511-2017-11-01-emotion

Rick Gilmore

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Prelude

Inside Out Official Trailer #1 (2015) - Disney Pixar Movie HD

Today's Topics

- Biology of emotion

Biology of emotion

- Components
- Functional purposes
  - Distal causes
  - Proximal causes
- Dimensions and types
- Measurement
- Emotion == Cognition?

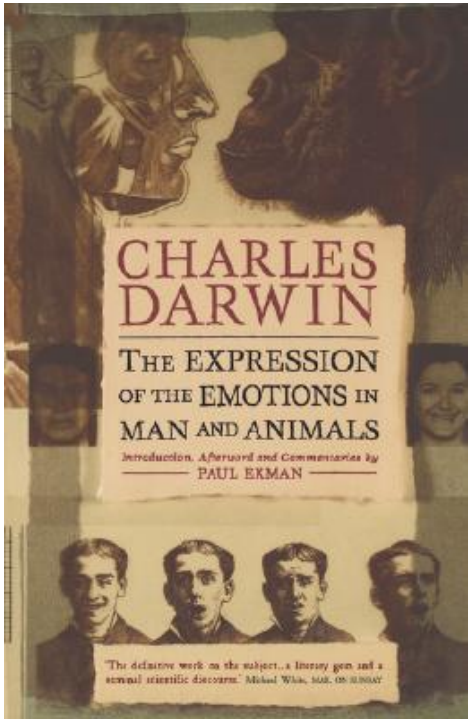
Components of emotion

- Physiological responses
  - Autonomic
  - Endocrine
- Subjective feelings
- Verbal responses
- Facial expressions
- Body movements

Distal causes

- Biological goals
  - Ingestion, defense, reproduction, affiliation
- Emotions serve biological goals
  - Approach/avoid or appetitive/aversive (Schneirla 1959)
  - Preservative vs. protective functions (Knorkski 1967)

Distal causes



Proximal causes and effects

"Do we run from a bear because we are afraid or are we afraid because we run? William James posed this question more than a century ago, yet the notion that afferent visceral signals are essential for the unique experiences of distinct emotions remains a key unresolved question at the heart of emotional neuroscience."

(Harrison et al. 2010)

Proximal causes and effects

- James-Lange
  - Physiological response -> subjective feelings
- Cannon-Bard
  - Severing CNS (spinal cord & vagus) from rest of body leaves emotional expression unchanged
  - Physiological states slow, don't *differentiate among emotions*

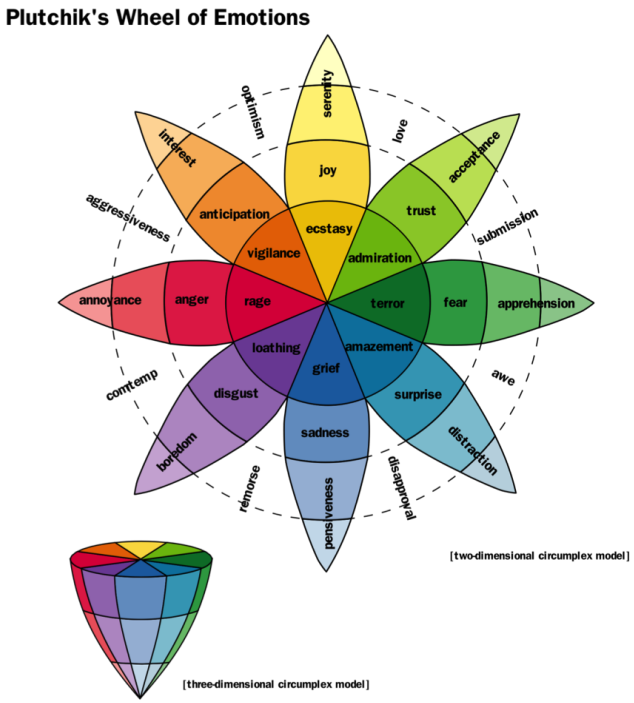
Proximal causes and effects

- Schacter-Singer
  - Physiological arousal + cognitive appraisal -> emotional states

Dimensions

- Valence
  - Positive/negative
- Intensity (arousal)
- Action tendency
  - Approach/avoid

Types



(Plutchik 1980)

Measurement

- ANS
- Endocrine
- Brain activity
- Facial expression
- Subjective state

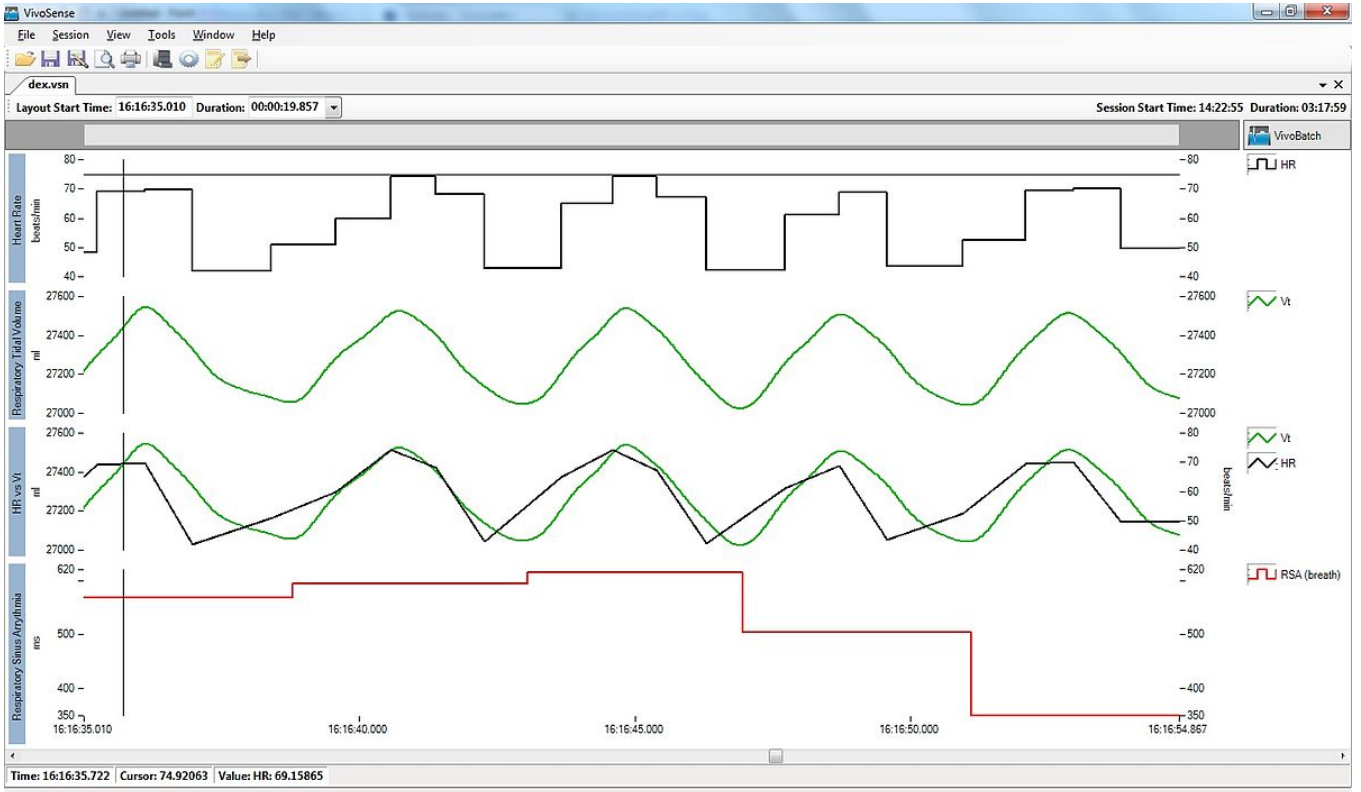
ANS measures of emotion

- Heart rate or heart rate variability (HRV)
- Galvanic skin response (GSR)
- Skin temperature
- Pupil dilation
- Electro-gastrogram (EGG)

Measuring heart rate variability (HRV)

- *Variability* in heart period (inter-beat interval, *IBI*)
- *Respiratory sinus arrhythmia (RSA)*: variation in IBI due to respiratory inhalation/exhalation
- Sympathetic (SNS) and parasympathetic (PSNS) inputs converge on sinoatrial (SA) node of the heart
- *Vagal (Xth cranial) nerve* provides PSNS input
- *Vagal tone*: inferred effects of vagal/parasympathetic modulation of RSA (more vagal tone = more RSA)

Illustration of HRV

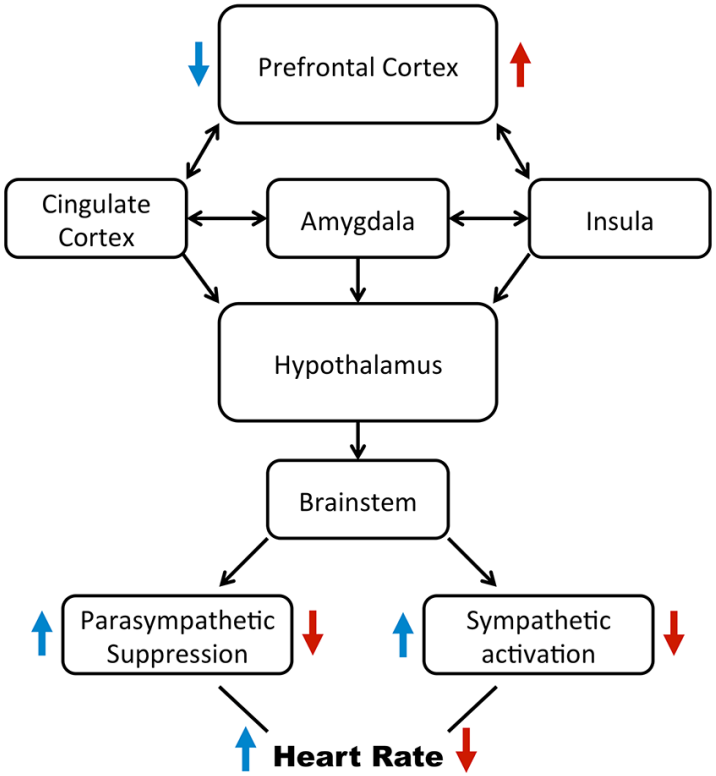


By Vivonoetics - Own work, CC BY-SA 3.0, Link

HRV as a *psychological* measure

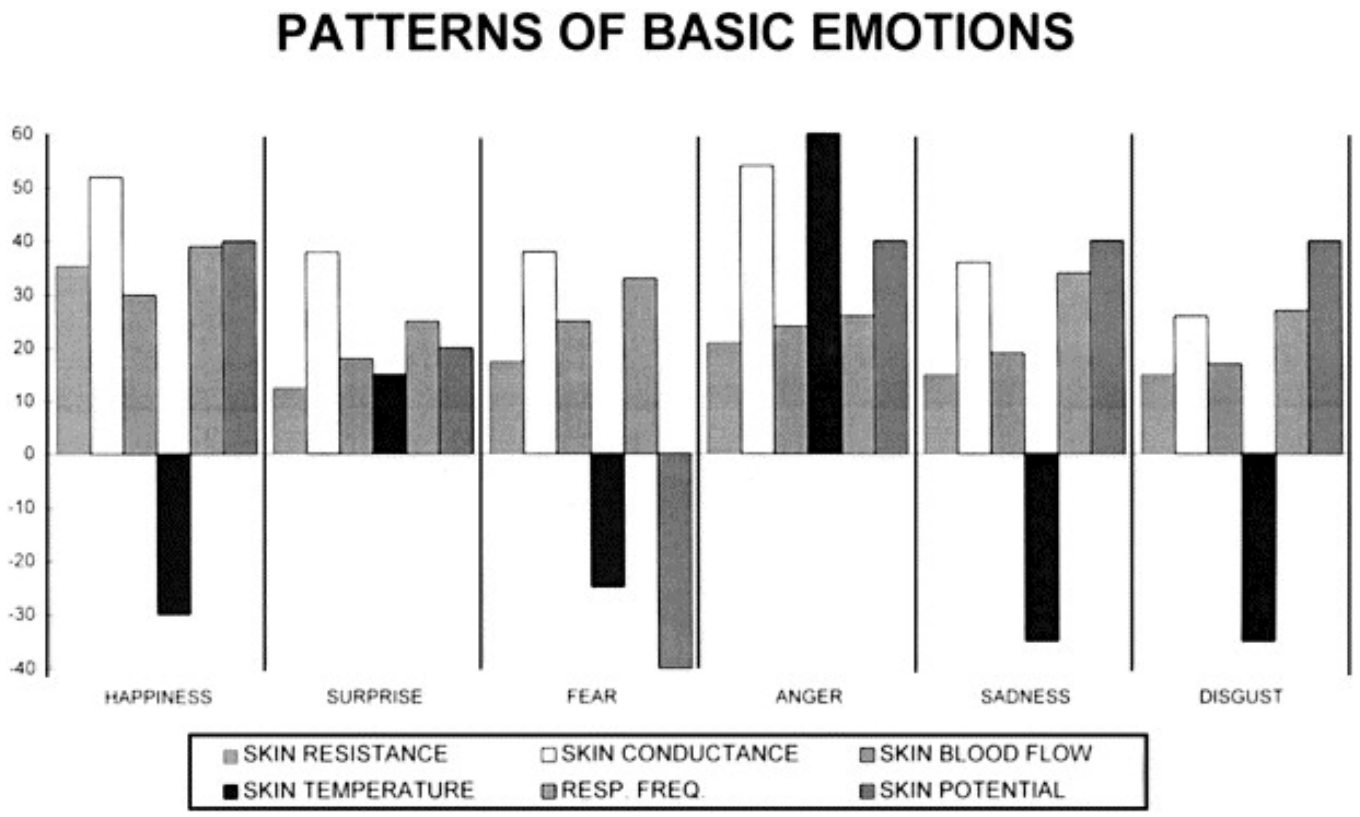
- IBI controlled by SNS and PSNS
- PSNS/vagal influences dominate @ rest, but are transient
- RSA (normally) declines with age
- Can measure SNS influence via impedance cardiography
- HRV and impedance cardiography are *indirect* measures of PSNS & SNS

ANS modulation of the heart



By Stevan Nikolin, Tjeerd W. Boonstra, Colleen K. Loo, Donel Martin - Nikolin S, Boonstra TW, Loo CK, Martin D (2017) Combined effect of prefrontal transcranial direct current stimulation and a working memory task on heart rate variability. PLoS ONE 12(8): e0181833. https://doi.org/10.1371/journal.pone.0181833, CC BY 2.5, Link

Covariance among ANS measures



(Collet et al. 1997)

"From the six ANS parameters studied, different autonomic patterns were identified, each characterizing one of the six basic emotion used as inducing signals. No index alone, nor group of parameters (EDR and thermovascular for instance) were capable of distinguishing each emotion from another. However, electrodermal, thermo-vascular and respiratory responses taken as a whole, redundantly separated each emotion thus demonstrating the specificity of autonomic patterns."

(Collet et al. 1997)

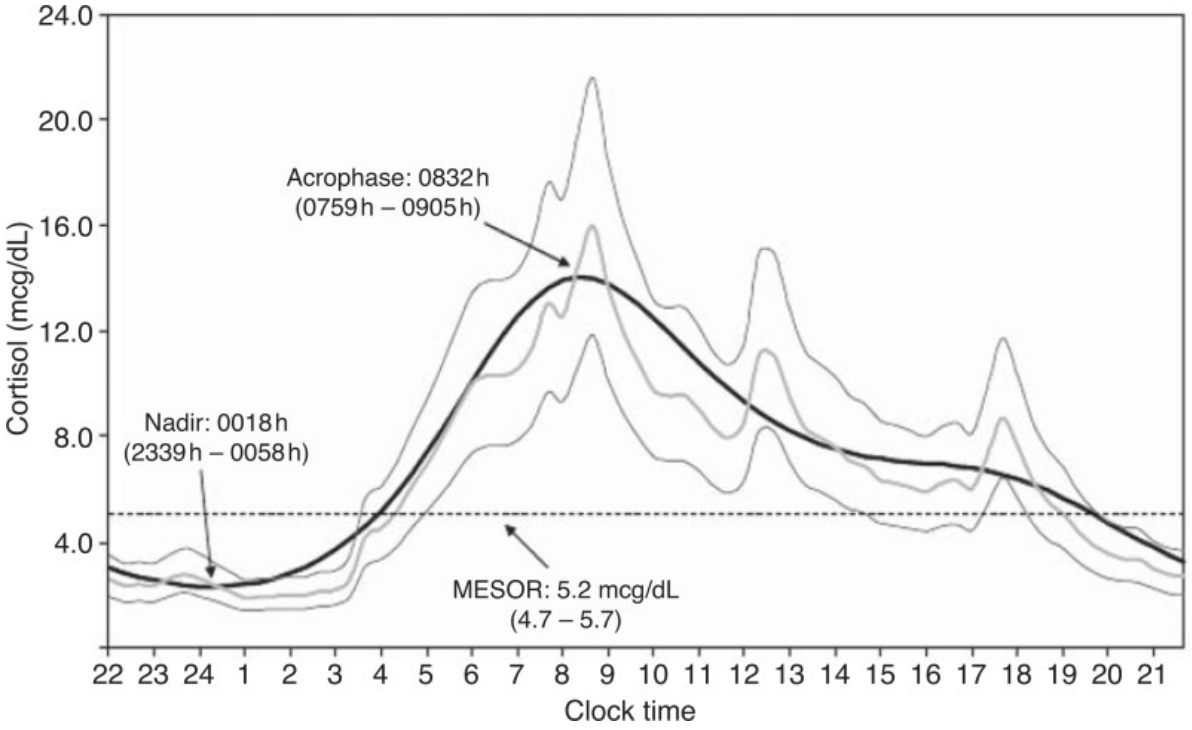
Biochemical measures

- Catecholamines (norepinephrine, epinephrine)
  - Released by adrenal medulla following sympathetic nervous system stimulation
  - *S*ympathetic *A*drenal *M*edullary axis
  - Metabolites in urine or blood

Biochemical measures

- Corticosteroids (e.g., hydrocortisone or cortisol)
  - Released from adrenal cortex into bloodstream
  - HPA axis
  - Measured in blood, saliva, or hair

Diurnal corisol patterns



(Chan and Debono 2010)

Cortisol as *psychological* measure

- Circadian periodicity
- Peaks around meal times
- Primary *physiological* role is modulating glucose & fat metabolism, anti-inflammatory

Do the measures cohere?

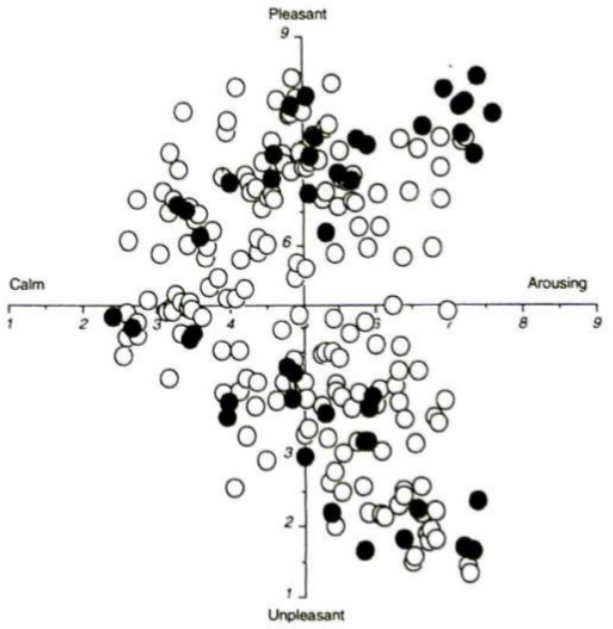


Figure 1. Distribution of normative affective (valence, arousal) judgments for slides used in the current study (dark circles) together with all of the slide contents (open circles) currently comprising the International Affective Picture System (Lang et al., 1988).

(Lang et al. 1993)

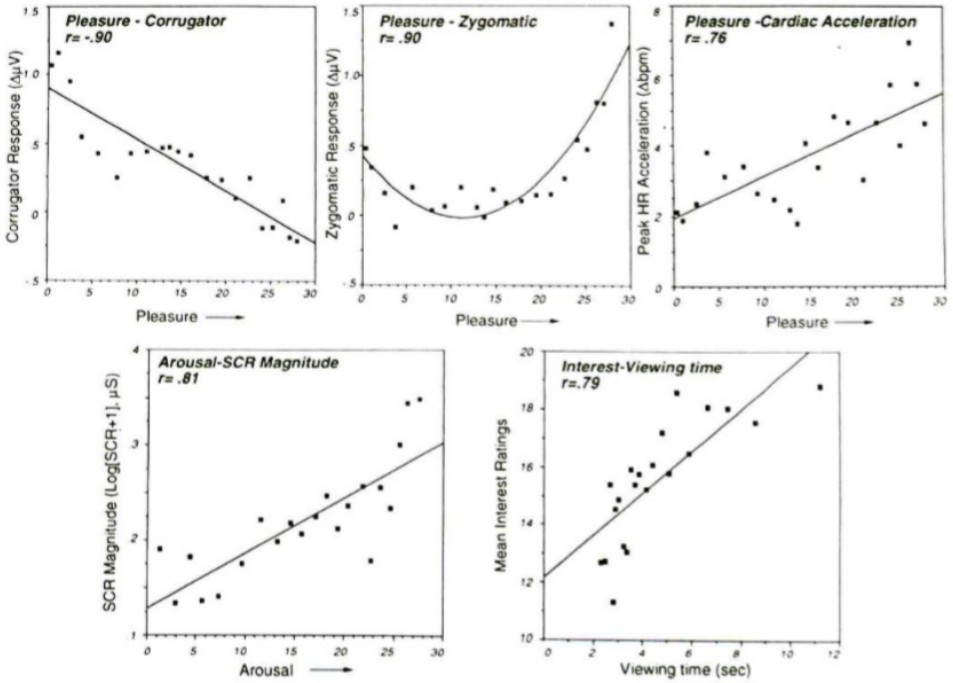
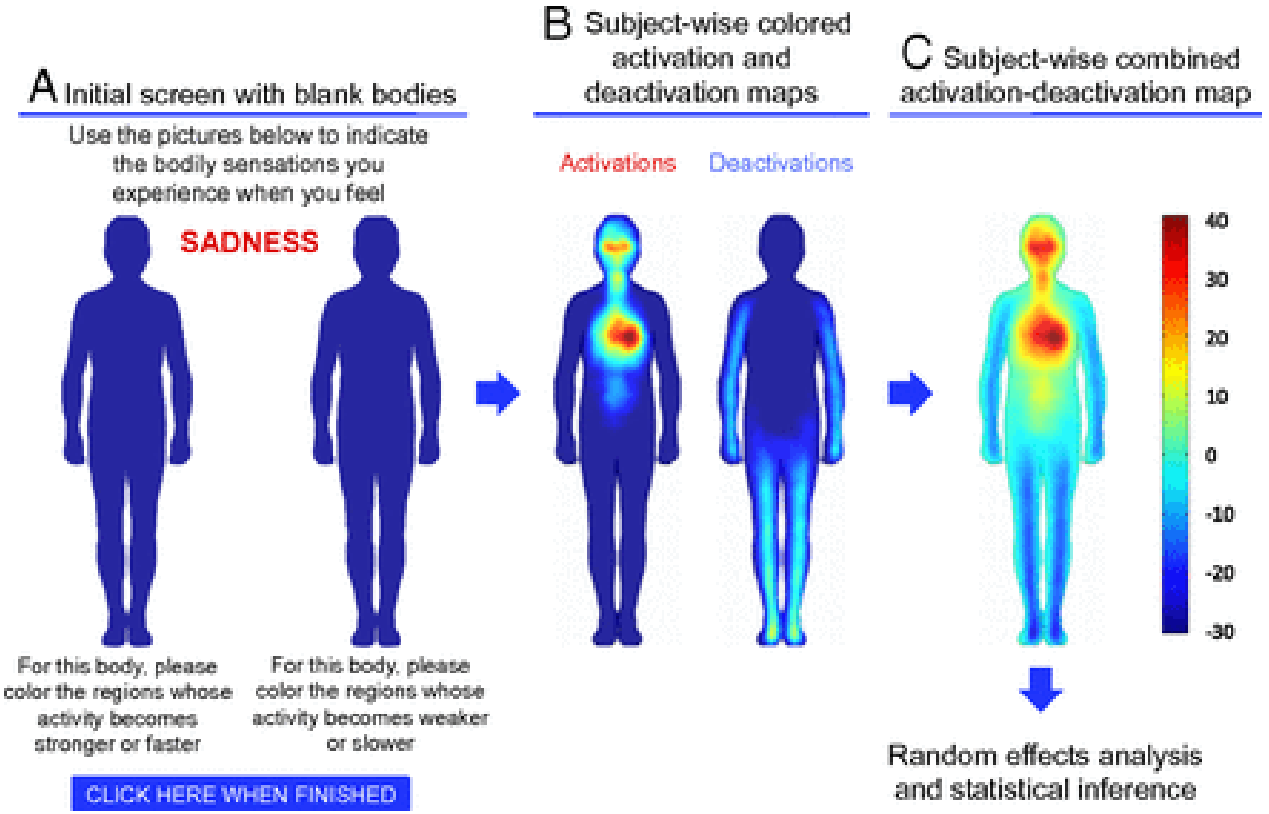


Figure 2. Covariation of affective valence judgments with slide corrugator response (upper left), zygomatic response (upper middle), peak heart rate acceleration (upper right); covariation of arousal judgments with electrodermal response magnitude (lower left); and interest judgments with duration of choice viewing time (lower right). In each case, judgments are rank ordered for each subject; the graphs depict mean responses at each rank across subjects.

(Lang et al. 1993)

Alternative self-report measures: Bodily maps of emotions



(Nummenmaa et al. 2014)

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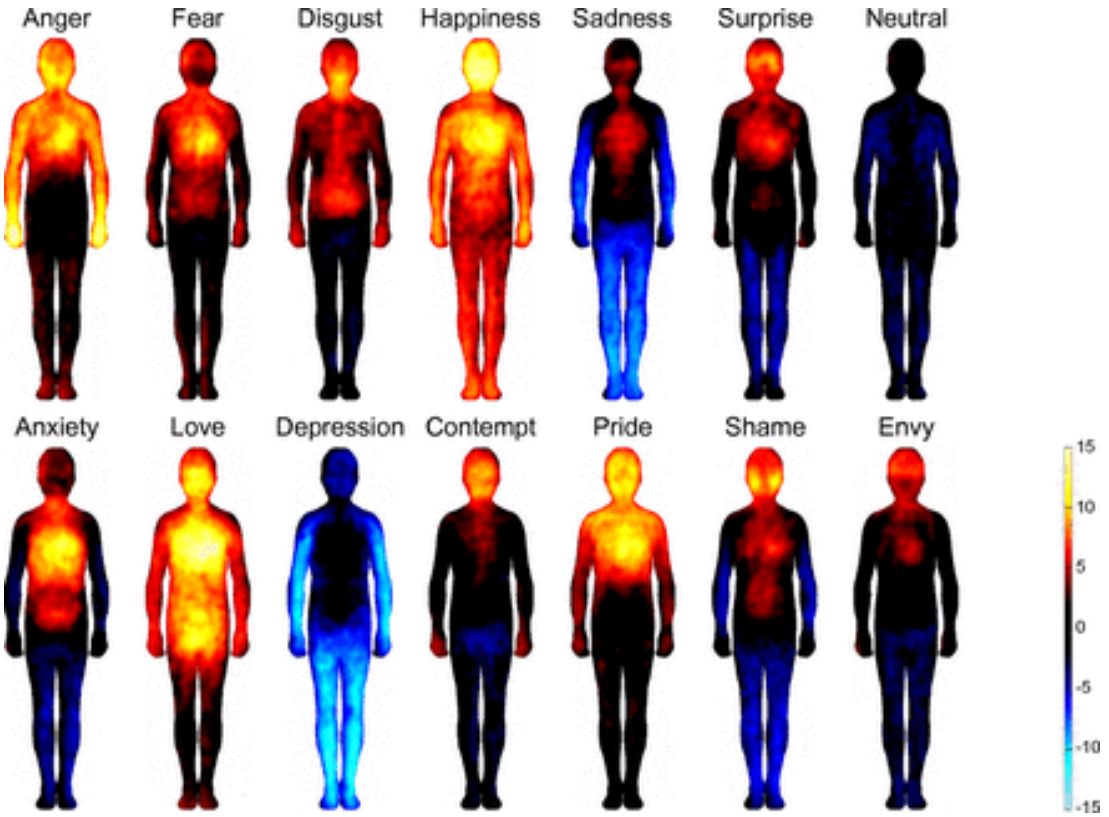


(Nummenmaa et al. 2014)

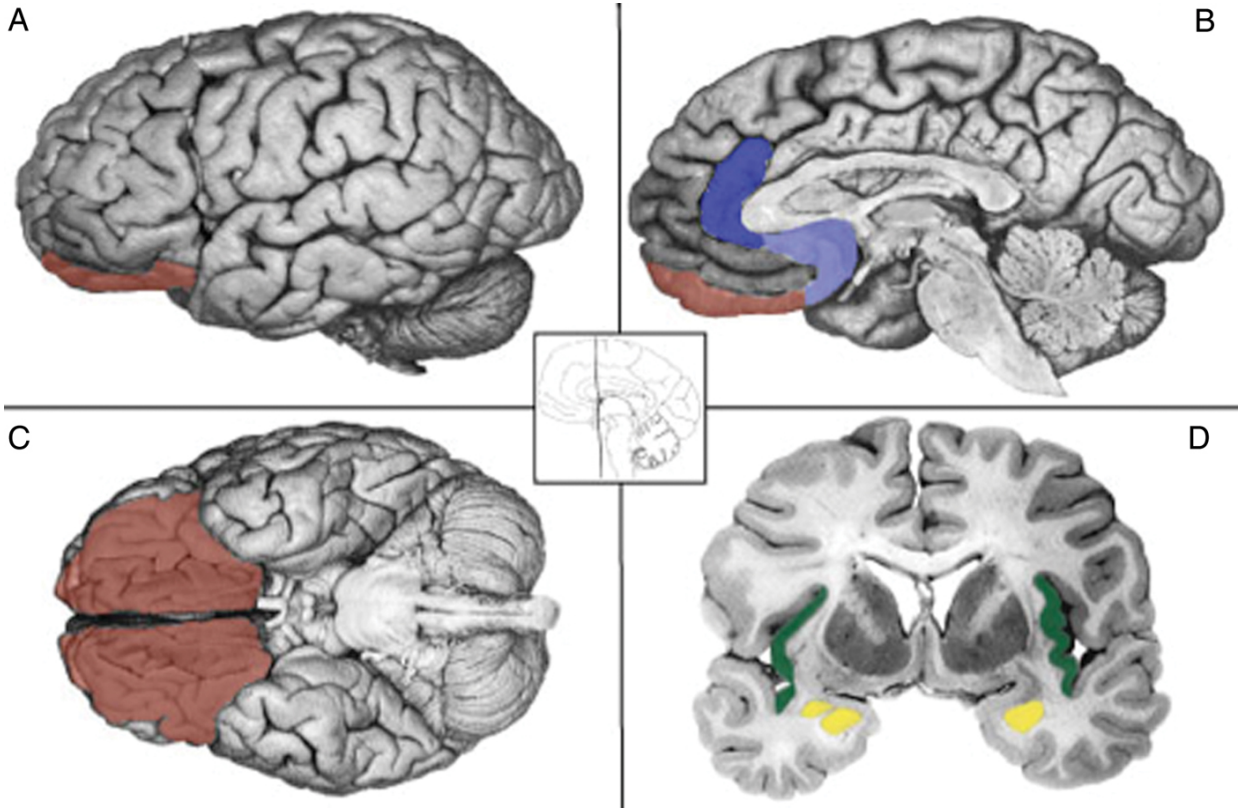
(Nummenmaa et al. 2014)

We propose that emotions are represented in the somatosensory system as culturally universal categorical somatotopic maps. Perception of these emotion-triggered bodily changes may play a key role in generating consciously felt emotions.

Are emotions 'natural kinds' distinguished by the brain?

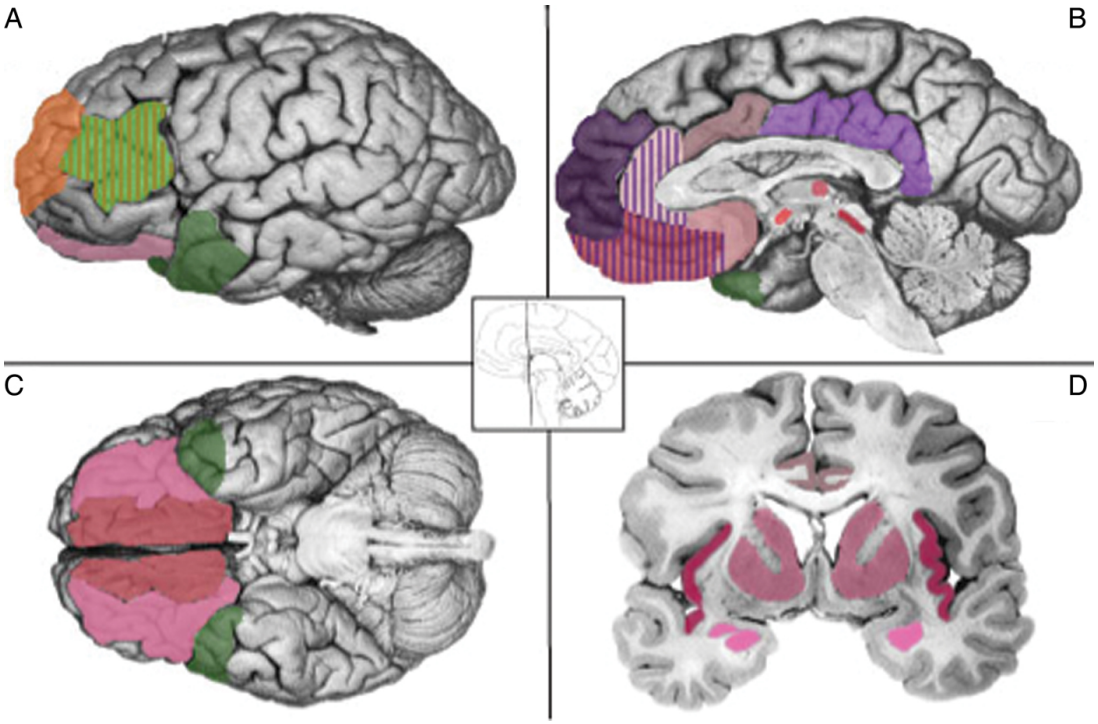
- Or are emotions "*…psychological events that emerge out of more basic psychological operations that are not specific to emotion.*" (Lindquist et al. 2012)

'Locationist' view



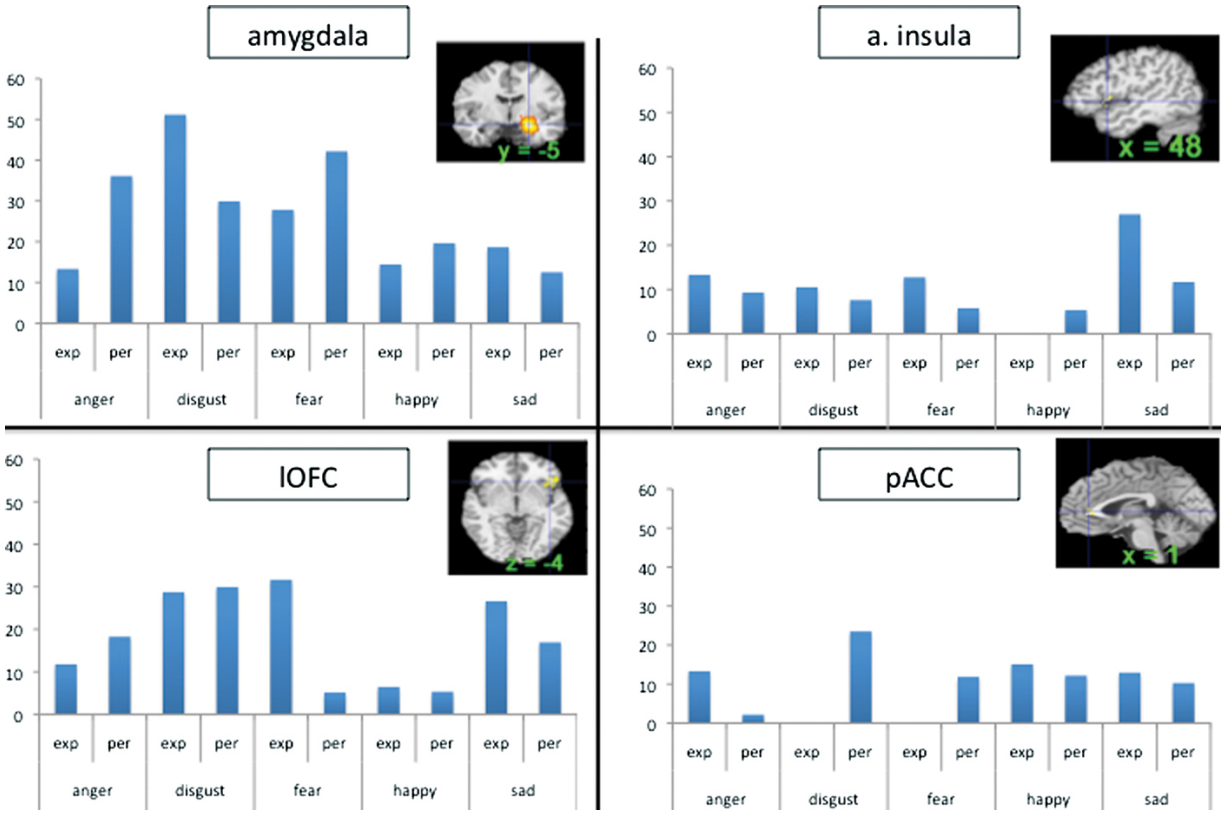
Fear: amygdala (yellow); Disgust: insula (green); Anger: OFC (rust); Sadness: ACC (blue). (Lindquist et al. 2012)

'Constructionist' view



Core Affect (pink): amygdala, insula, mOFC (Bas 10m, 11m, 13a, b, 14r, c), lOFC (BAs 47, 12, 13l, m, 11l), ACC (Bas, 32, 24, 25), thalamus, hypothalamus, bed nucleus of the stria terminalis, basal forebrain, PAG. Conceptualization (purple): VMPFC (Bas 11, 25, 32, 34), DMPFC (BAs 9, 10p), medial temporal lobe* (hippocampus, entorhinal cortex, parahippocampal cortex), posterior cingulate cortex/retrosplenial area (BA 23, 31). Language (green): VLPFC (Bas 44, 45, 46), anterior temporal lobe (BA 38); for additional regions, see Vigneau et al. (2006). Executive Attention (orange): DLPFC (BAs 9, 10, 46), VLPFC (BAs 44, 45, 46). (Lindquist et al. 2012)

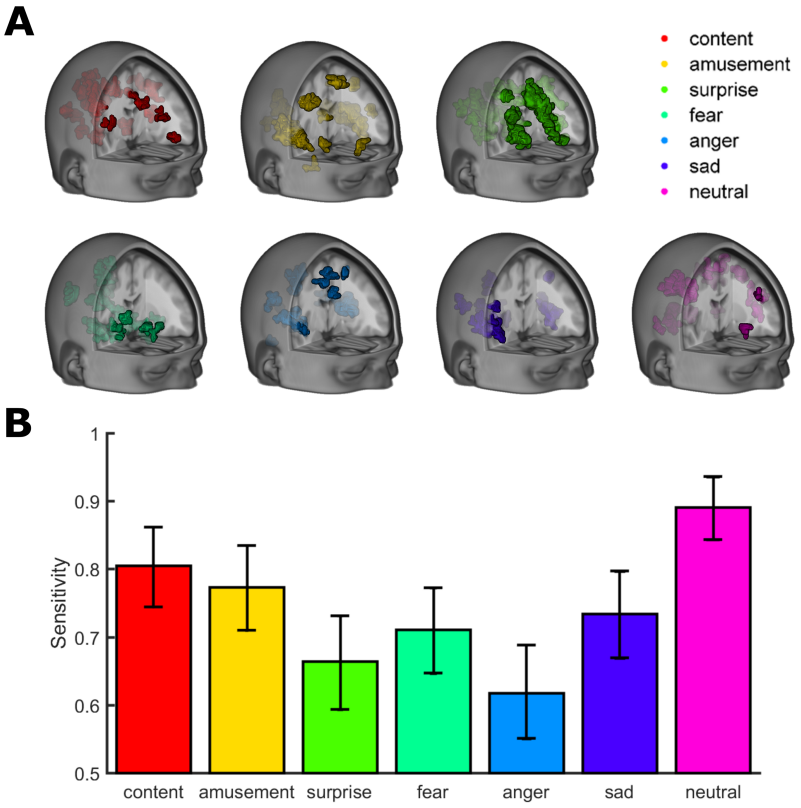
Meta-analytic results



(Lindquist et al. 2012)

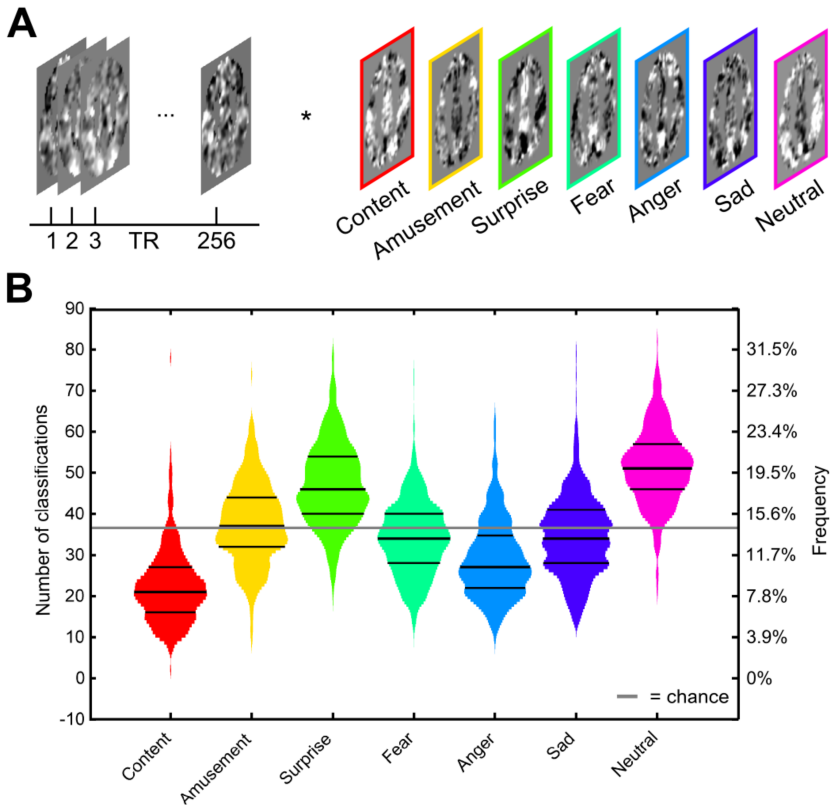
"James believed that emotions, thoughts, and memories are categories derived from commonsense with instances that do not require special brain centers. With respect to emotion, he wrote, “sensational, associational, and motor elements are all that [the brain] need contain” to produce the variety of mental states that correspond to our commonsense categories for emotion (cf. James 1890/1998, p. 473). James' view foreshadowed modern psychological constructionist models of the mind and the findings of our meta-analytic review, which are largely in agreement with this approach. Our findings are consistent with the idea that emotion categories are not natural kinds that are respected by the brain."

Emotions as distributed activation states



(Kragel et al. 2016)

Emotions as distributed activation states

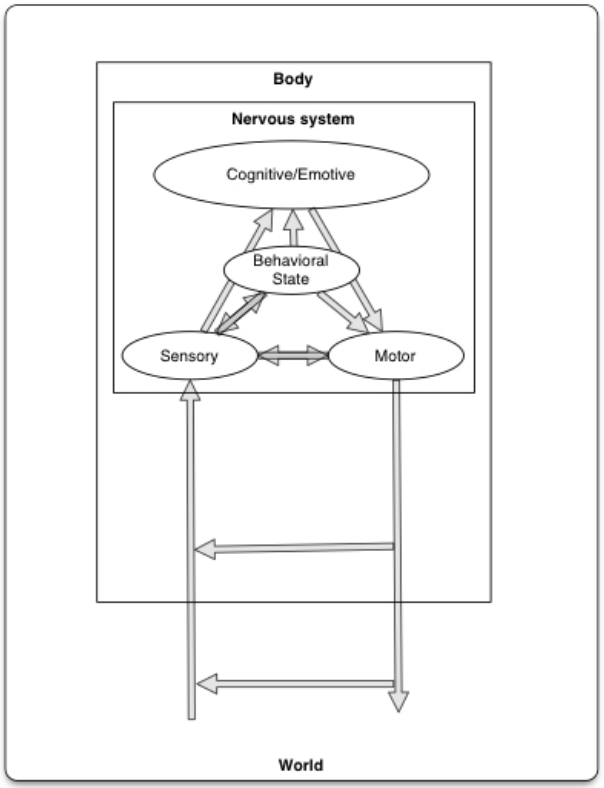


(Kragel et al. 2016)

Questions

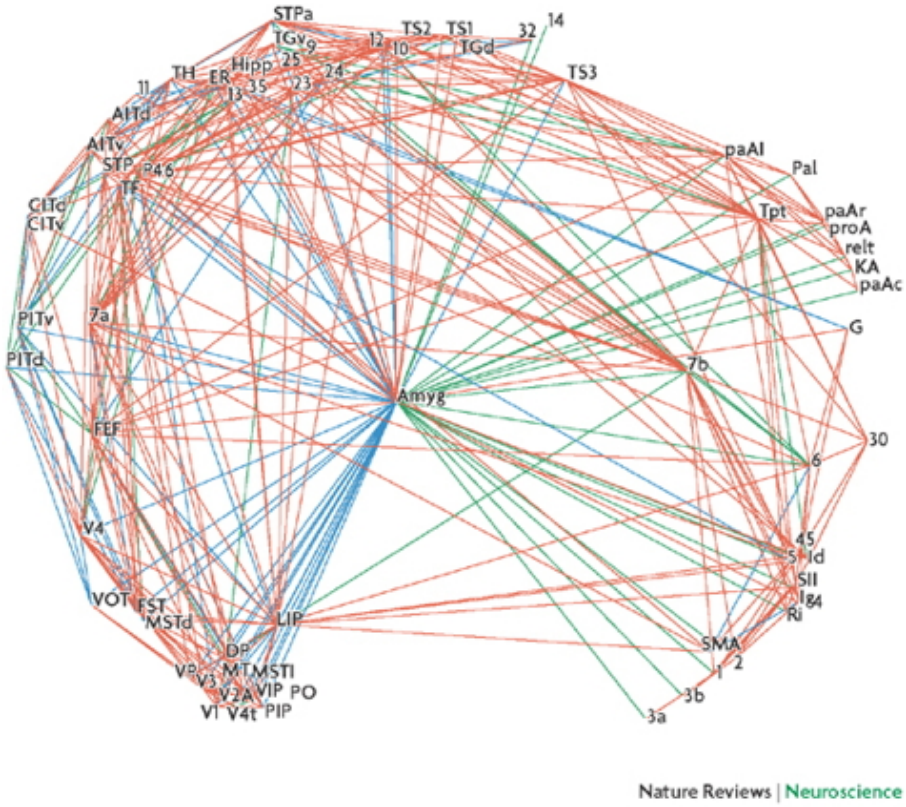
- Is emotional experience discrete/unidimensional?
- Are physiological responses (ANS, endocrine, brain activity)?

Is emotion different from cognition?



(Swanson 2012)

Is emotion different from cognition?



Nature Reviews | Neuroscience

(Pessoa 2008)

(Pessoa 2008)

"Here, I will argue that complex cognitive–emotional behaviours have their basis in dynamic coalitions of networks of brain areas, none of which should be conceptualized as specifically affective or cognitive. Central to cognitive–emotional interactions are brain areas with a high "degree of connectivity, called hubs, which are critical for regulating the flow and integration of information between regions."

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