Kognitionspsychologie II: Session 8

Emotion

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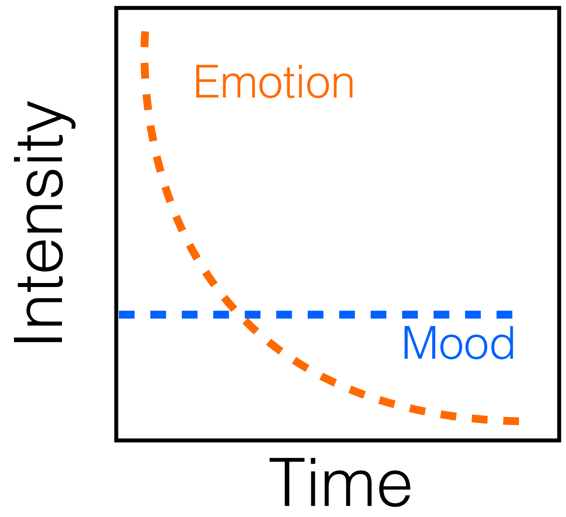
Learning Objectives

- Be able to discuss the potential adaptive function of emotions and answer whether there is such thing as a basic emotion (and whether this is a helpful concept!)…
- Discuss the possible **adaptive significance** of emotions
- Learn how **comparative approaches** give some support to the idea of basic emotions
- Learn about **developmental patterns** in the maturation of the neural architecture of emotional experience and regulation
- Learn about **neural model**(s) of basic (and not so basic) emotions

Affect, Mood, and Emotion

Summary of distinctions between emotion and mood

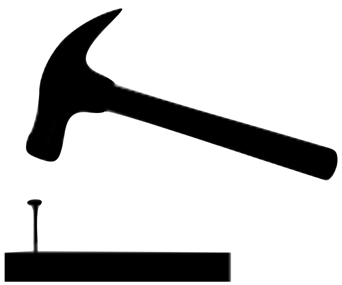
Criterion	*Emotion*	*Mood*
Anatomy	Related to the heart	Related to the mind
Awareness of cause	Individual is aware of cause	Individual may be unaware of cause
Cause	Caused by a specific event or object	Cause is less well defined
Clarity	Clearly defined	Nebulous
Consequences	Largely behavioural and expressive	Largely cognitive
Control	Not controllable	Controllable
Display	Displayed	Not displayed
Duration	Brief	Enduring
Experience	Felt	Thought
Intensity	Intense	Mild
Intentionality	About something	Not about anything in particular
Physiology	Distinct physiological patterning	No distinct physiological patterning
Stability	Fleeting and volatile	Stable
Timing	Rises and dissipates quickly	Rises and dissipates slowly



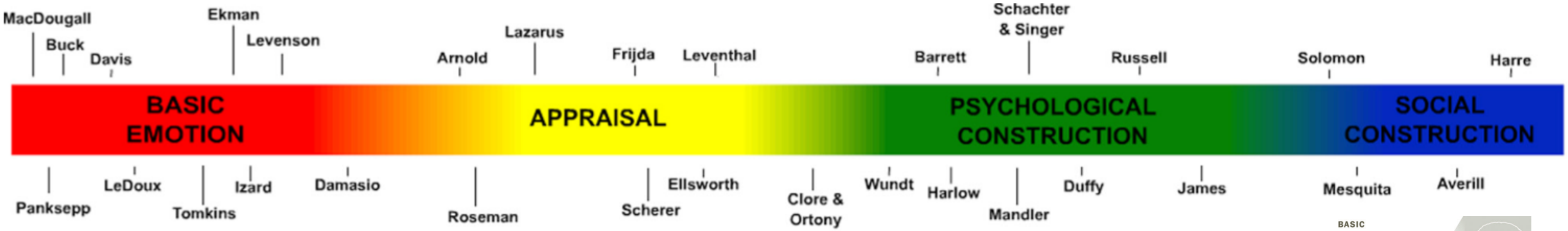
Affect is typically used as general term to refer to mental states consisting of emotions and moods; emotions have episodic nature, are triggered by specific (internal or external) stimuli - hence, have intentionality (i.e., are about something) and have high(er) intensity and more limited temporal course relative to moods.

Beedie, C., Terry, P., & Lane, A. (2005). Distinctions between emotion and mood. *Cognition & Emotion, 19*(6), 847–878. doi:10.1080/02699930541000057

Emotion

Ontogeny	Mechanism
Phylogeny	 Adaptive Significance

Four perspectives on emotion



Basic Emotion: emotion words such as "anger," sadness," and "fear" each name a unique mechanism that causes a unique mental state with unique measurable outcomes.

Appraisal: emotion words name privileged mental states that are unique in form, function, and cause from other mental states, but "anger," "sadness," "fear," and other emotion words do not name distinct, dedicated mental mechanisms per se. Instead, emotions are linked to appraisals which in turn trigger biologically basic emotional responses characterised either by stereotyped outputs or by a strong and almost inescapable tendency to interact with the world in a particular way (both fear and surprise are linked to the appraisals of uncertainty).

Psychological Construction: all mental states are seen as emerging from an ongoing, continually modified constructive process that involves more basic ingredients that are not specific to emotion.

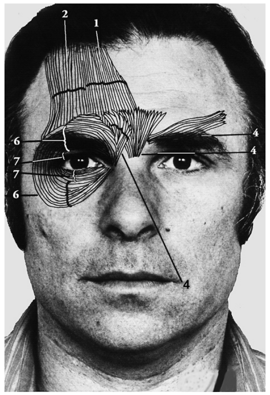
Social Construction: Emotions are viewed as social artifacts or culturally-prescribed performances that are constituted by sociocultural factors, and constrained by participant roles and social context.

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.

Basic Emotions

"Emotions are viewed as having evolved through their adaptive value in dealing with fundamental life-tasks. Each emotion has unique features: signal, physiology, and antecedent events. Each emotion also has characteristics in common with other emotions: rapid onset, short duration, unbidden occurrence, automatic appraisal, and coherence among responses. These shared and unique characteristics are the product of our evolution, and distinguish emotions from other affective phenomena."

"Most of my presentation will describe nine characteristics of the emotions of **anger, fear, sadness**, **enjoyment**, **disgust**, and **surprise**. I will also raise the possibility that contempt, shame, guilt, embarrassment, and awe may also be found to share these nine characteristics."



Paul Ekman

Characteristics which Distinguish Basic Emotions from One Another and from Other Affective Phenomena

	Basic with regard to:	
	Distinctive States	*Biological Contribution*
1. Distinctive universal signals	x	x
2. Presence in other primates		x
3. Distinctive physiology	x	x
4. Distinctive universals in antecedent events	x	x
5. Coherence among emotional response		x
6. Quick onset		x
7. Brief duration		x
8. Automatic appraisal		x
9. Unbidden occurrence		x

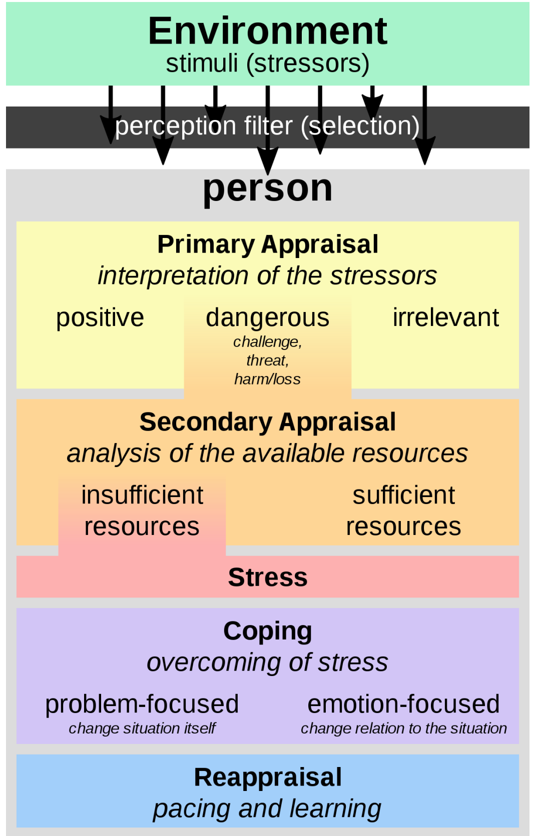
Ekman, P. (1992). An argument for basic emotions. ***Cognition & Emotion, 6***(3/4), 169-200. doi:10.1080/02699939208411068

Appraisals

Richard S. Lazarus

Susan Folkman

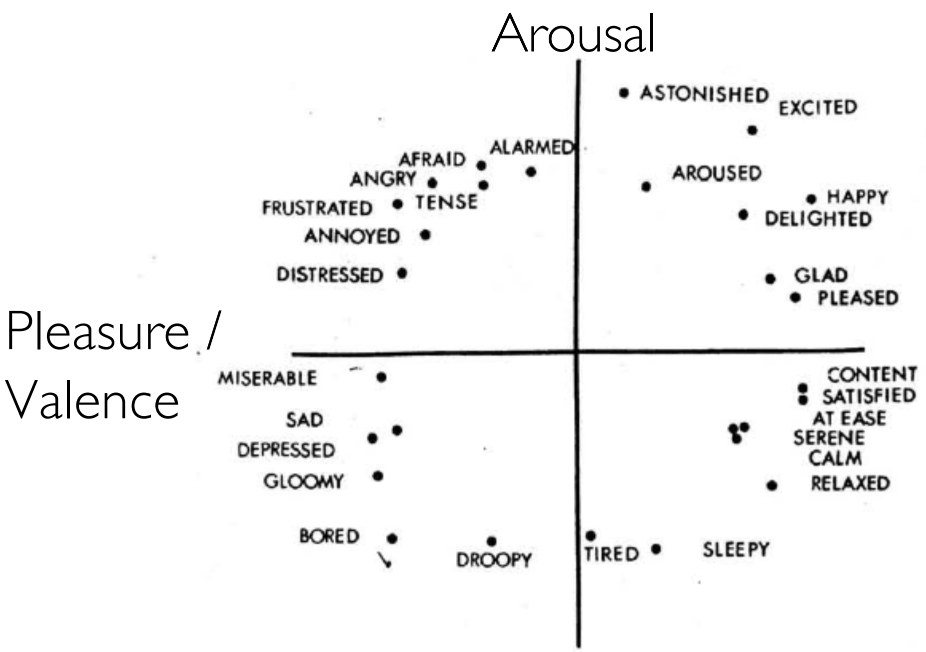
Lazarus and Folkman (1984) conducted a number of experiments in which they used movies to produce emotional reactions and stress (e.g., genital mutilation). A number of manipulations were used to change cognitive interpretation (e.g., narrator comments). Lazarus and Folkman found that participants' interpretations had a crucial role in the emotional experience and behaviour leading Lazarus and Folkman to propose a theory of "cognitive appraisal" which is based on the importance of individuals' appraisals (cognitive interpretations of the environment). This theory has had many uses in clinical and educational practice, particularly in the form of reappraisal interventions (see figure on the right).



According to such approaches, appraisals are cognitive phenomena (i.e., "part of the cloud of associates that each perceived or thought of informational element stirs") and respective "action tendencies" may have adaptive/maladaptive character depending on either universal (anger -> fight) or individually learned patterns.

Lazarus, R.S., & Folkman, S. (1984). Stress, appraisal and coping. New York: Springer.

Psychological Construction

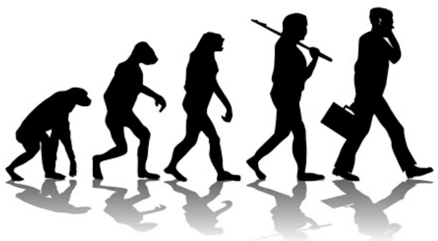


The circumplex model of affect proposes that all affective states arise from cognitive interpretations of core neural sensations that are the product of two independent (neurophysiological) systems. This model stands in contrast to theories of basic emotions, which posit that a discrete and independent (neural) system subserves every emotion.

"At the heart of emotion, mood, and any other emotionally charged event are states experienced as simply feeling good or bad, energized or enervated. These states—called core affect—influence reflexes, perception, cognition, and behavior and are influenced by many causes internal and external, but people have no direct access to these causal connections. Core affect can therefore be experienced as free-floating (mood) or can be attributed to some cause (and thereby begin an emotional episode). These basic processes spawn a broad framework that includes perception of the core-affect-altering properties of stimuli, motives, empathy, emotional meta-experience, and affect versus emotion regulation; it accounts for prototypical emotional episodes, such as fear and anger, as core affect attributed to something plus various nonemotional processes."

Russell, J.A. (1980). A circumplex model of affect. ***Journal of Personality and Social Psychology, 39***, 1161–1178.

Emotion

Ontogeny	Mechanism
 Phylogeny	Adaptive Significance

Emotion specificity: Fear

amygdala lesion

AM-61

inferior temporal lesion

IT-60

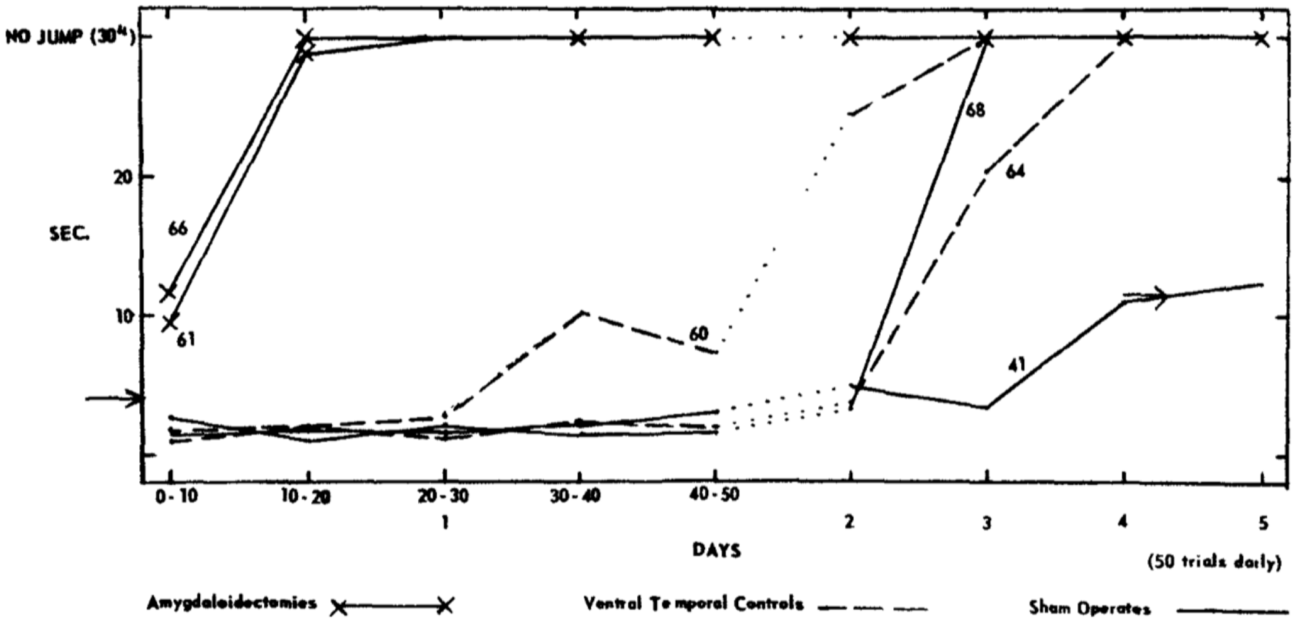
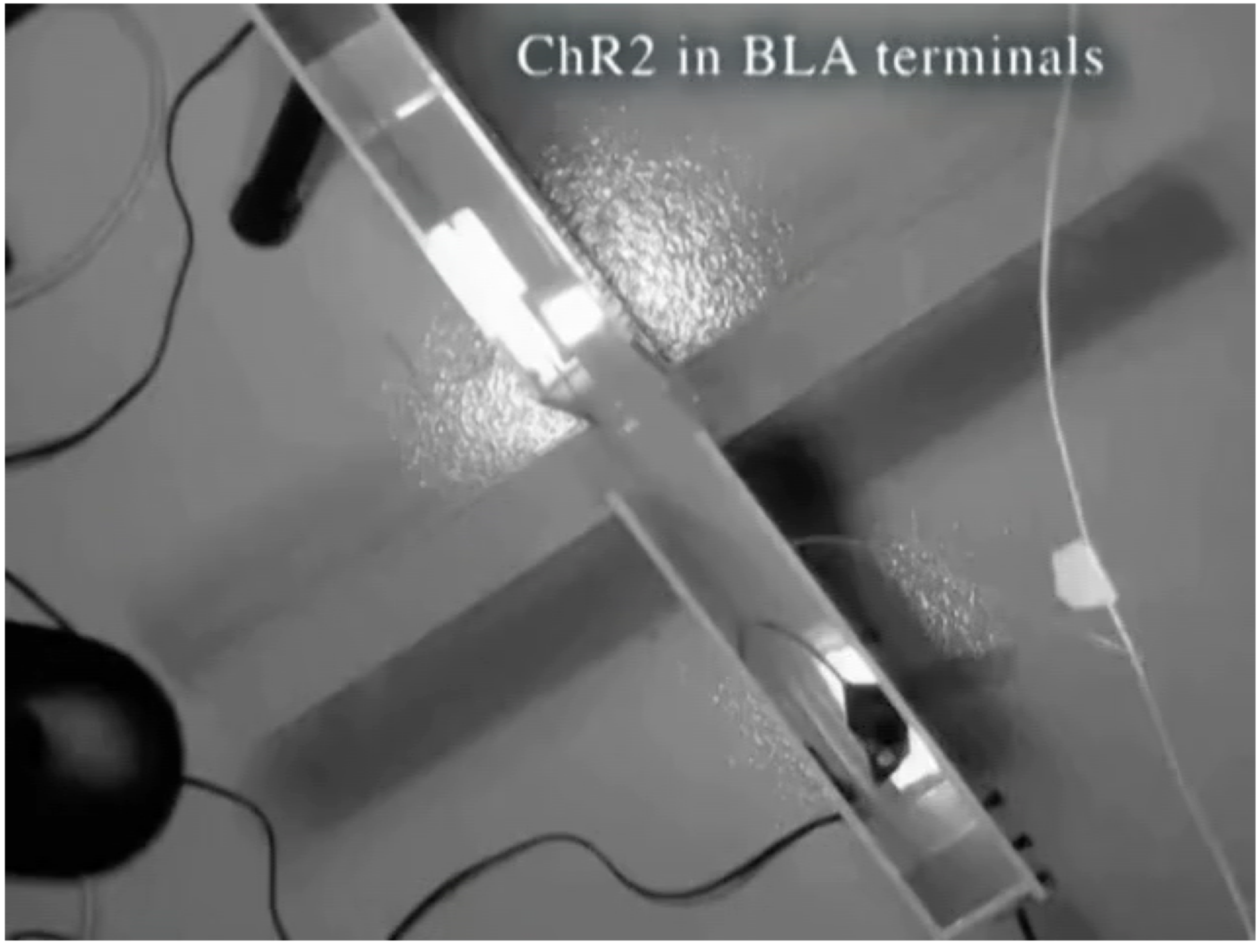


FIG. 3. Extinction of conditioned avoidance.

Ablation of the amygdala lead to ”a marked increase in tameness and a weakening or disappearance of fear responses to previously aversive stimuli by amygdala animals.”

Weiskrantz, L. (1956) Behavioral changes associated with ablation of the amygdaloid complex in monkeys. *Journal of Comparative Physiology and Psychology, 49*, 381–391.

Emotion specificity in neural responses: Fear

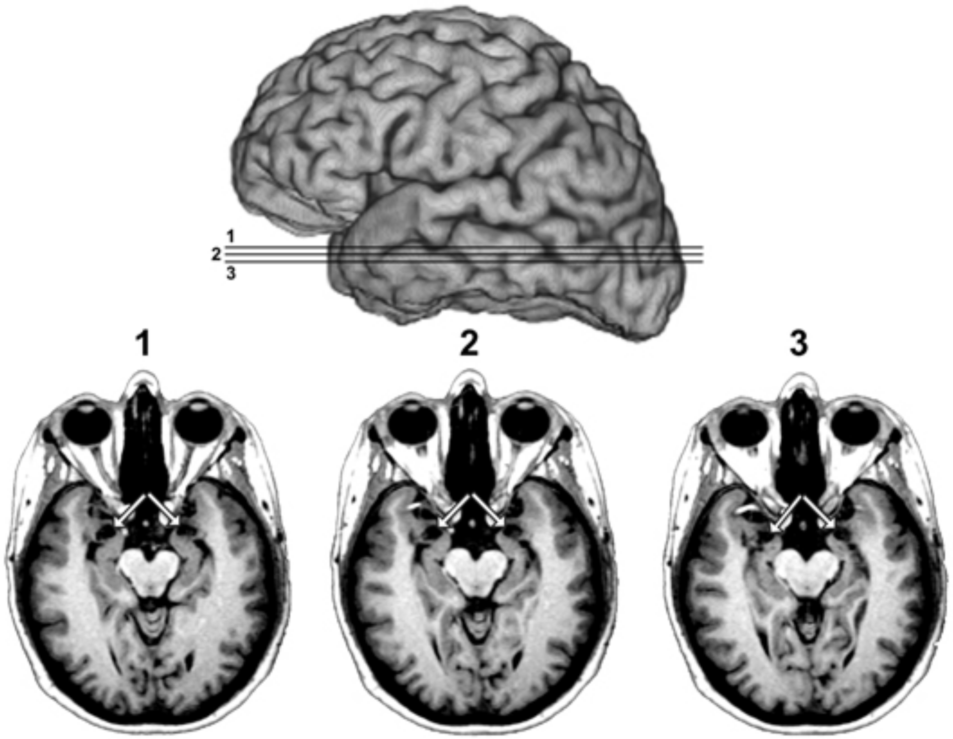


Optogenetics
a biological technique which involves the use of light to control cells in living tissue, typically neurons, that have been genetically modified to express light-sensitive ion channels. It is a neuromodulation method that uses a combination of techniques from optics and genetics to control and monitor the activities of individual neurons in living tissue—even within freely-moving animals—and to precisely measure these manipulation effects in real-time.

"With the capability of optogenetics to control not only cell types but also specific connections between cells, we observed that temporally precise optogenetic stimulation of basolateral amygdala (BLA) terminals in the central nucleus of the amygdala (CeA) exerted an acute, reversible anxiolytic effect. "

Tye, K. M., & Deisseroth, K. (2012). Optogenetic investigation of neural circuits underlying brain disease in animal models. Nature Reviews Neuroscience, 13(4), 251–266. http://doi.org/10.1038/nrn3171

Emotion specificity in neural responses: Fear



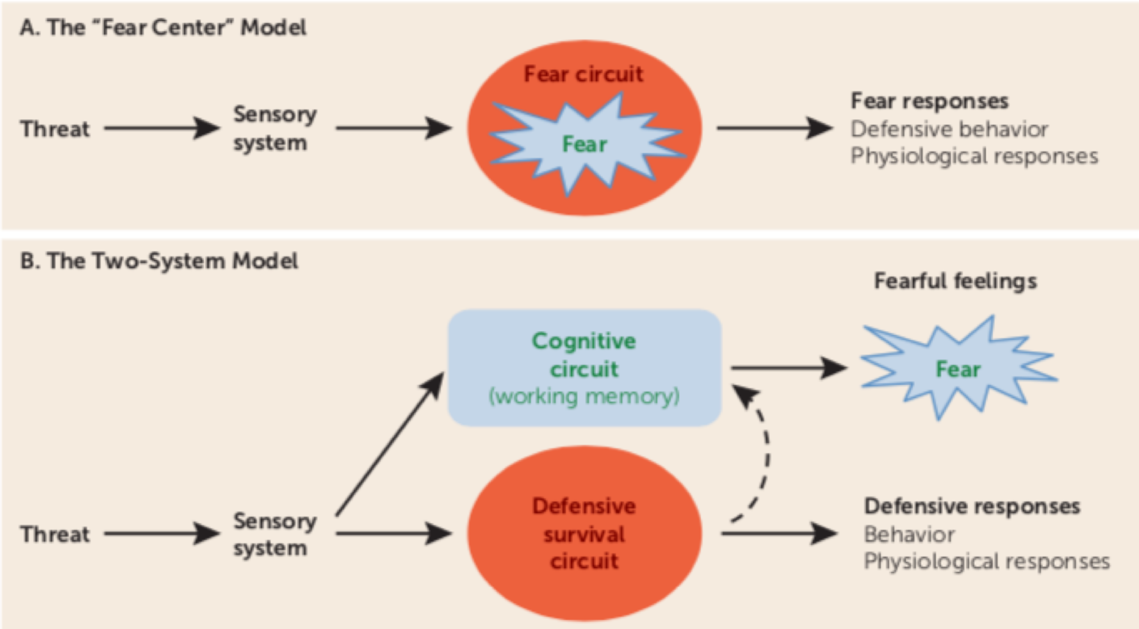
the woman without fear

Adolphs et al. report the case of an individual (SM) with a rare genetic condition, Urbach-Wiethe disease, which caused parts of her brain to harden, destroying her amygdala. SM reportedly had trouble recognising fear in other people and could not tell what fearful facial expressions mean, but was capable of discerning other emotions. SM did not show fear responses to typically frightening stimuli (e.g., snakes, horror movies).

Adolphs R, Tranel D, Damasio H, Damasio A (1994). Impaired recognition of emotion in facial expressions following bilateral damage to the human amygdala. ***Nature***. **372** (6507): 669–72. doi:10.1038/372669a0

Emotion specificity in neural responses: Fear

FIGURE 1. The Traditional "Fear Center" View Versus the "Two-System" View of "Fear"[a]



[a] In the traditional "fear center" model, the subjective experience of "fear" in the presence of a threat is innately programmed in subcortical circuits that also control defensive behaviors and physiological responses. The two-system framework views "fear" as a product of cortical circuits that underlie cognitive functions such as working memory; subcortical circuits control defensive behaviors and physiological responses and only indirectly contribute to conscious "fear." The traditional view thus requires different mechanisms of consciousness in the brain for emotional and nonemotional states, whereas in the two-system framework, both emotional and nonemotional states of consciousness are treated as products of the same system. In the two-system framework, what distinguishes an emotional from a nonemotional state of consciousness, and what distinguishes different kinds of emotional states of consciousness, are the input processes by the cortical consciousness networks (see Figure 3).

Modern theories of fear posit an important role for the amygdala in behavioural fear responses (cf. defensive survival circuit in the figure above) while proposing a central cognitive contribution to the conscious perception of "fear".

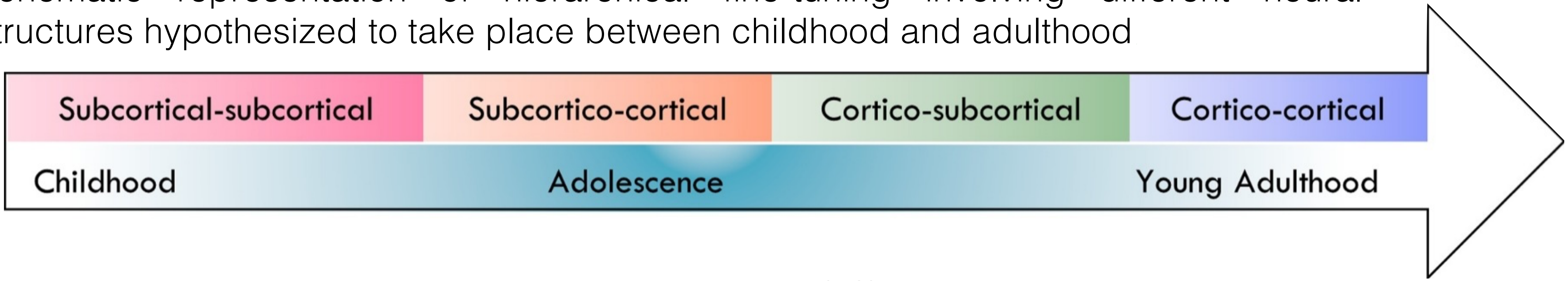
LeDoux, J. E., & Pine, D. S. (2016). Using Neuroscience to Help Understand Fear and Anxiety: A Two-System Framework. *The American Journal of Psychiatry*, *173*(11), 1083–1093.

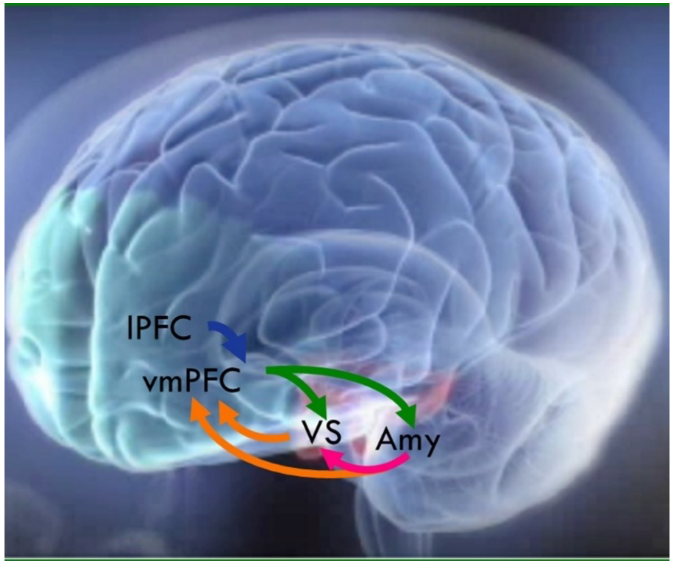
Emotion

Ontogeny 	Mechanism
Phylogeny	Adaptive Significance

Emotional development

Schematic representation of hierarchical fine-tuning involving different neural structures hypothesized to take place between childhood and adulthood





The ventral striatum (VS) is implicated in learning and prediction of positive outcomes and receives inputs from the basolateral amygdala (Amy). The amygdala is important in learning the emotional significance of cues in the environment, and can facilitate ventral striatum activity through its direct inputs from the basolateral nucleus, leading to motivated action. The ventromedial prefrontal cortex (vmPFC) has been implicated in fear and emotion regulation. This region has dense projections to the (inhibitory) cells in the amygdala and to the ventral striatum (VS) that modulate emotive behaviors. Cortico-cortical connections include pathways between lateral prefrontal cortex (lPFC), implicated in higher cognitive functions, and medial prefrontal regions, involved in emotion and social interactions. These connections may serve as an interface between cognitive and emotional processes.

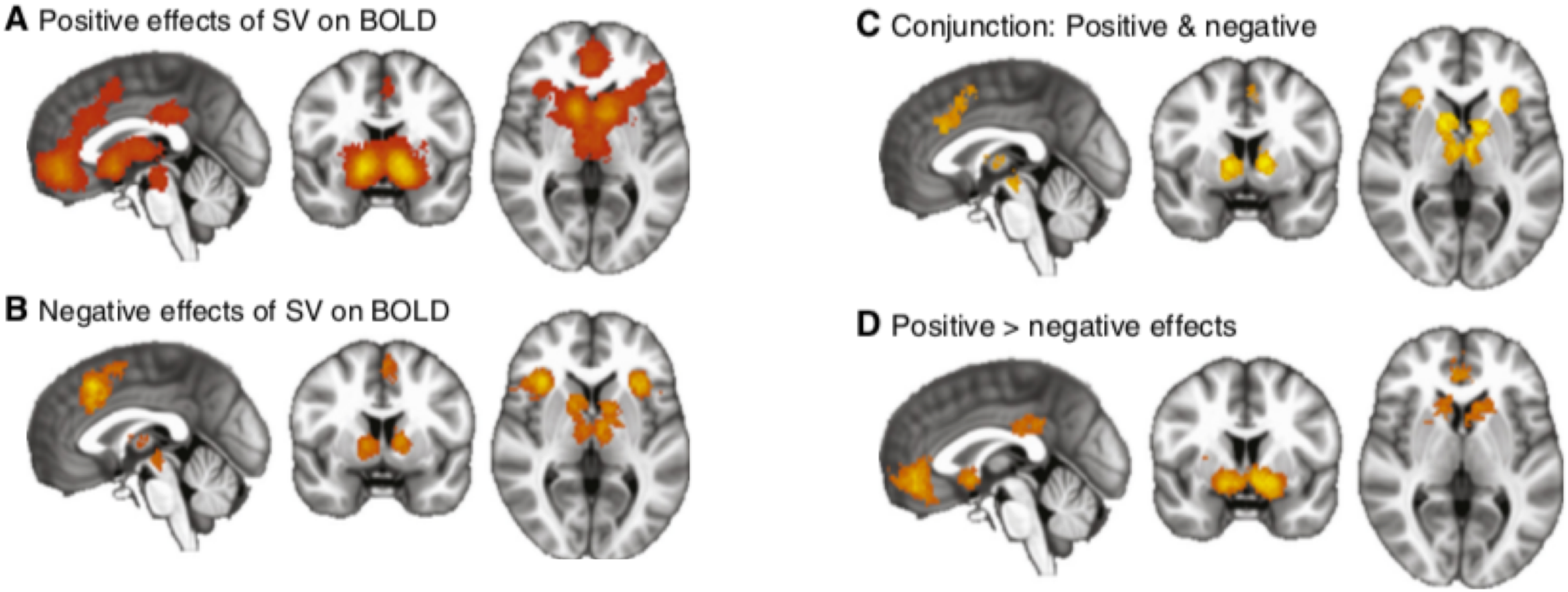
Current developmental models propose that there is a hierarchical fine-tuning that takes place across childhood and adolescence as a function of biological maturation and experience; this process represents a potential mechanism for the observed changes in emotional reactivity and regulation across childhood and adolescence (e.g., patterns of self-control and risk taking).

Casey, B. J., Heller, A. S., Gee, D. G., & Cohen, A. O. (2019). Development of the emotional brain. *Neuroscience Letters, 693*, 29–34. http://doi.org/10.1016/j.neulet.2017.11.055

Emotion

Ontogeny	Mechanism 
Phylogeny	Adaptive Significance

The emotional brain: Reward and Punishment



Meta-analysis of different studies involving outcomes consisting of either rewards or penalties (e.g., monetary payoffs, consumable liquids, arousing pictures, social feedback): "In one set of regions, both positive and negative effects of subjective value (SV) on BOLD are reported at above-chance rates (…). Areas exhibiting this pattern include anterior insula, dorsomedial prefrontal cortex, dorsal and posterior striatum, and thalamus. The mixture of positive and negative effects potentially reflects an underlying U-shaped function, indicative of signal related to arousal or salience. In a second set of areas, including ventromedial prefrontal cortex and anterior ventral striatum, positive effects predominate. Positive effects in the latter regions are seen both when a decision is confronted and when an outcome is delivered, as well as for both monetary and primary rewards. These regions appear to constitute a "valuation system," carrying a domain-general subjective value signal and potentially contributing to value-based decision making."

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.

The emotional brain: Emotional states

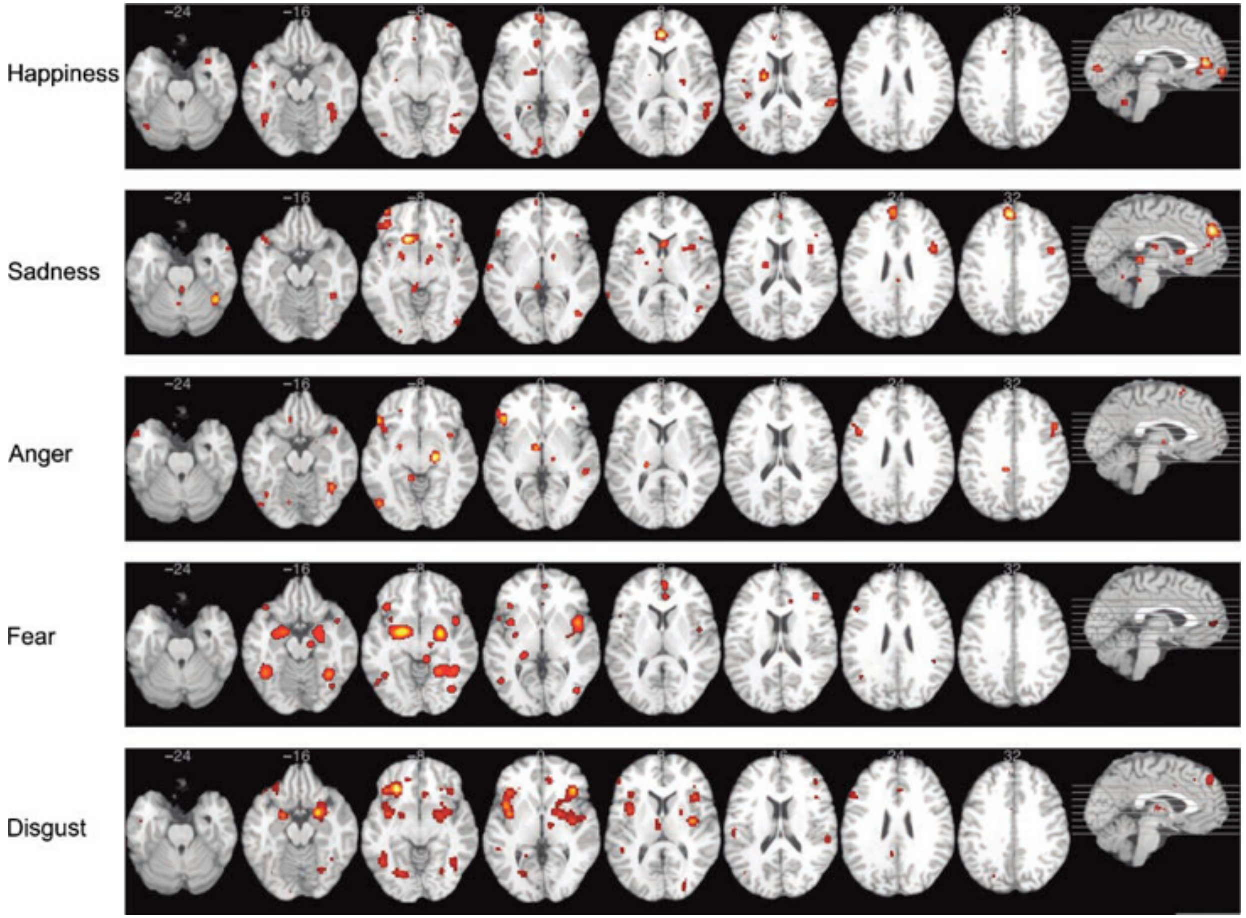
STG, ACC

caudate
head

IFG

Amygdala

Insula



Activation likelihood maps representing activity consistently associated with each basic emotion state in experiments involving emotional stimuli (e.g., pictures, faces). Rather than representing magnitude of activation, the color gradient represents the degree of overlap (i.e., activation likelihood or **consistency**) among the activation coordinates across studies that contributed to the analysis. Additional analysis (not shown here) further suggest neural **discriminability** between the specific emotional states considered.

Vytal, K. & Hamann, S. (2010). Neuroimaging support for discrete neural correlates of basic emotions: A voxel-based meta-analysis. ***Journal of Cognitive Neuroscience, 22***, 2864-85

The emotional brain: Emotional states

Emotions were induced with short movies or mental imagery during functional magnetic resonance imaging. Multi-voxel pattern analysis (MVPA) accurately classified emotions induced by both methods, and the classification generalized from one induction condition to another and across individuals.

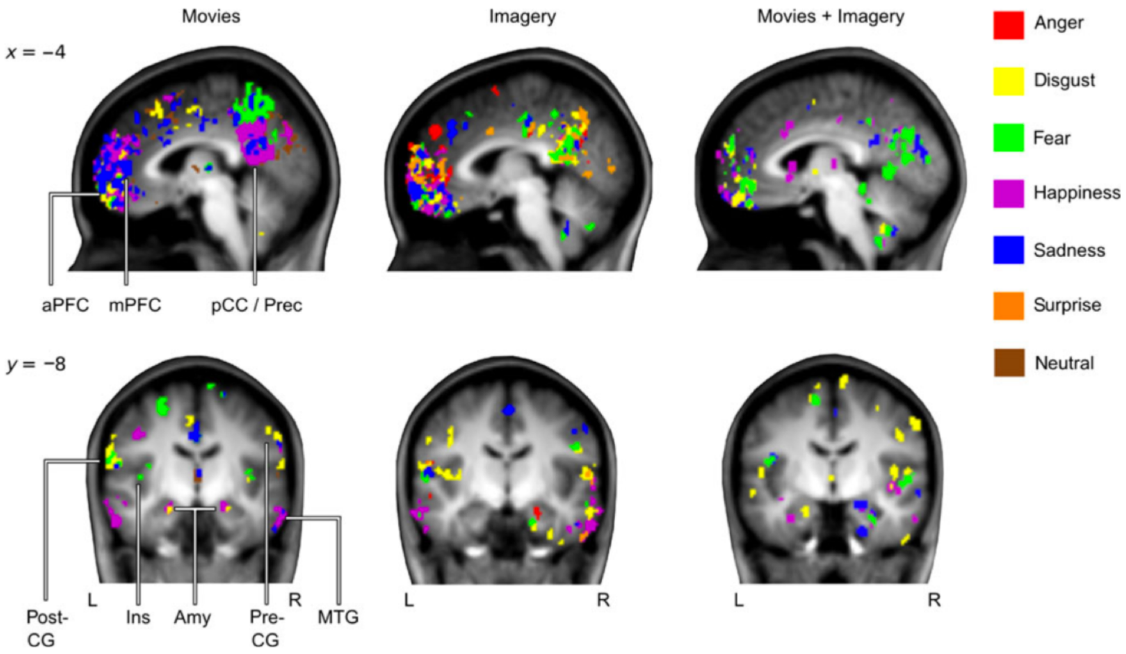


Figure 3. Brain regions with the largest importance for within-participant classification for each basic emotion. mPFC, medial prefrontal cortex; PCC, posterior cingulate cortex; Prec, precuneus; aPFC, anterior prefrontal cortex; LOC, lateral occipital cortex; post-CG, postcentral gyrus; pre-CG, precentral gyrus; Ins, insula; Amy, amygdala; MTG, middle temporal gyrus. Note: These importance maps are shown for visualization only. All inference is based on the classifier performance.

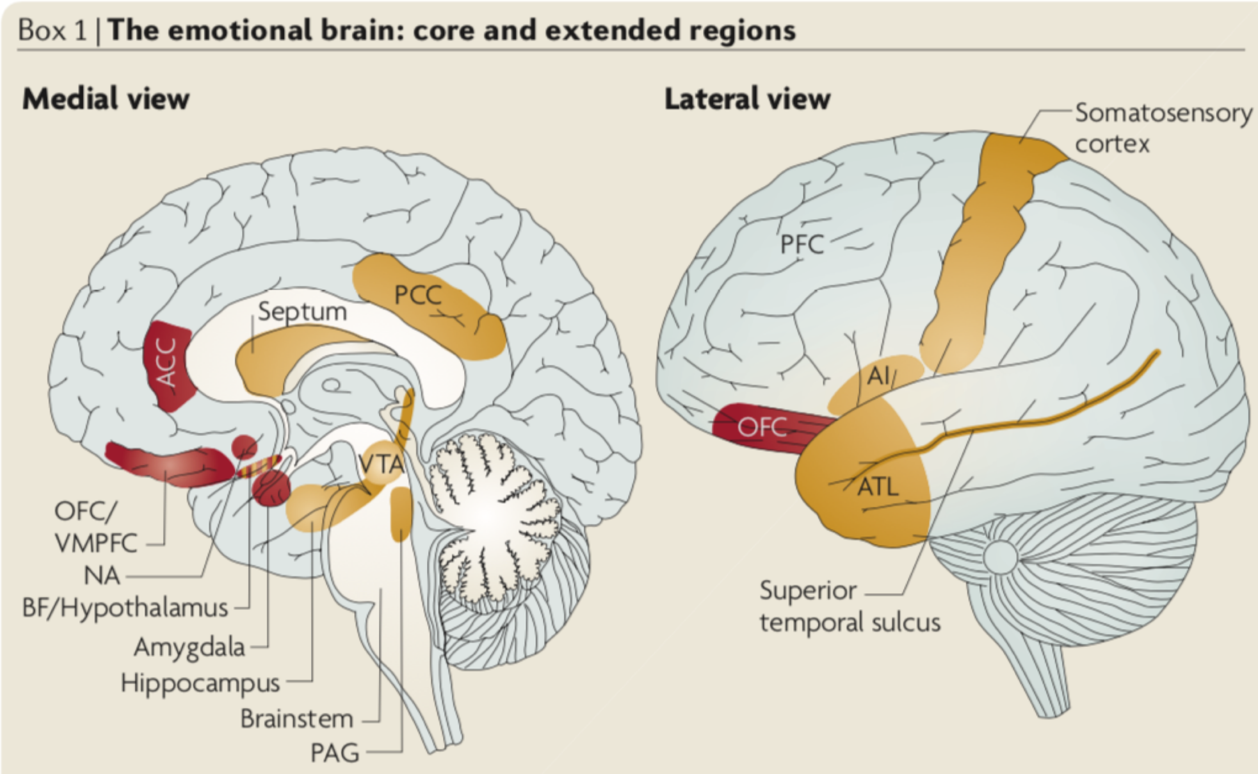
MVPA

multi-voxel pattern analysis utilizes the unique contributions of multiple voxels within a voxel-population. In a typical implementation, an algorithm (i.e. classifier) is trained to distinguish trials for different conditions within a subset of the data. The trained model is then tested by predicting the conditions of the remaining (independent) data. This approach is most typically achieved by training and testing on different scanner sessions or runs.

Evidence for consistency and discriminability of neural responses at the level of the individual and that generalise across modalities (movies vs. mental imagery) - mostly for heterogenous/distributed cortical areas - not specific well-defined structures!

Saarimäki, H., Gotsopoulos, A., Jääskeläinen, I. P., Lampinen, J., Vuilleumier, P., Hari, R., et al. (2016). Discrete Neural Signatures of Basic Emotions. Cerebral Cortex, 26(6), 2563–2573. http://doi.org/10.1093/cercor/bhv086

The emotional brain



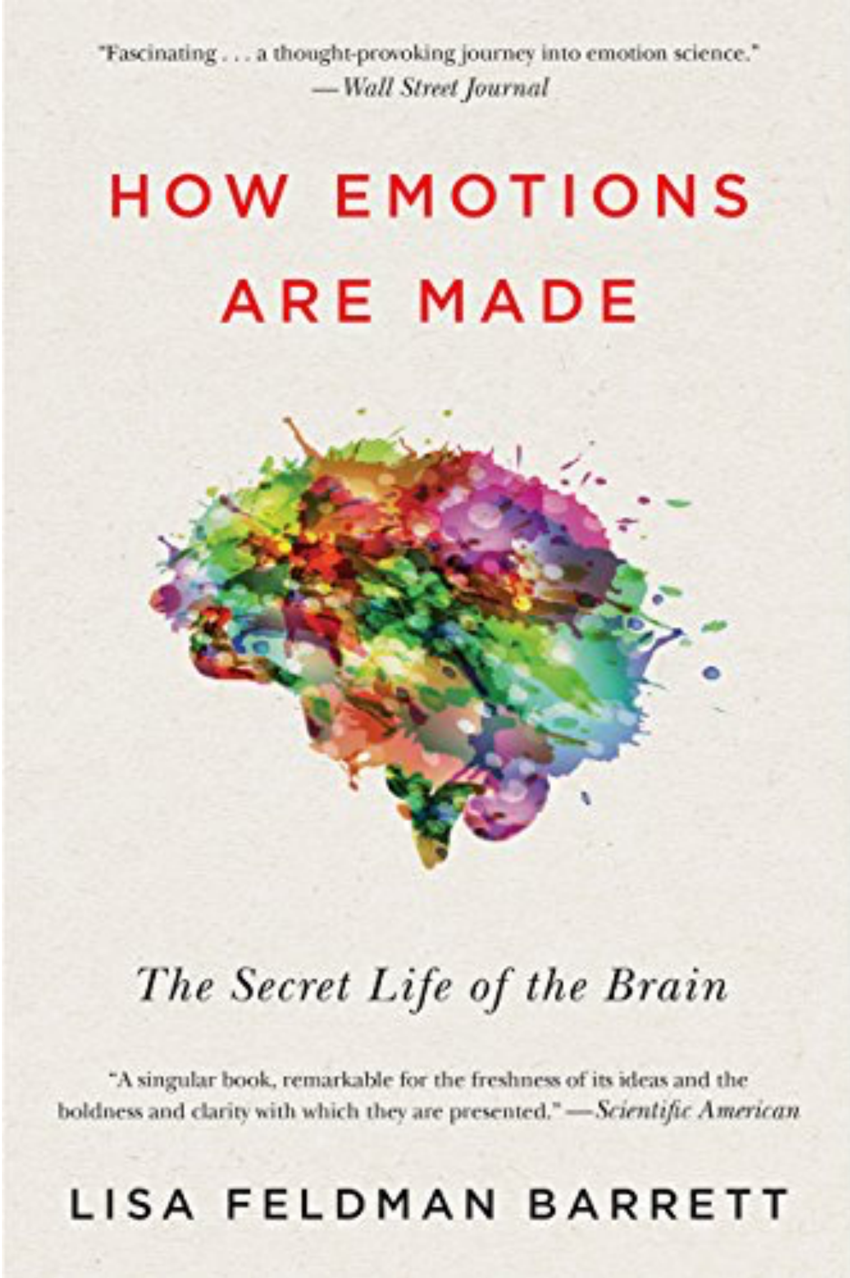
Core emotional regions (dark red areas) include, subcortically, the amygdala, the nucleus accumbens (NA) and the hypothalamus, and cortically, the orbitofrontal cortex (OFC), the anterior cingulate cortex (ACC) (especially the rostral part) and the ventromedial prefrontal cortex (VMPFC). Extended regions (brown areas) include, subcortically, the brain stem, the ventral tegmental area (VTA) (and associated mesolimbic dopamine system), the hippocampus, the periaquaeductal grey (PAG), the septum and the basal forebrain (BF); and cortically, the anterior insula (AI), the prefrontal cortex (PFC), the anterior temporal lobe (ATL), the posterior cingulate cortex (PCC), superior temporal sulcus, and somatosensory cortex.

Although one could attempt to link the core and extended regions to specific affective functions, such an attempt would be largely problematic because none of the regions is best viewed as 'purely affective'.

Pessoa, L. (2008). On the relationship between emotion and cognition. ***Nature Reviews Neuroscience, 9(***2), 148–158. http://doi.org/10.1038/nrn2317

Summary

- **Adaptive Significance**: Different perspectives on affect and emotion put emphasis on specific vs. general adaptive functions by either assigning a specific mapping between emotional experience and a biological substrate (i.e basic emotions) or, alternatively, emphasising context and development (i.e., constructivist approach).
- **Comparative approaches:** animal models have provided evidence for biological specificity of specific behavioural syndromes/emotional states (e.g., amygdala - fear); this mapping is simplistic and modern theories of human emotion see emotional states as involving interplay of various neural/cognitive processes.
- **Development:** Developmental patterns in the experience and regulation of emotion suggest a progressive development of the neural circuits (subcortical to cortical) that are responsible for both coding different aspects of the world (e.g., reward, punishment) and their integration/regulation.
- **Neural basis:** current models of emotional experience and regulation encompass a number of neural structures with only a few being core emotional regions and most being associated with other aspects of cognitive processing (e.g., memory, decision-making) – this stance makes clear the somewhat arbitrary distinction between emotional and cognitive processing (cognition is not value free!).


"Fascinating . . . a thought-provoking journey into emotion science."
—Wall Street Journal
HOW EMOTIONS
ARE MADE
The Secret Life of the Brain
"A singular book, remarkable for the freshness of its ideas and the boldness and clarity with which they are presented." —Scientific American
LISA FELDMAN BARRETT