-Laird, 1987). With respect to the generation of new goals, two main mechanisms have been proposed (Reisenzein, 1996). First, it has been proposed that emotions or their anticipation generate hedonistic desires (e.g., Baumeister, Vohs, DeWall, & Zhang, 2007; Mellers, 2000). This path from emotion to motivation is central in *hedonistic theories of motivation* (e.g., Bentham, 1789/1970; Cox & Klinger, 2004) which assume that one ultimate goal or basic motive of humans, if not their only basic motive, is the desire to maximize pleasure and to minimize pain (displeasure). This hedonistic motive can be activated both by currently experienced emotions and by emotions that are merely anticipated: Negative feelings generate a desire to reduce them (if they are present) or to avoid them (if they are anticipated); analogously, positive feelings generate a desire to maintain them, or to bring them about. It is widely assumed that hedonistic desires can also influence cognitive processes including appraisals. For example, the unpleasant

feeling of fear elicited by a threatening event may motivate the person to avoid thinking about the event, or to try to reappraise it in more benign terms (e.g., Lazarus, 1991; Gross, 1998).

There can be little doubt that emotions influence motivation partly through the hedonistic route (see e.g., Baumeister et al., 2007). However, several emotion and motivation theorists have argued that this not the only path from emotion to motivation. Rather, according to these theorists, at least some emotions evoke adaptive goals or action tendencies (e.g., fear causes the desire to flee, anger to aggress, pity to help) *directly*, that is, without the mediation of hedonistic desires (e.g., McDougall, 1908/1960; Frijda, 1986; Lazarus, 1991; Weiner, 1995; for a discussion see Reisenzein, 1996). Conceivably, this nonhedonistic effect of emotions on motivation is based on their attention-directing and informational functions. The nonhedonistic theory of the emotion-action link may be better able than the hedonistic theory to explain the motivational effects of some emotions, such as the effect of pity on helping and of anger on aggression (Rudolph, Roesch, Greitemeyer, & Weiner, 2004).

The three described functions of emotions—the attention-directing, informational, and motivational function—can be seen as contributing, in different ways, to a single overarching function of emotions: to improve the generation of adaptive intentional actions (at least in the evolutionary environment). To achieve this effect, emotions need to influence the motivational machinery that proximately controls actions. According to the standard view of action generation in psychology and other disciplines, actions are proximately caused by a mechanism whose inputs are the person's desires (goals) and her means-ends beliefs, and whose basic decision principle is that *agents attempt to do what they believe will lead to what*

they desire (e.g., Bratman, 1987; Pollock, 1989).⁵ These considerations suggest that—contrary to the claims of some emotion theorists (e.g., Bentham, 1789/1970; Damasio, 1994; McDougall, 1908/1960)—emotions are *not* indispensable for the generation of adaptive actions, although “affect-free” actions may well be overall less adaptive than actions that are also informed by emotions.

The Nature of Emotion

Problems of Bodily Feeling Theory

The central assumption of James’s theory concerns the nature of emotion: According to James, emotions are a class of sensations—the feelings of the bodily reactions generated by evolutionary emotion mechanisms. This assumption of James, too, immediately met with criticism (see Gardiner, 1896; Stumpf, 1899; Cannon, 1927). Two main objections were raised. The first was that this theory of the nature of emotion fails to account for other salient properties of emotion, in particular their object-directedness. This objection is considered later. The second objection was that James’s theory even fails to account for the phenomenon it was primarily meant to explain, the phenomenal quality of emotions. The arguments that were advanced to support this second objection can be summarized in two main objections to James’s explanation of emotional experience, one theoretical and the other empirical (see Reisenzein & Stephan, in press). The *theoretical* objection was that James’s theory is unable to explain in a noncircular way (i.e., without referring back to emotions) what distinguishes “emotional” bodily changes from nonemotional ones (e.g., a quickened pulse from running; Irons, 1894; Stumpf, 1899). The *empirical* objection was that, contrary to what James’s theory implies, bodily feelings are neither necessary nor sufficient for emotion, and do not match the subtle qualitative differences and intensity gradations of emotional experiences. A

⁵ Psychological decision theories (e.g., Ajzen, 1991; Kahneman & Tversky, 1979) can be regarded as quantitatively refined versions of this qualitative belief-desire theory of action (see Reisenzein, 1996).

particularly convincing version of this objection—because it was supported by systematic experimental data—was published by Walter B. Cannon (1927). As a result, for many years, James's theory of emotion was widely regarded as having been refuted by Cannon.

However, in the wake of the renaissance of emotion research after the cognitive revolution of the 1960ies, a number of emotion researchers argued that Cannon's criticisms were overdone and that a revised version of James's theory of the nature of emotion might, after all, be tenable. Accordingly, several more or less strongly modified Neo-Jamesian theories were proposed (e.g., Damasio, 1994; Laird, 1974; Schachter, 1964). In support of their views, the Neo-Jamesians refer to a variety of more recent empirical findings. The relatively most convincing of these are studies which suggest that experimentally induced physiological and expressive changes can, under certain circumstances, intensify emotional experiences (see Laird, 2007, for a summary). To illustrate, Strack, Martin and Stepper (1988) found that when participants held a pen between their front teeth in a way that resulted in an expression resembling a smile, they judged cartoons to be funnier than in a no-smile control condition, suggesting that they felt more strongly amused. However, interesting as these findings are, they do not show that emotions are nothing but sensations of bodily (including facial) changes; nor even, that bodily perceptions are necessary for emotions. In fact, other evidence suggests that this is not the case. In particular, studies of the emotional experiences of spinal-cord-injured people, who have much reduced bodily feedback, suggest that their emotional life is largely intact (e.g., Cobos, Sánchez, Garcia, Vera, & Vila, 2002; see Reisenzein & Stephan, in press). Similarly, studies on the effects of beta-adrenergic blocking agents (which specifically inhibit the reactivity of the cardiovascular system) on emotions typically failed to find reduced emotions in healthy subjects (e.g., Erdmann & van Lindern, 1980). Likewise, the experimental or natural reduction of facial feedback typically does not diminish emotional experience (see Reisenzein & Stephan, in press).

Mental Feeling Theory

Although the available evidence suggests that emotional experiences are not (at very least not *only*) bodily sensations, James's more basic intuition, that the phenomenal quality of emotions is best explained by assuming that they are *sensation-like* mental states, remains forceful (Reisenzein, 2012). This intuition can be saved if one assumes that although emotions are indeed sensation-like feelings (or at least, contain such feelings as components; see the next section), the emotional feelings are not created in the body but in the brain (e.g., Buck, 1985; Cannon, 1927; Oatley & Johnson-Laird, 1987; Wundt, 1896). The oldest and most prominent of these "mental" (as opposed to James's "bodily") feeling theories of emotion holds that emotions are feelings of pleasure and displeasure (e.g., Bentham, 1789/1970). Pleasure-displeasure theory was in fact the standard view of the phenomenal quality of emotional feelings in 19th century psychology (e.g., Meinong, 1894; Wundt, 1896). Notwithstanding James's protest that this "hackneyed psychological doctrine....[is] one of the most artificial and scholastic of the untruths that disfigure our science" (James, 1894, p. 525), pleasure-displeasure theory is in fact much better established empirically than James's own theory of emotional experience (see e.g., Mellers, 2000; Russell, 2003) and is today held, in some form, by many emotion researchers (e.g., Ortony, Clore, & Collins, 1998; Mellers, 2000; Reisenzein, 2009b).

However, one must concede to James (1894) that, taken by itself, pleasure-displeasure theory cannot account for the qualitative distinctions among emotional experiences beyond positive-negative. As one attempt to overcome this problem of the theory, several theorists have postulated other mental feelings in addition to (or in place of; see Footnote 6) pleasure and displeasure. For example, Wundt (1896) proposed that (a) the centrally generated emotional feelings comprise not just pleasure-displeasure, but two more pairs of opposed (mutually exclusive) feeling qualities, excitement-quiescence and tension-relaxation; and that

(b) emotions are different mixtures of these six “basic feelings” (e.g., anger is an unpleasant feeling also characterized, at least typically, by excitement and tension). In broad agreement with Wundt, contemporary “dimensional” theories of emotional experience (e.g., Russell, 2003; see also Reisenzein, 1994) assume that the feeling core of emotions consists of mixtures of pleasure or displeasure and (cortically produced) activation or deactivation (which corresponds approximately to Wundt’s dimension of excitement-quiescence). Supportive evidence for this theory is summarized in Russell (2003).⁶

Cognition-Feeling Theory

Although mental feeling theory is able to solve some problems of bodily feeling theory, it does not solve all. Two remaining problems are: (1) even if one assumes the existence of several different mental feeling qualities, this still does not allow to explain the fine-grained distinctions among emotions; and (2) like the bodily feeling theory, the mental feeling theory has difficulties accounting for the object-directedness of emotions. To solve these problems, several feeling theorists have proposed to bring in other mental elements into the emotion in addition to feelings. The most frequently proposed additional emotion components have been the cognitions (appraisals) by which the emotional feelings are caused (e.g., Schachter, 1964; Lazarus, 1991; Oatley & Johnson-Laird, 1987). According to the resulting “hybrid” cognition-feeling theory, emotional experiences are complex mental states that consist of feelings plus the appraisals that caused them. Because appraisals are undoubtedly finely differentiated, cognition-feeling theory is able to solve the problem of

⁶ Another version of mental feeling theory postulates several distinct, unanalyzable mental feelings corresponding to presumed biologically basic emotions, such as joy, sadness, fear, anger, and disgust (e.g., Johnson-Laird, 1987; see also Buck, 1985). On a broad understanding of “mental feelings”, one can also subsume in the category of mental feeling theories the proposal that emotions are felt action tendencies (e.g., Arnold, 1960; Frijda, 1986). However, both of these versions of mental feeling theory have to cope with a number of problems (Reisenzein, 1995; 1996).

emotion differentiation. It also seems to be able solve, at first sight at least, the problem of accounting for the object-directedness of emotions: According to cognition-feeling theory, emotions have objects because they contain object-directed cognitions as components and their objects are just the objects of these cognitions (but see Reisenzein, 2012, for objections to this idea).⁷

However, the “hybrid” cognition-feeling theory is not the only option available to the feeling theorists. To solve the emotion differentiation problem, feeling theorists need not assume that cognitions are *components* of emotion; they can continue to regard them as the *causes* of emotions construed as sensation-like feelings, but assume that emotions are partly distinguished by their causes (Reisenzein, 1994; 2012). For example, joy can be analyzed as a feeling of pleasure caused by the belief that a desire has been fulfilled, whereas pride can be analyzed as a feeling of pleasure caused by the belief that one has made an extraordinary achievement. With respect to the problem of accounting for the object-directedness of emotions, feeling theorists can argue that subjective impressions are misleading and that emotions do not really *represent* the objects at which they seem to be focused (e.g., Reisenzein, 2009a). For a discussion of these options, see Reisenzein (2012).

The Evolutionary Core of the Emotion System

In my discussion of the effects of emotion, I already referred to their adaptive effects, or biological functions. The assumption that such functions exist implies that at least the core of the emotion system has been created by evolutionary processes, specifically through natural selection. This hypothesis is per se not very controversial among today’s emotion psychologists; after all, presumably the cores of all mental subsystems (perception, cognition,

⁷ Impressed by the apparent ability of cognitions (appraisals) to explain the differentiation and object-directedness of emotions, several emotion theorists—mostly in philosophy—have proposed that emotional experiences are just conscious evaluations (e.g., Nussbaum, 2001; Solomon, 1976). However, this “radically cognitive” theory of the nature of emotions has its

motivation, emotion etc.) were created by natural selection. Controversy starts, however, when it comes to specifying exactly what the evolutionary core of the emotion system consists of, and relatedly, to what degree and in which respects the emotion system is molded, and moldable, by learning. James's proposal was that the evolutionary core of the emotion system is a multi-modular system consisting of a set of discrete emotion mechanisms, each of which generates a distinct, "basic" emotion (see James, 1890/1950). The set of basic emotion mechanisms was not precisely enumerated by James, but he suggested that they comprise at least anger, fear, joy, grief, love, hate, and pride (see Reisenzein & Stephan, in press). These evolutionary assumptions have turned out to be even more influential than James's views about the nature of emotional experience. However, this part of James's emotion theory, too, remained a sketch. It was left to William McDougall (1908/1860) to explicate it in the first book-length account of the evolutionary theory of discrete basic emotions.

McDougall's Theory of Discrete Basic Emotions

McDougall claimed that the biological core of the emotion system consists of a small set of modular information processing mechanisms—McDougall called them *instincts*—that developed during evolution because each solved a specific, recurrent adaptive problem. McDougall initially proposed seven basic instincts or emotion modules, including the fear module (or flight instinct), the disgust module (or instinct of repulsion), and the anger module (or instinct of pugnacity). Formulated in information processing terminology, each basic emotion module consists of a *detector* that monitors incoming sensory information, and a *reaction program*. When the detector receives appropriate input—namely, information that indicates the presence of the adaptive problem which the module was designed by evolution to solve—the associated reaction program is triggered, which causes the occurrence of a

own serious problems. In particular, it fails to provide a plausible explanation of the

coordinated pattern of mental and bodily responses. According to McDougall, this emotional reaction pattern comprises an emotion-specific action impulse, a specific pattern of bodily (in particular peripheral-physiological) reactions, and a specific kind of emotional experience (see Reisenzein, 2006).

McDougall was much more certain than James that the emotional mechanisms are adaptive. The central biological function of the emotion modules, he claimed, is *motivational*; that is, they serve to generate impulses for adaptive actions—actions that regularly solved the pertinent adaptive problem in the ancestral environment (e.g., avoidance of bodily injury in the case of fear, or protection against poisoning in the case of disgust). Accordingly, the central output of the emotion modules is the action impulse (e.g., the impulse to flee in the case of fear or the impulse to reject offensive substances in the case of disgust). The remaining outputs of the emotion modules, including emotional experience, only serve to support, in one way or other, this main biological function.

According to McDougall, the *internal configuration* of the emotion modules—the connection between the detector and the reaction program—is “hardwired” and cannot be modified by experience and learning. Nevertheless, during individual development, the emotional system as a whole is greatly modified by learning processes that affect the *inputs and outputs* of the emotion modules: Only very few of the elicitors of the emotion modules are innate, most are acquired; likewise, although the emotional action impulses are innate, whether they are expressed in action or not, and if yes, to which concrete actions they lead, depends mostly on learning.

Modern Theories of Basic Emotions

Post-behaviorist emotion psychology saw not only a renaissance of cognitive and feeling theories of emotion, but also of evolutionary emotion theories. Most of these theories

phenomenal quality of emotional experiences (see Reisenzein, 2012).

are modern variants of McDougall's (and James's) theory of discrete basic emotions (e.g., Ekman, 1972; Izard, 1971; Plutchik, 1980; Tooby & Cosmides, 1990). The more recent basic emotions theorists differ from McDougall mainly in that they ascribe a more important role to cognitive processes in the elicitation of emotions as well as, in some cases (e.g., Ekman, 1972; Izard, 1971) to the facial expression of emotion. Perhaps the best-known modern basic emotions theory was proposed by Ekman (1972; 1992). According to Ekman, there are at least six (but possibly up to 15; Ekman, 1992) basic emotion modules: joy, sadness, anger, disgust, fear, and surprise. When activated by suitable perceptions or appraisals, these inherited "affect programs" generate emotion-specific feelings, physiological reaction patterns, and an involuntary tendency to show a particular facial expression (e.g., smiling in the case of joy). However, this "instinctive" tendency need not result in a facial expression, because it can be, and often is, voluntarily controlled in an attempt to comply with social norms that regulate emotional expression (so-called "display rules").

Actually, the influence of the James-McDougall theory of discrete, biologically basic emotions extends far beyond the mentioned, contemporary evolutionary emotion theories; for central assumptions of this theory have also found their way into several contemporary appraisal theories (e.g., Arnold, 1960; Frijda, 1986; Lazarus, 1991; Roseman, 1984; see Reisenzein, 2006, for a discussion).

Are there Discrete Basic Emotions?

Given the prominence of the basic emotions view, it is important to realize that it is not the only possibly theory of the evolutionary architecture of the emotion system. The main alternative that has been proposed is that, rather than consisting of multiple discrete emotion modules, the emotion system consists of small number of mechanisms that produce *all* emotions. This idea, which is already implicit in some classic emotion theories (e.g., Wundt, 1896), has been developed in different ways by different contemporary theorists (e.g., Lang,

1995; Russell, 2003; Reisenzein, 2009a). To illustrate, one proposal is that the emotion system consists of but two mechanisms, one of which compares newly acquired beliefs with existing beliefs, and another that compares newly acquired beliefs with existing desires; these mechanisms are assumed to generate sensation-like feelings (e.g., of pleasure and displeasure, and of surprise) that combine to form different emotions (Reisenzein, 2009a; 2009b).

Since the 1960ies, a great deal of empirical research has been devoted to answering the question whether or not the emotion system consist of a multimodular system of discrete “basic emotion” modules. A central testable implication of basic emotions theory is that presumed biologically basic emotions are associated with distinct patterns of physiological and expressive responses (see Barrett, 2006). The comparatively best support for this hypothesis stems from cross-cultural studies of facial expression (e.g., Ekman, Friesen et al., 1987; for summaries see Elfenbein & Ambady, 2002; Nelson & Russell, 2013). In these studies, judges were presented with photographs of prototypical facial expressions of basic emotions (typically Ekman’s six) together with a list of the names of the emotions, and were asked to indicate which emotion is expressed by which facial expression. Using this method, very high “correct” emotion classifications have been obtained (e.g., Ekman et al., 1987). However, Russell (1994) has pointed out that observer agreement on the expressed emotions is artifactually inflated in these studies. Furthermore, observer agreement decreases significantly with increasing distance to Western cultures (Nelson & Russell, 2013). In addition, being studies of emotion *recognition*, these investigations do not directly speak to the question of the *production* of emotional facial expressions, which is the more important test case for basic emotions theory. Recent reviews of studies of spontaneous facial expressions of emotions in laboratory experiments (Reisenzein, Studtmann, & Horstmann, 2013) and naturalistic field studies (Fernandez-Dols & Crivelli, 2013) suggest that (a) with

the exception of amusement, experiences of basic emotions are accompanied by their presumably characteristic facial expressions only in a minority of cases; and (b) low emotion intensity and attempts to control facial expressions are insufficient to explain the observed emotion-face dissociations. Studies of peripheral-physiological changes in emotions have found even less coherence between emotional experience and behavior (e.g., Mauss & Robinson, 2009). However, it can be argued that the best place look for evidence for basic emotion modules is the brain (cf. James, 1884). The issue is addressed in the next section.

The Neurophysiological Basis of Emotions

James versus Cannon

According to James (1884), the neurophysiological processes which underlie emotions are, in their entirety, ordinary sensory and motor processes in the neocortex. This assumption, too, was rejected by Cannon (1927) in his critique of James's theory. Indeed, brain lesion studies in cats by Cannon's coworker Bard (e.g., Bard, 1934; see also, Cannon, 1931) suggested that the programs for bodily reactions are not located in the motor cortex, as James had thought, but in what Cannon called the "thalamic region", a subcortical brain region comprising the thalamus, hypothalamus and adjoining structures. Based on these and other findings, Cannon and Bard proposed that emotional experience and expression are generated *simultaneously* when an "affect program" in the thalamic region is activated. However, because Cannon's affect programs were, like those of James, programs for *bodily reactions*, James need not have been too much disconcerted by Cannon's neurophysiological model and could even have welcomed it an alternative implementation proposal for his own emotion theory, that accounted for several problematic findings (Cannon, 1927; Reisenzein & Stephan, in press). However, another assumption of the Cannon-Bard theory—that physiological reactions are essentially emotion-unspecific—is incompatible with James's

theory (Cannon, 1927). In fact, the lack of physiological response differentiation speaks against any theory that assumes multiple discrete emotion mechanisms.

Limbic System Theory

This conclusion was incorporated in the next historically important neurophysiological emotion model, the limbic system theory proposed by Papez (1937) and McLean (1952; see Dalgleish, 2004, for a summary). The central assumption of this theory is that the neurophysiological basis of emotions, rather than consisting of a set of distinct emotion modules (as James and McDougall had assumed), is a single system—the *limbic system*. With this name, McLean denoted a group of subcortical and cortical structures (including among others nuclei of the thalamus and hypothalamus, as well as the amygdala, on the subcortical side and the cingular cortex and hippocampus on the cortical side) which, he claimed, are tightly connected to each other but relatively isolated from the rest of the brain, in particular the neocortex, and hence form a neurophysiological module. In addition, McLean proposed that the limbic system is a phylogenetically old part of the brain, whereas the neocortex is of comparatively recent origin.

The limbic system theory of emotion became highly influential; in fact, it dominated neurophysiological theorizing on emotions until the 1990ies. Since then, however, the theory has been strongly criticized (e.g., Kotter & Meyer, 1992; LeDoux, 1998; 2012). The basic criticism is that, contrary to McLean's claims, the structures subsumed under the name "limbic system" are neither neuroanatomically nor phylogenetically clearly distinct from the rest of the brain, and hence, do not really form a separate processing system. Furthermore, although some limbic system structures (e.g., the amygdala) certainly do play a role in emotions, others (e.g., the hippocampus) seem to have primarily cognitive functions (Dalgleish, 2004; LeDoux, 1998).

The demise of the limbic system theory has led some authors to conclude that some version of a multimodular, discrete basic emotions theory might after all be correct (e.g., LeDoux, 1998). But of course, it is also possible that emotions are produced by an integrated neural system that simply was not correctly described by limbic system theory (see also, Arnold, 1960).

In Search of the Emotion Modules in the Brain

Since the 1980ies, fostered by the development of new and improved methods of investigating brain structure and brain activity (such as neuroimaging methods, e.g. fMRI [functional magnetic resonance imaging] and PET [positron emission tomography]), neurophysiological emotion research has been growing at an exponential rate. Much of this research has been inspired, indirectly or indirectly, by the discrete basic emotions theory proposed by Ekman and others, and has sought to provide evidence for or against the emotion modules assumed by this theory. An important boost to the search for emotion modules in the brain was provided by LeDoux (e.g., 1998). Based on research with animals, LeDoux argued that the amygdala—one of the subcortical structures of McLean’s limbic system—is in fact the “hub in the wheel of fear” (LeDoux, 1998, p. 168), that is, the central structure of a neurophysiological fear module of the kind proposed by the basic emotion theorists. LeDoux’s neurophysiological model of fear has been supported, among others, by studies which suggest that the amygdala is necessary for the acquisition and display of most (but not all) conditioned fear reactions in animals. Parallel findings have been reported for the conditioning of physiological fear reactions in humans (LeDoux, 1998; 2012).

However, more recent brain imaging research has found that the amygdala is not only activated by fear-related stimuli, but can also be activated by unpleasant pictures and odors and the induction of a sad mood (see Murphy, Nimmo-Smith, & Lawrence, 2003). Even some positive stimuli have been found to activate the amygdala (see Murphy et al., 2003). In

addition, the amygdala has been found to respond to novel, unexpected stimuli, to which it rapidly habituates when they have no relevant consequences (Armony, 2013). Furthermore, there is so far no firm evidence that the amygdala is necessary for the *experience* of fear, or other emotions. On the contrary, a study by Anderson and Phelps (2002) of people with lesions of the amygdala found no evidence for reduced emotional experience. Taken together, these findings suggest that the function of amygdala activation is not primarily the generation of fear, nor of negative emotions, nor of emotions in general. Rather, as suggested by a number of authors, the function of amygdala activation may be to support the focusing of attention on stimuli that are potentially motivationally relevant.

The fear theory of the amygdala is representative for several other recent claims of having detected modules for discrete basic emotions in the brain. For example, it has been claimed that the disgust module is localized in the insula, the sadness module in the subgenual anterior cingulate cortex, and the anger module in the orbitofrontal cortex (see Lindquist, Wagner, Kober, Bliss-Moreau, & Barrett, 2012). As in the case of LeDoux's fear theory, subsequent research has found these claims to be premature. Accordingly, a recent comprehensive meta-analysis of brain imaging studies of emotion concludes that there is little evidence that discrete basic emotions can be localized to distinct brain regions (Lindquist et al., 2012). These data reinforce the doubts about discrete basic emotions theory raised by research on the expression of emotions reported above. For further discussion of the conclusions that might be drawn from the neurophysiological data, readers are referred to Lindquist et al. (2012) and LeDoux (2012).

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