Introduction to Cognitive Science

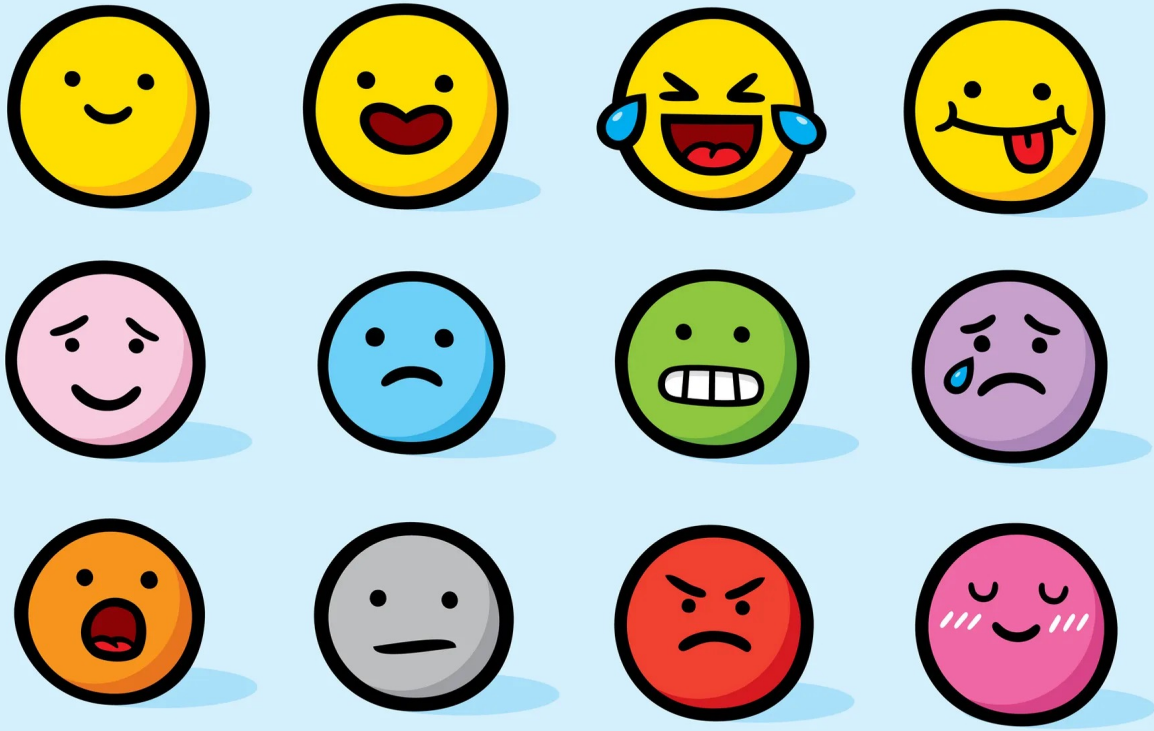


Dr. Mark Miller

MONASH University · UNIVERSITY OF TORONTO · CHAIN



The **Embodied** Cognitive-Emotional Brain



Stimulus

Physiological response

Emotion

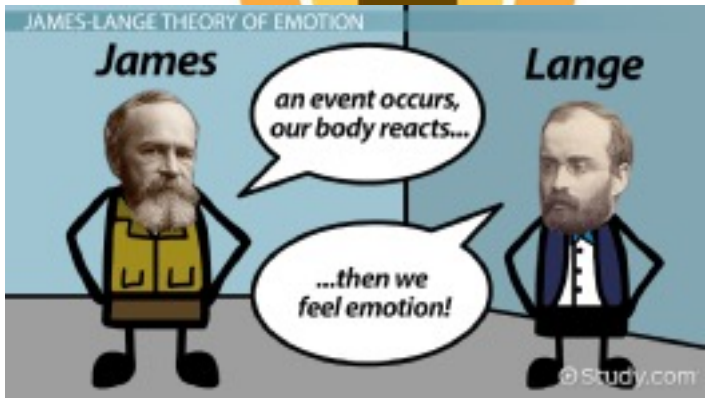


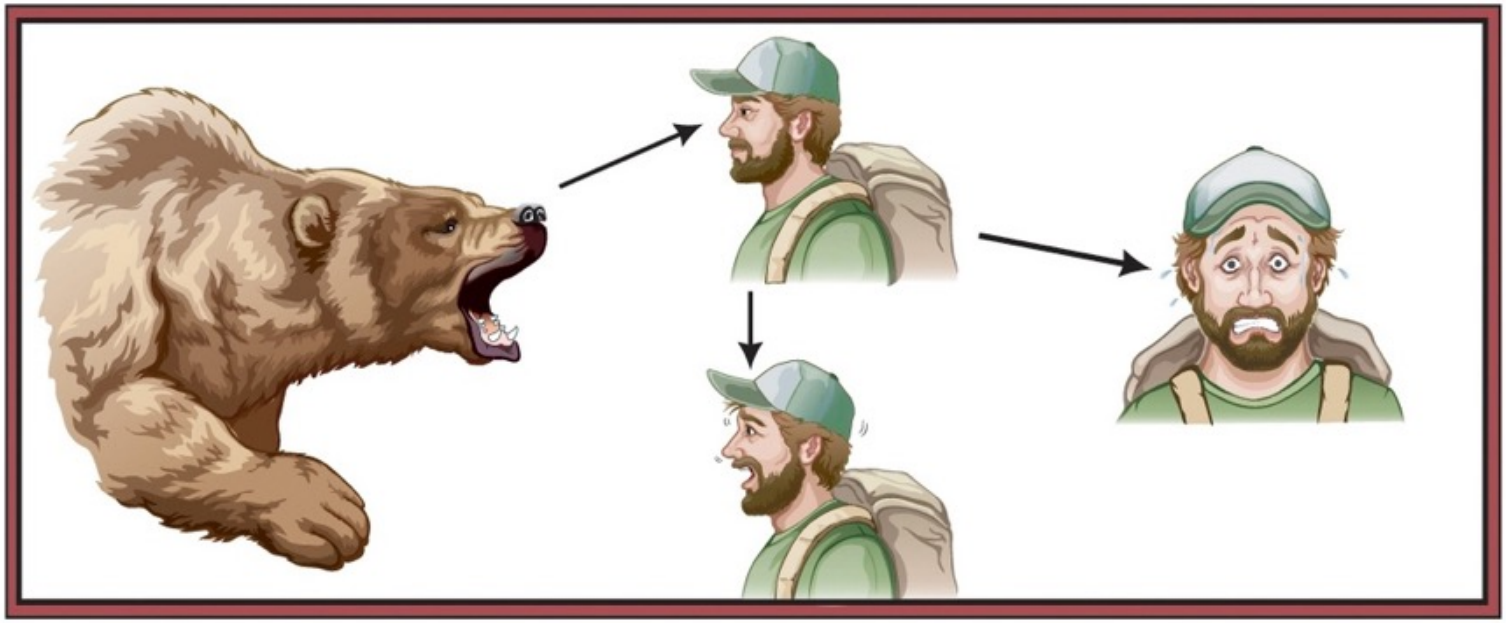




Angry dog barking

Heart rate increase





Schacter Two-Factor Theory: George is scared because he is aroused and he interprets his arousal as being caused by the danger in this situation.

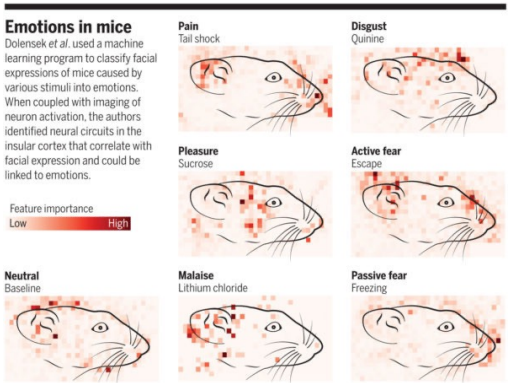


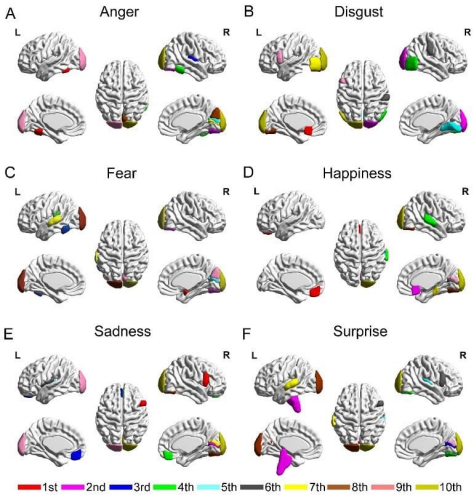


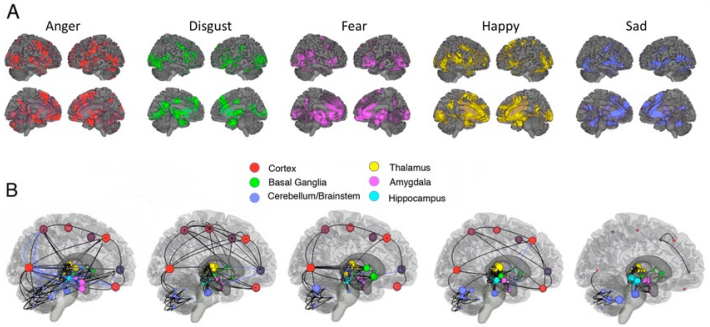
Discrete Theories of Emotion:

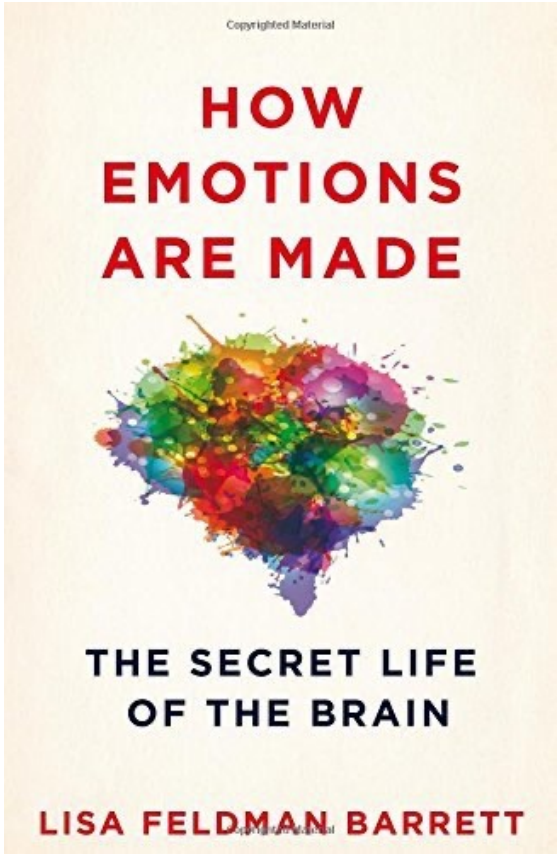
Basic emotions (e.g. anger, fear, sadness, happiness, disgust and surprise) are **species-universal**, **hardwired**, and have **unique physiological and neural signatures or profiles** (see e.g. Panksepp 1998; Ekman 1999; Izard 2007, 2011).

Discrete theories of emotion have unfortunately often subscribed to the **problematic division of the brain into emotional and cognitive systems.**





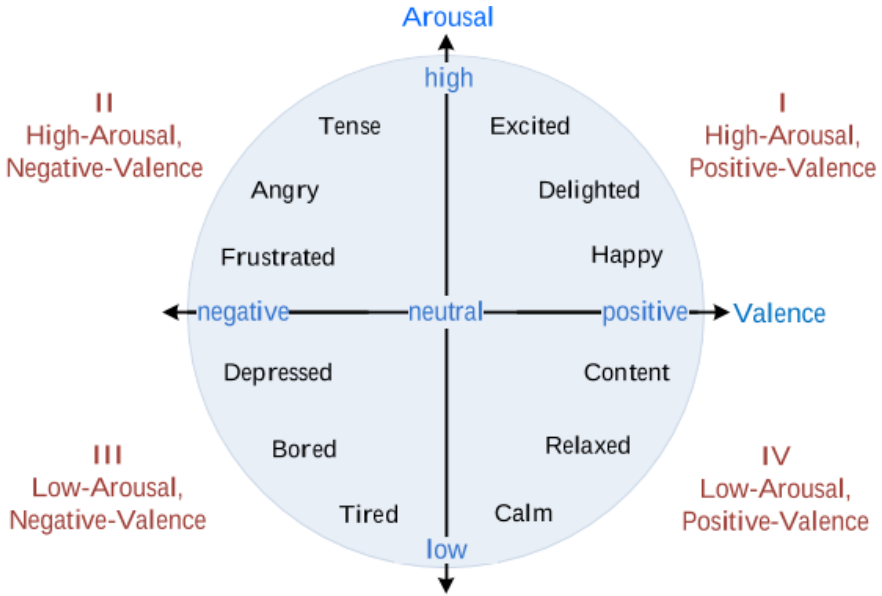



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HOW EMOTIONS ARE MADE
THE SECRET LIFE OF THE BRAIN
LISA FELDMAN BARRETT


TED

Psychological constructionism grew out of the **dimensional theory of emotion**.

The dimensional theory claims that emotional episodes such as fear, anger, and sadness are **combinations of more fundamental dimensions** such as **arousal** (the strength and intensity of an emotion) and **valence** (the degree of pleasantness or unpleasantness) working in **combination with cognitive processes of appraisal**



Situated Conceptualization:

Make sense of the ambiguous sensations by filling them out with "stored representations of prior experiences (i.e., memories, knowledge)" (Wilson-Mendenhall et al. 2011, 124)

“During every moment of waking life, the brain constructs mental states such as emotions, body states, and thoughts by creating situated conceptualizations" (Oosterwijk, 2011).

Our emotional and mental experiences according to this model are a good example of what Edelman (1989) calls the 'remembered present'.



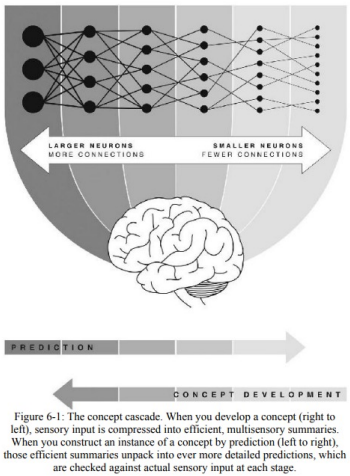
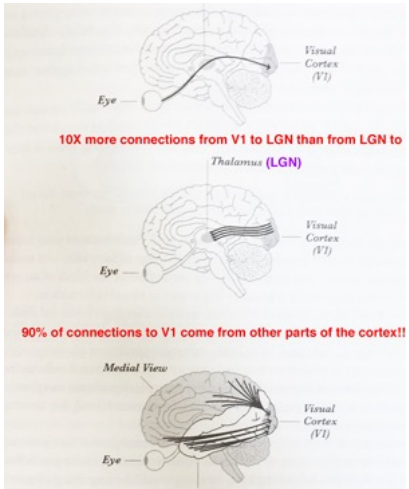


Figure 6-1: The concept cascade. When you develop a concept (right to left), sensory input is compressed into efficient, multisensory summaries. When you construct an instance of a concept by prediction (left to right), those efficient summaries unpack into ever more detailed predictions, which are checked against actual sensory input at each stage.

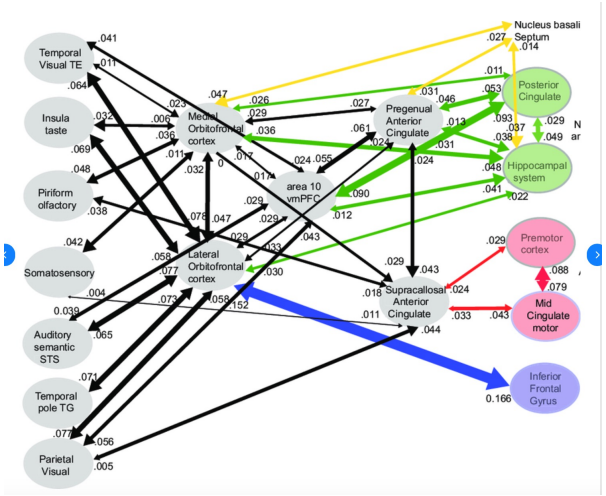


The **orbitofrontal cortex (OFC)** is divided into lateral and medial parts.

Medial OFC takes rough visual information from subcortical areas and makes an **extremely fast guess** at what the rough information could mean.

This best guess flows through the hypothalamus, midbrain, brainstem and spinal column into the perceiver's body **recreating the internal affective state previously associated with that stimuli**.

This affective reactivation loops into pre-motor areas that transform the affective signal into **action plans** (eg. approach or avoid; Meanwhile the lateral OFC is integrating the initial affective response, including autonomic and endocrine changes, with increasingly rich visual information.



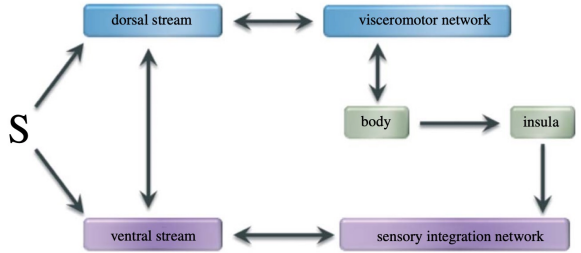
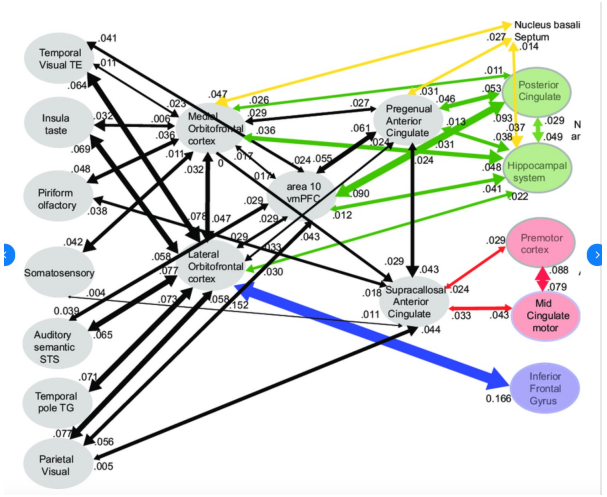


Figure 4. Connections between the OFC and visual networks. 'S' represents visual information that reaches the dorsal 'where' stream and the ventral 'what' stream both from early visual areas and from the thalamus. The medical OFC is part of a 'visceromotor' network that helps to control internal body state. The lateral OFC is part of a 'sensory integration network' that joins together sensory representations from outside and inside the body.

This is **not the end of the line**.

As the object gets clearer the OFC **updates its prediction**, which invokes subsequent affective reactivations and reactions, which further fills out the percept This recursive process continues until "a precise representation of the object is finally constructed”

The resonant body here is highlighted as a key contributor in the unfolding of the prediction that constitutes the experience. As Barrett and Bar write "the internal world of the body may be one element in the ‘context frame’ that facilitates object recognition" (1330). The emergent visual experience then is the result of **both neural and physiological signals evolving dynamically together over time**.



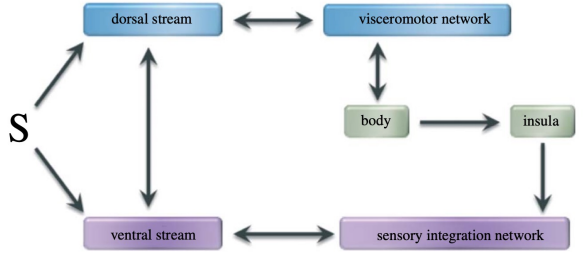
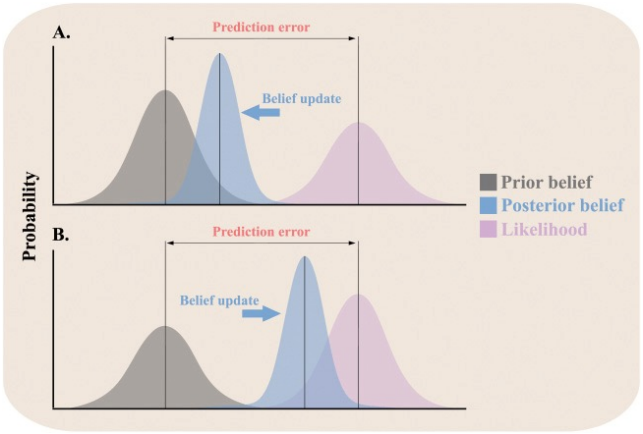


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A.
Prediction error
Belief update
Probability
Prior belief
Posterior belief
Likelihood
B.
Prediction error
Belief update



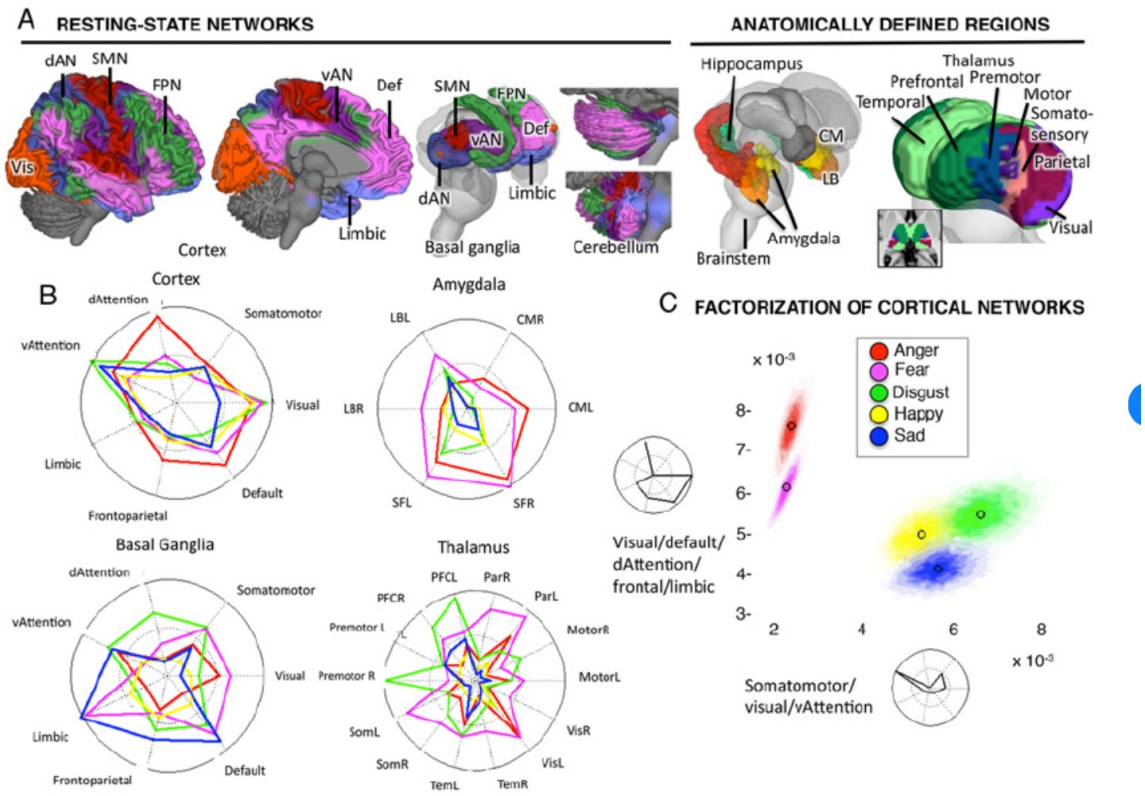






According to constructionists, emotions **do not map onto distinct regions and networks** in the brain.

They are instead the result of **dynamic interactions between large-scale networks** that compute domain-general functions (Barrett & Satpute 2013).



A recent **meta-analyses** showed that brain regions associated with emotion (e.g. AIC, ACC, OFC) show increases in activity for a **variety of different emotion states**.

Lindquist and colleagues **compared the sets of brain regions that were consistently activated** in studies of anger, disgust, fear, happiness and sadness. They found **six distributed networks** that consistently showed up in the studies they analyzed from 1990-2007.

The networks and the regions of which they were composed were not associated with particular emotion categories, but were instead found to be **active in all studies of emotion** experience they analyzed.

They found no brain regions that were functionally specialized – every region that was activated for one emotion category was also activated for at least one other emotion category

The same brain regions can carry out a variety of distinct psychological operations and belong to different overlapping networks over time (also see Anderson 2010, 2014; Colombo 2013). What a brain region does at any given time will depend on the network with which it is affiliated.

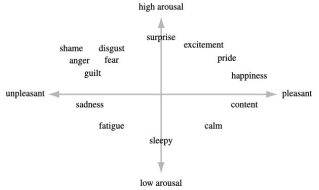


Figure 1. A descriptive map of core affect.

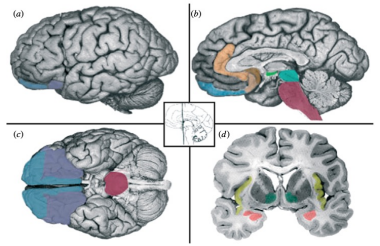


Figure 2. (*a–d*) The affective workspace. The neural workspace for core affect includes a broadly distributed set of interconnected cortical and subcortical brain areas that are not functionally specific to affect, but that realize affective responses as a network (for imaging evidence, see Kringelbach & Rolls 2004; Barrett *et al.* 2007*a*; Wager *et al.* 2008; for a discussion, see Barrett & Bliss-Moreau in press). Some areas are traditionally considered to be 'emotional', such as the amygdala (rose) and ventral striatum (green). Other areas were (until recently) considered 'cognitive' (cf. Duncan & Barrett 2007; for a similar view, see Pessoa 2008), such as the orbitofrontal cortex (OFC; blue and purple). Typically, researchers use the term 'orbital frontal cortex' to refer to anywhere within the orbital sector of the prefrontal cortex. This includes the lateral parts (blue) that are bounded by the ventrolateral prefrontal cortex (vlPFC) and agranular insula (yellow), as well as the medial portions that wrap to include the ventromedial prefrontal cortex (vmPFC; purple) extending back to the sub/pregenual portions of the anterior cingulate cortex (ACC; brown and gold). Other components of this workspace include the hypothalamus (light green) and autonomic control centres in the midbrain and brainstem (turquoise and maroon). This neural reference space for effect is meant to be non-specific without sounding vague, in that different assemblies of neurons across these areas realize momentary representations of value (Ghashghaei & Barbas 2002; Barbas *et al.* 2003). Photographs taken from DeArmond *et al.* (1989), pp. 5, 7, 8 and 43.

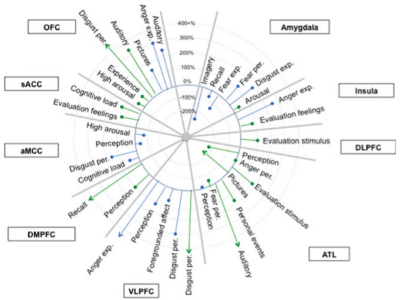
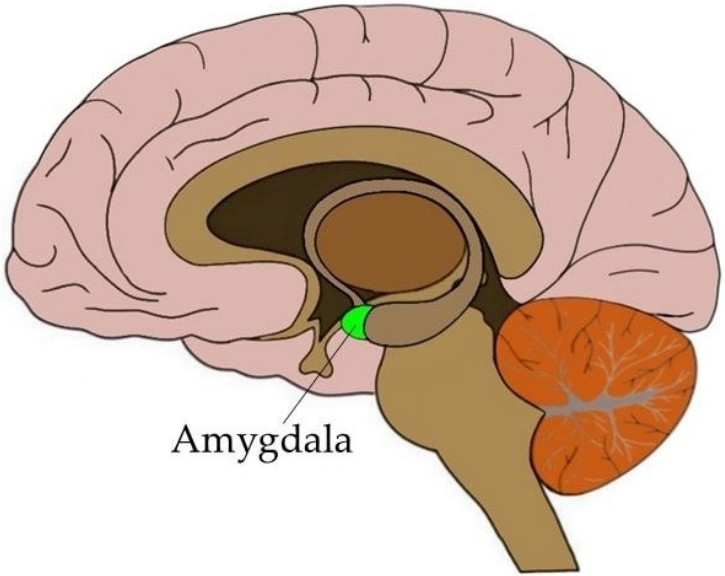


Figure 5. Logistic Regression Findings. Selected results from the logistic regressions are presented (for additional findings, see Table S6 in supplementary materials). Circles with positive values represent a 100% increase in the odds that a variable predicted an increase in activity in that brain area. Circles with negative values represent a 100% increase in the odds that a variable predicted there would not be an increase in activity in that brain area. **Legend:** Blue lines: left hemisphere; Green lines: right hemisphere. Arrowheads: % change in odds is greater than values represented in this figure. **Abbreviations:** OFC: orbitofrontal cortex; DLPFC: dorsolateral prefrontal cortex; ATL: anterior temporal lobe; VLPFC: ventrolateral prefrontal cortex; DMPFC: dorsomedial prefrontal cortex; aMCC: anterior mid-cingulate cortex; sAAC: subgenual ACC. A color version of this image can be viewed in the online version of this target article at http://www.journals.cambridge.org/bbs.

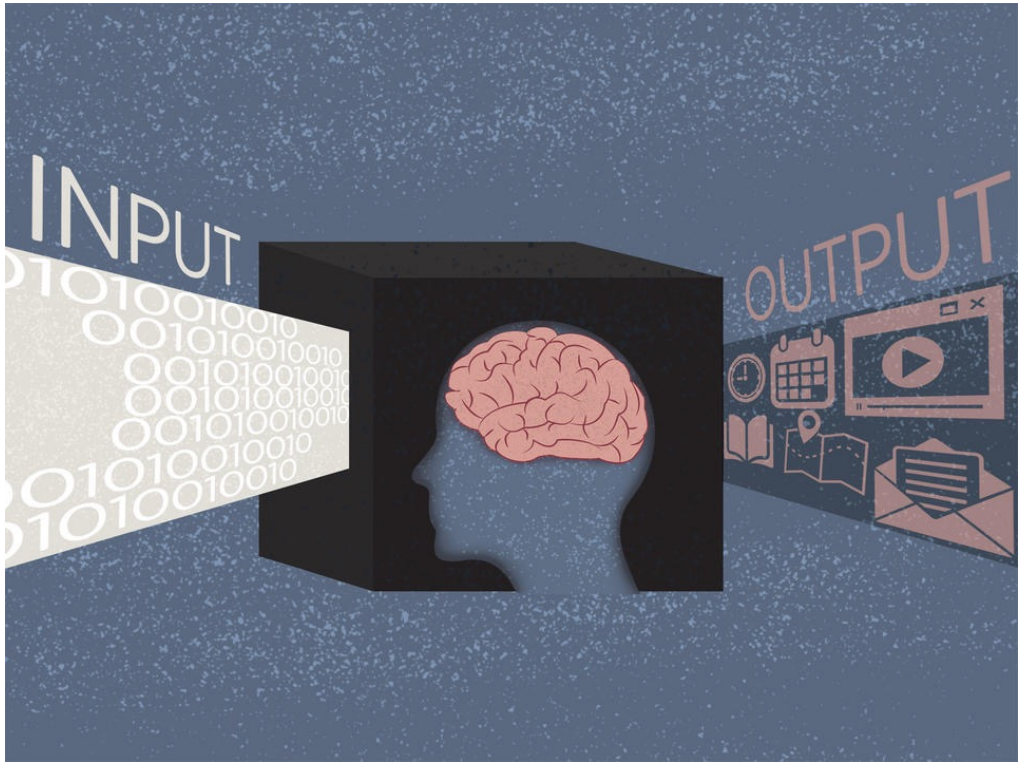


Traditionally thought to support a discrete **theory of fear** because it has repeatedly been shown to be involved in threat responses in rats and humans (see e.g. LeDoux 1996; Öhman & Mineka 2001; for critical discussion see Sander et al 2003).

However, its also active when people are presented with novel, but **emotionally neutral stimuli** (Moriguchi et al 2011; Balderston et al 2011; Blackford et al 2011.

Researchers found increased activity in the amygdala when subjects were presented with **unpredictable sequences** of tones as compared with predictable sequences (Herry et al 2007).

The amygdala is involved in a wide variety of different functions, including “cognitive” functions such as value representation and decision-making (Pessoa 2013).



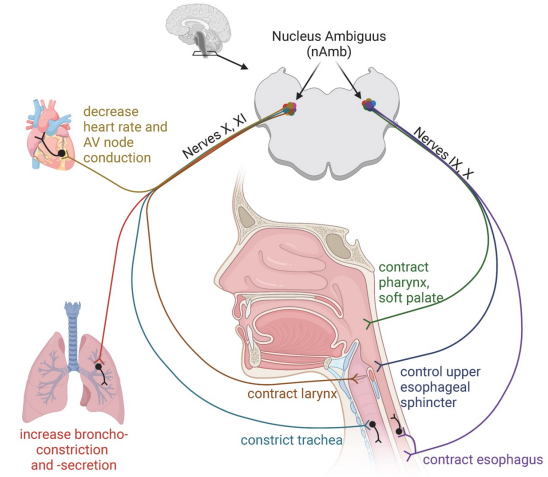
Core affect is specifically generated **within and between what they call intrinsic neural networks** (eg. default network, limbic network, salience network, etc.) which "combine and constrain one another like ingredients in a recipe, influencing and shaping one another in real time according to the principles of constraint satisfaction" (Lindquist et al. 2012).

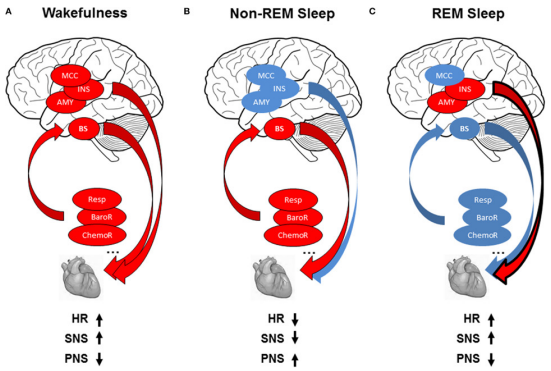
Getting Back Out of the Head:

Pessoa suggests that “In the extreme, two networks may involve the exact same regions interacting with each other in distinct ways across time”.

The function of a given network is also dynamic, with very different networks making the same functional contribution to behaviour at different times.

To determine the precise functional contribution of a given network we need to look at “global variables” such as **neurotransmitters**, **bodily arousal**, and **slow-wave potentials**.





QUESTIONS (Our Conclusion):

Once we start to admit the role of global variables such as activity in neurotransmitter systems and valenced states of bodily arousal in influencing the functioning of a given network, why think of the boundary between the brain and the rest of the body as a sort of “magical membrane”?

Why think that the factors that influence the function of a network reside only inside of the brain? Why not think of bodily states of arousal that manifest as changes in the body’s vascular, visceral and motor systems as global control parameters that influence the formation of large-scale networks in the brain?


ANY
QUESTIONS?

Thanks!



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