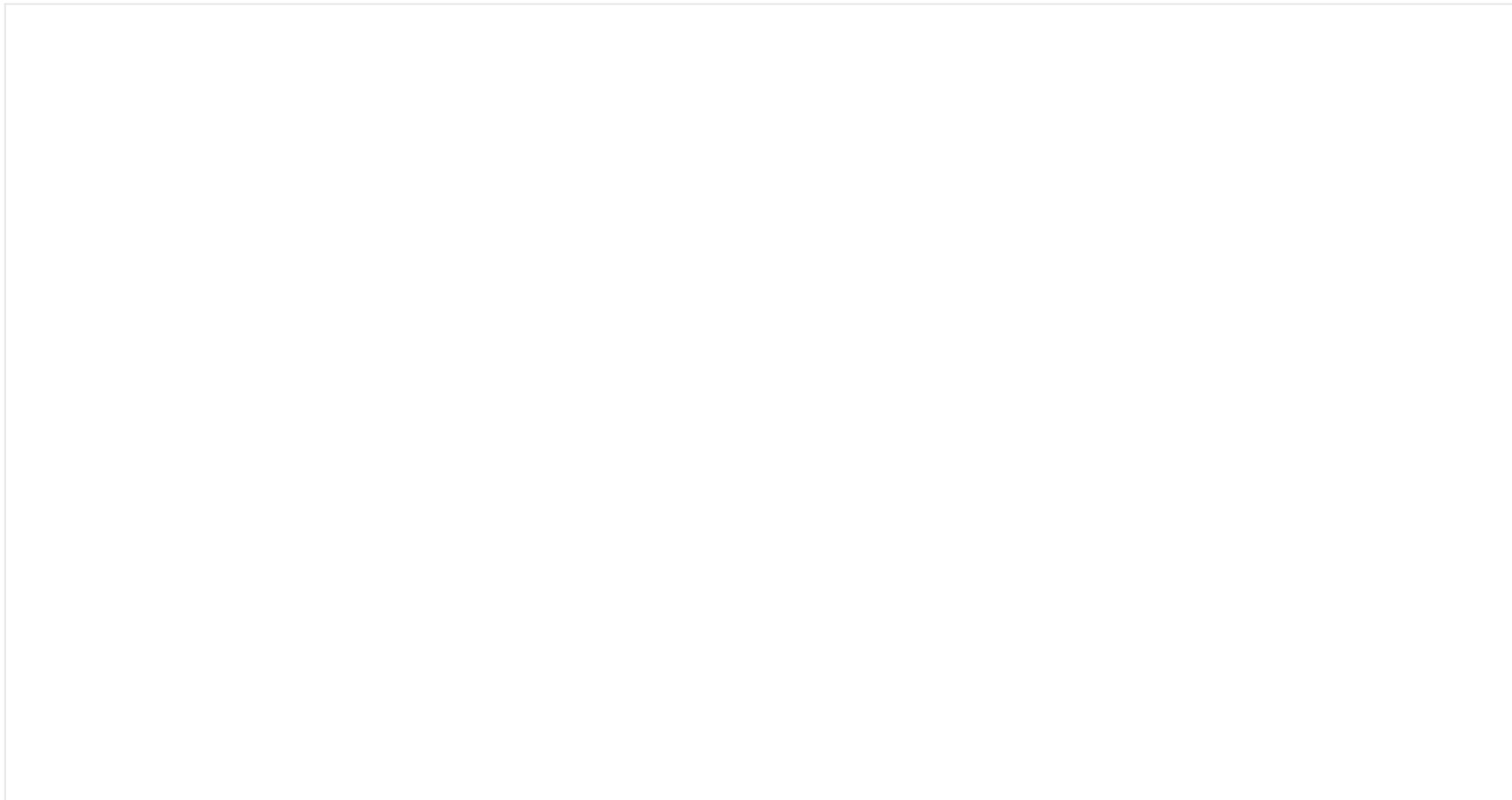


# 511-2018-10-31-emotion

Rick Gilmore

2018-10-31 08:30:27

# Prelude



# Today's Topics

- Wrap-up on memory
- Biology of emotion

# Biology of emotion

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

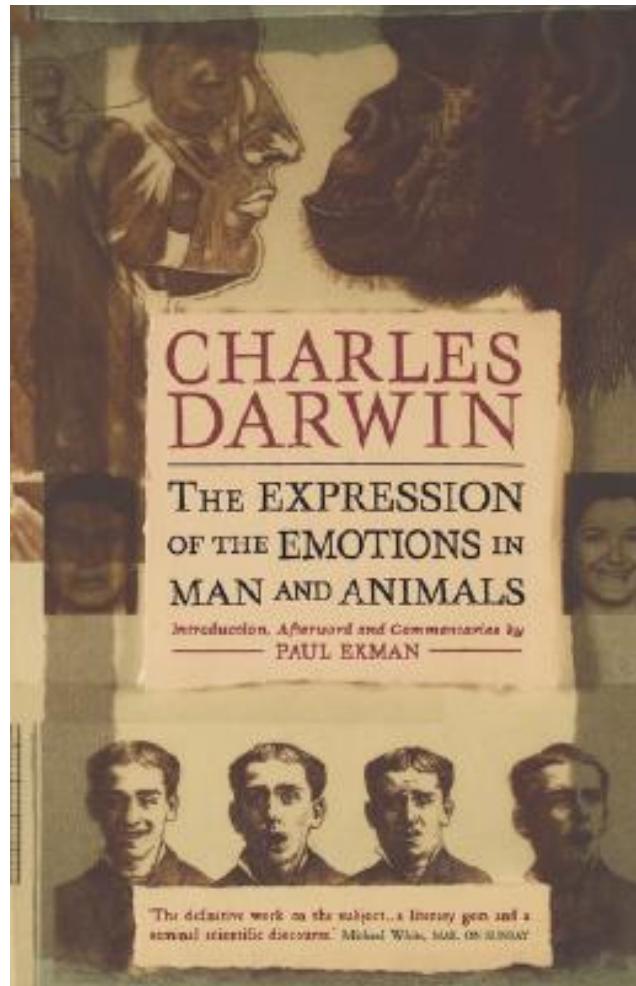
# Components of emotion

- 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, Gray, Gianaros, & Critchley, 2010)

# Proximal causes and effects

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

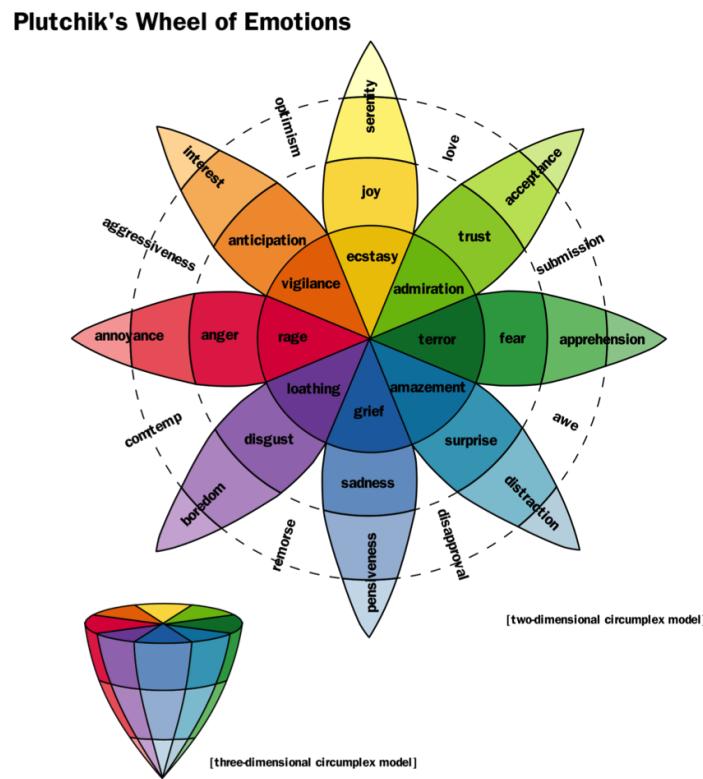
# Proximal causes and effects

- (Stanley) Schacter-(Jerome) Singer's Two-factor Theory
  - Physiological arousal + cognitive appraisal -> emotional states

# Dimensions

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

# Types (Plutchik, 1980)



# Measurement

- Autonomic Nervous System (ANS)
- Endocrine
- Brain activity
- Facial expression
- Subjective state

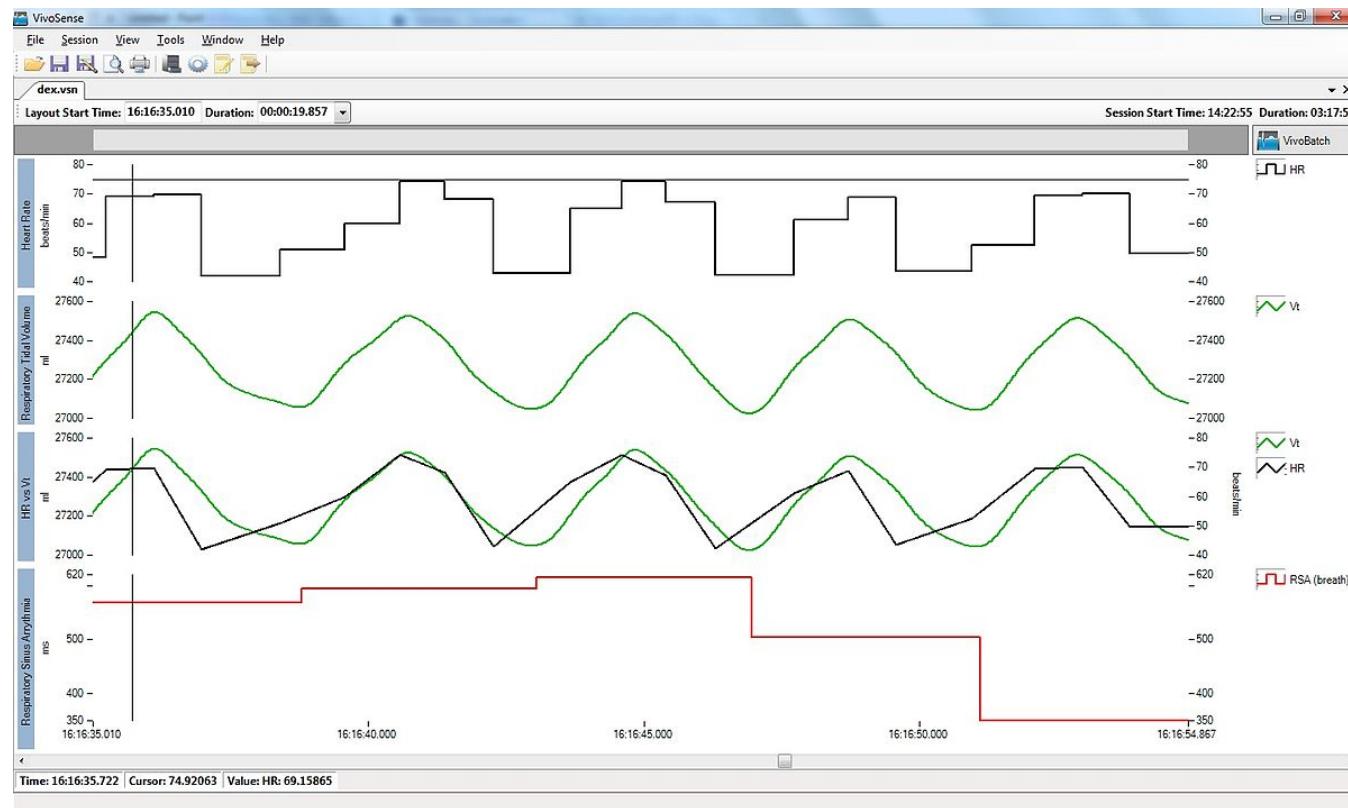
# ANS measures of emotion

- 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

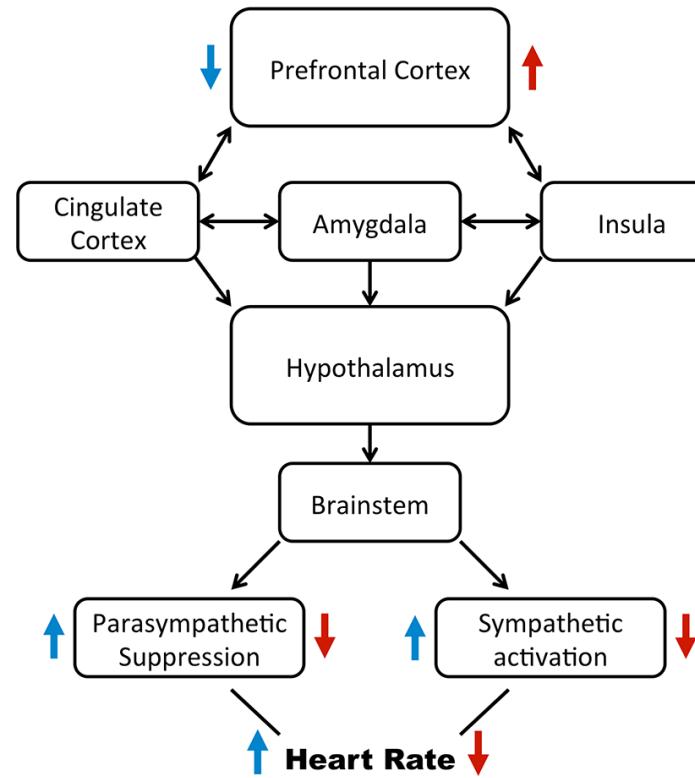


By [Vivonoetics](#) - Own work, [CC BY-SA 3.0](#), [Link](#)

# HRV as a 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

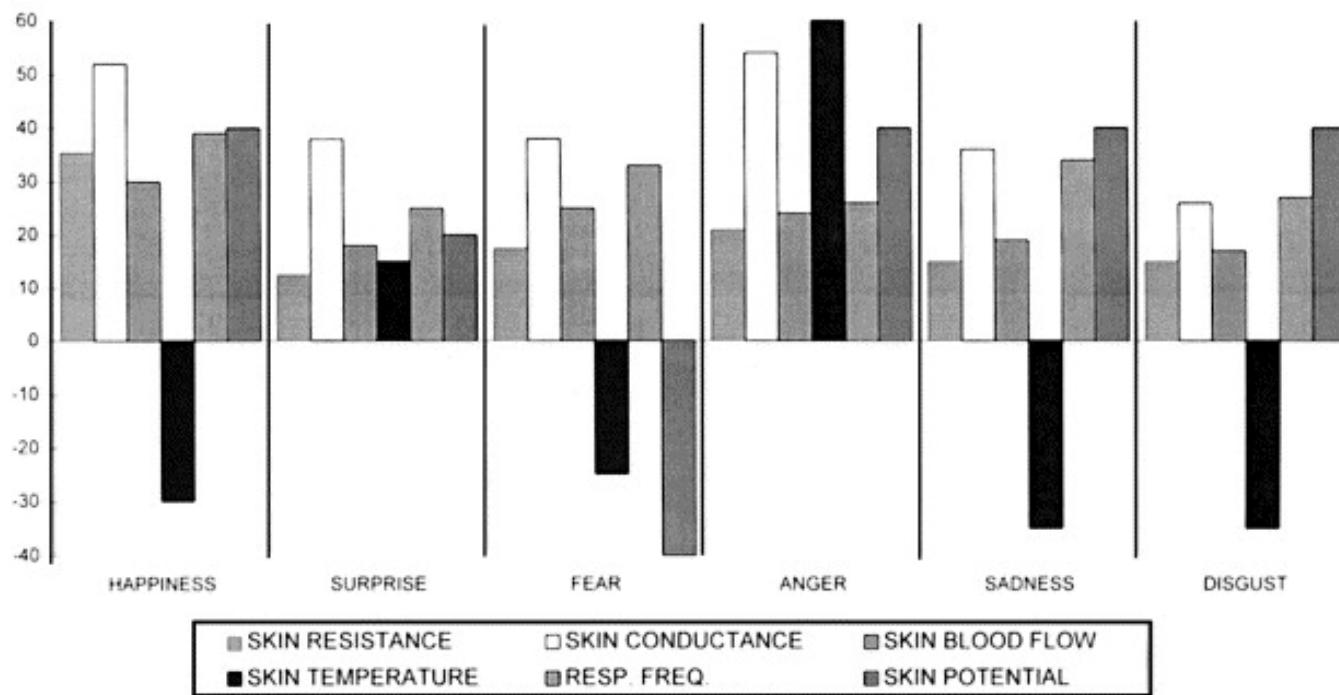


By Stevan Nikolin, Tjeerd W. Boonstra, Colleen K. Loo, Donel Martin - Nikolin S, Boonstra TW, Loo CK, Martin D (2017) Combined effect of prefrontal transcranial direct current stimulation and a working memory task on heart rate variability. PLoS ONE 12(8): e0181833.

<https://doi.org/10.1371/journal.pone.0181833>, CC BY 2.5, [Link](#)

# Covariance among ANS measures

## PATTERNS OF BASIC EMOTIONS



(Collet, Vernet-Maury, Delhomme, & Dittmar, 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)

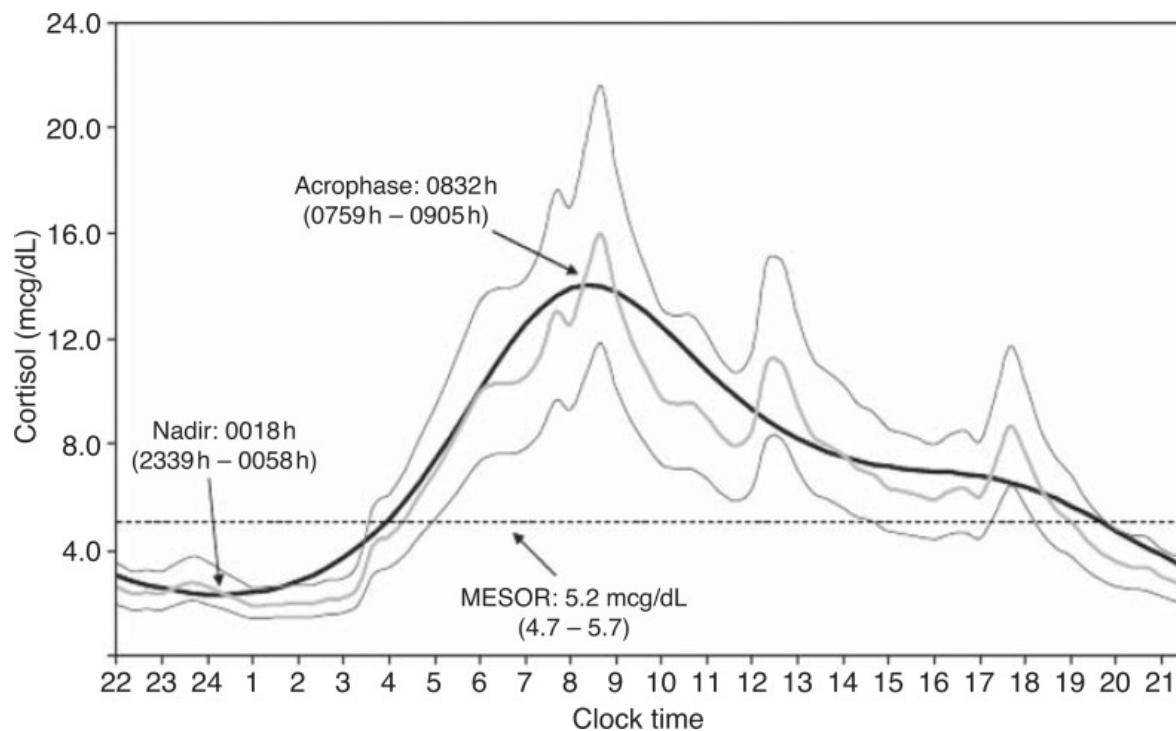
# Biochemical measures

- Catecholamines (norepinephrine, epinephrine)
  - Released by adrenal medulla following sympathetic nervous system (SNS) stimulation
  - Sympathetic Adrenal Medullary axis
  - Metabolites in urine or blood

# Biochemical measures

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

# Diurnal cortisol patterns

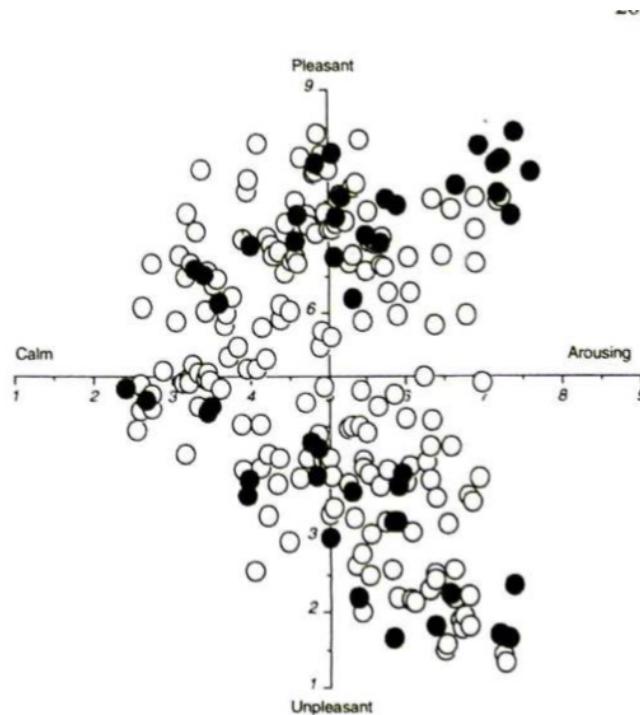


[\(Chan & Debono, 2010\)](#)

# Cortisol as measure

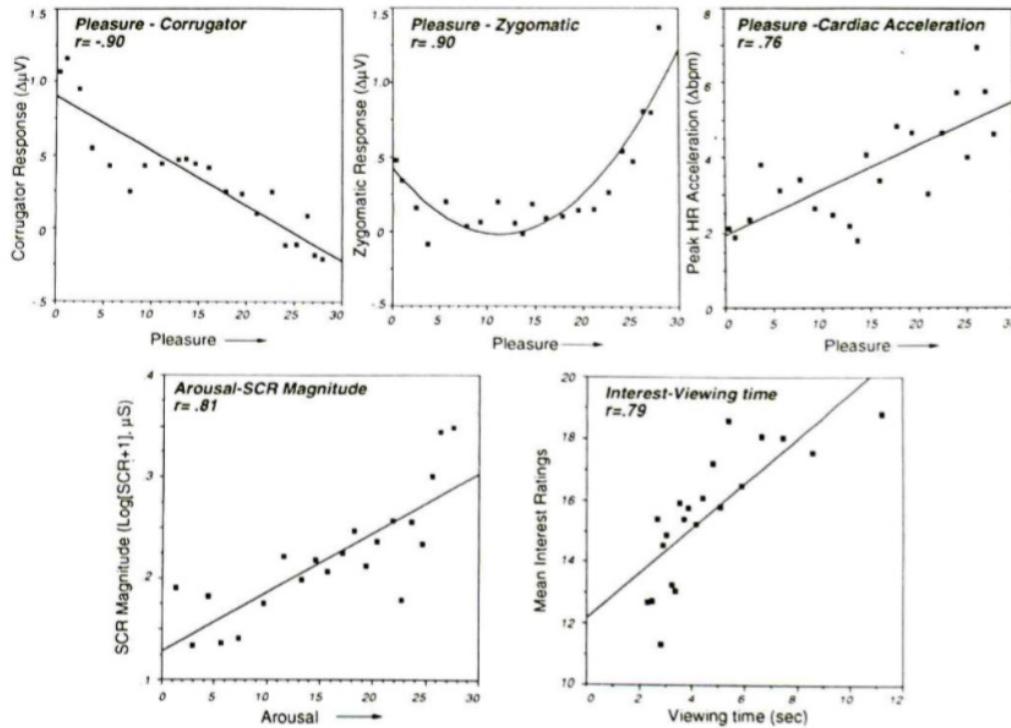
- Circadian periodicity
- Peaks around meal times
- Primary *physiological* role is modulating glucose & fat metabolism, anti-inflammatory

# 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).

[\(Lang, Greenwald, Bradley, & Hamm, 1993\)](#)



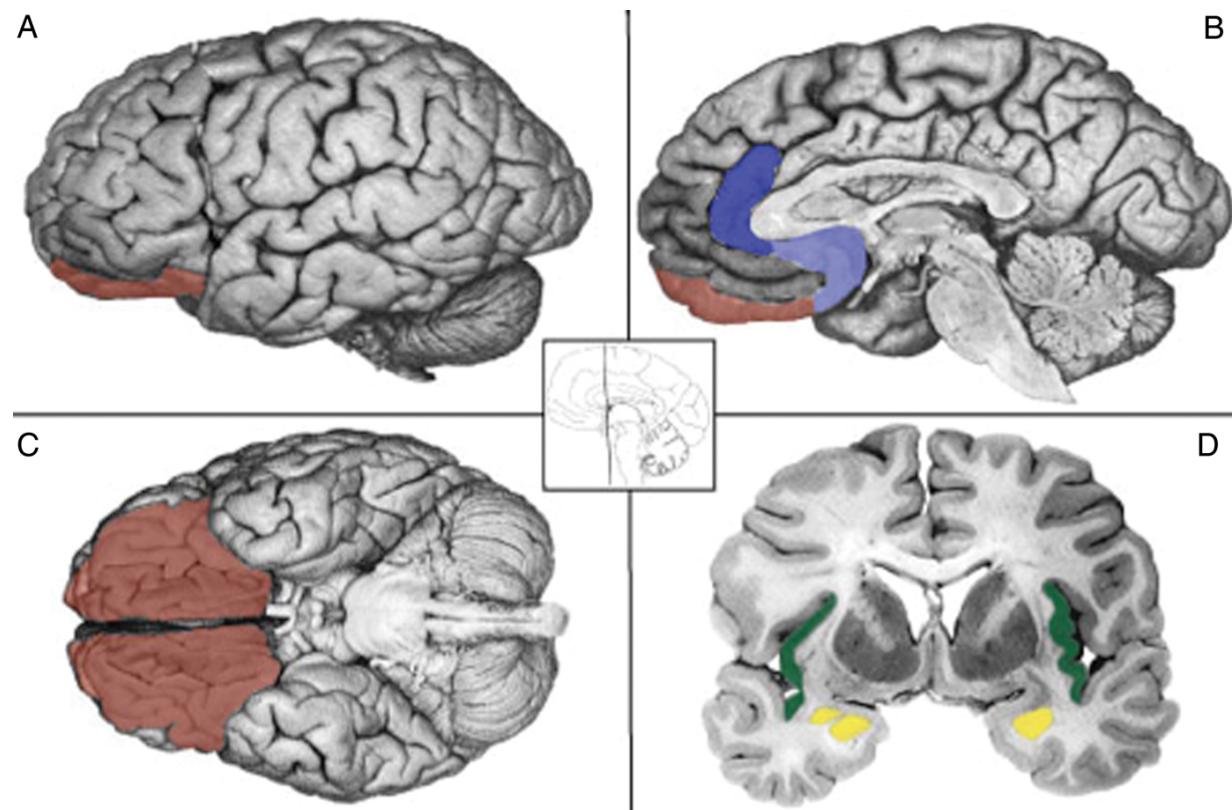
**Figure 2.** Covariation of affective valence judgments with slide corrugator response (upper left), zygomatic response (upper middle), peak heart rate acceleration (upper right); covariation of arousal judgments with electrodermal response magnitude (lower left); and interest judgments with duration 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)

# Are emotions 'natural kinds' distinguished by the brain?

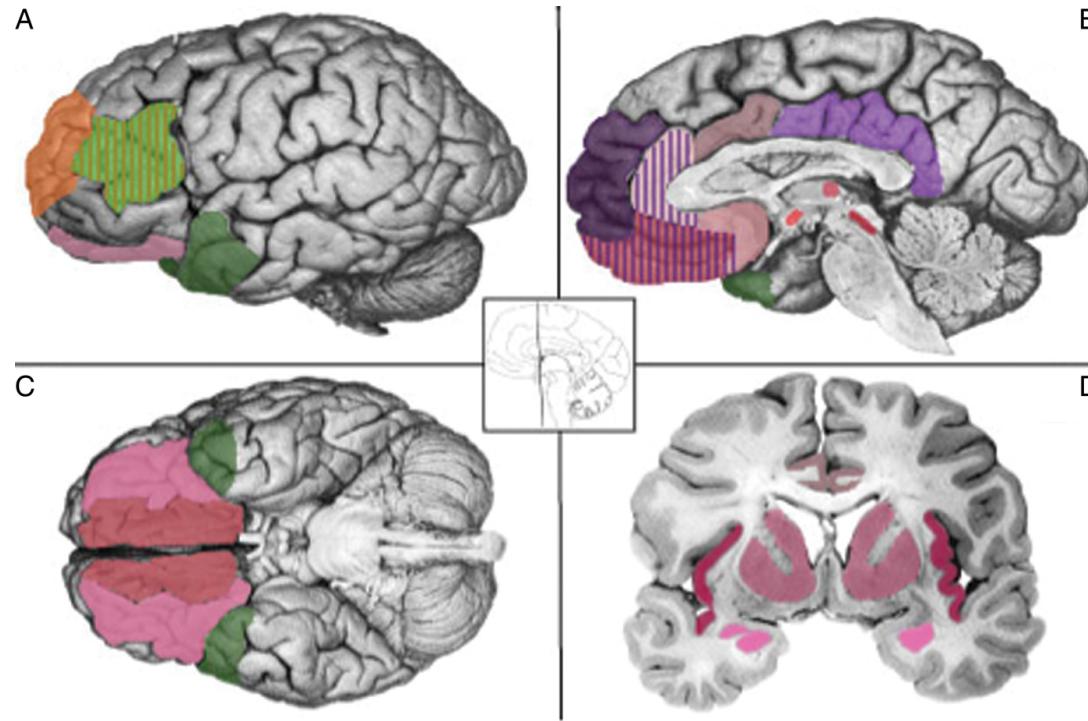
- Or are emotions "...*psychological events that emerge out of more basic psychological operations that are not specific to emotion.*" ([Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012](#))

# 'Locationist' view



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

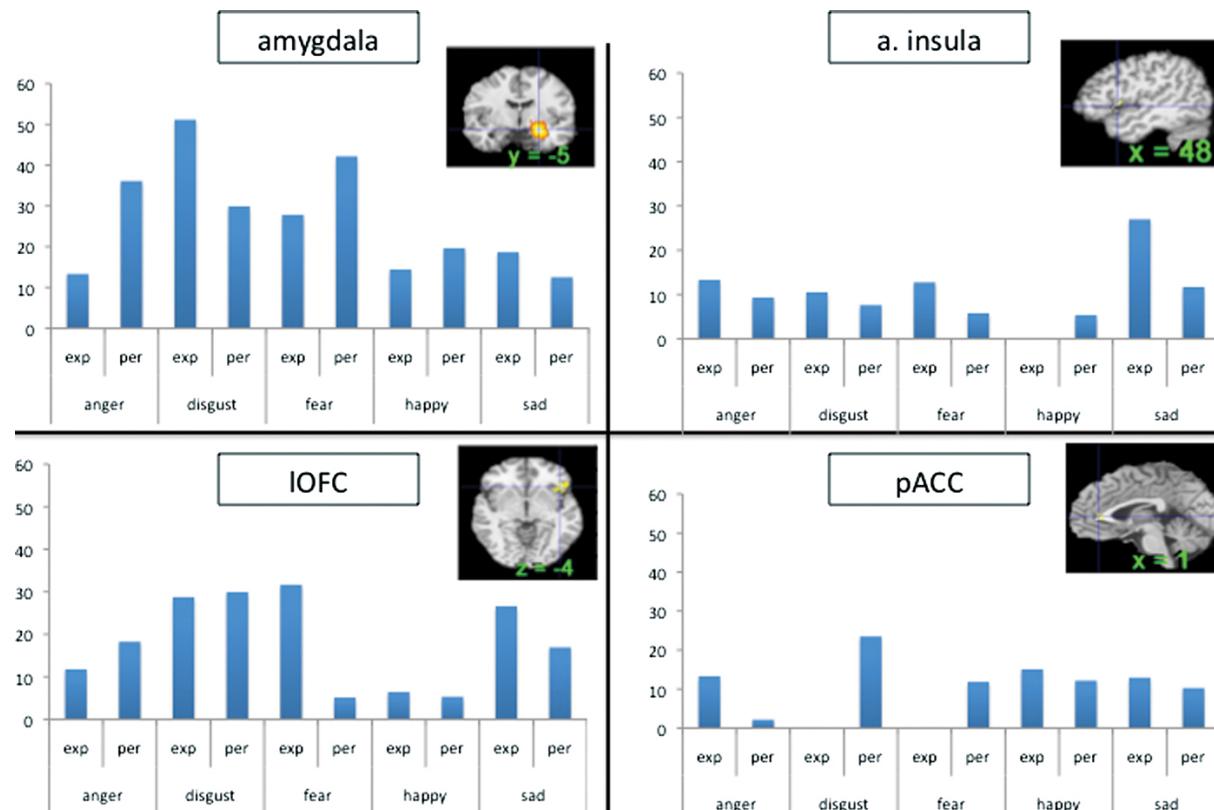
# 'Constructionist' view



Core Affect (pink): amygdala, insula, mOFC (Bas 10m, 11m, 13a, b, 14r, c), IOFC (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)

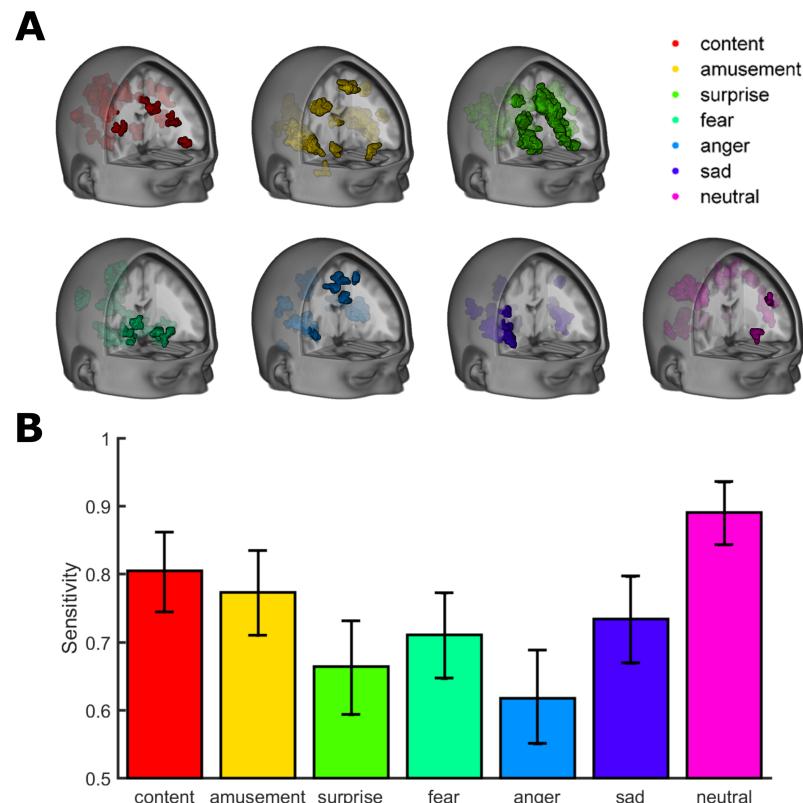
*"James believed that emotions, thoughts, and memories are categories derived from commonsense with instances that do not require special brain centers. With respect to emotion, he wrote, "sensational, associational, and motor elements are all that [the brain] need contain" to produce the variety of mental states that correspond to our commonsense categories for emotion (cf. James 1890/1998, p. 473)..."*

(Lindquist et al., 2012)

*"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."*

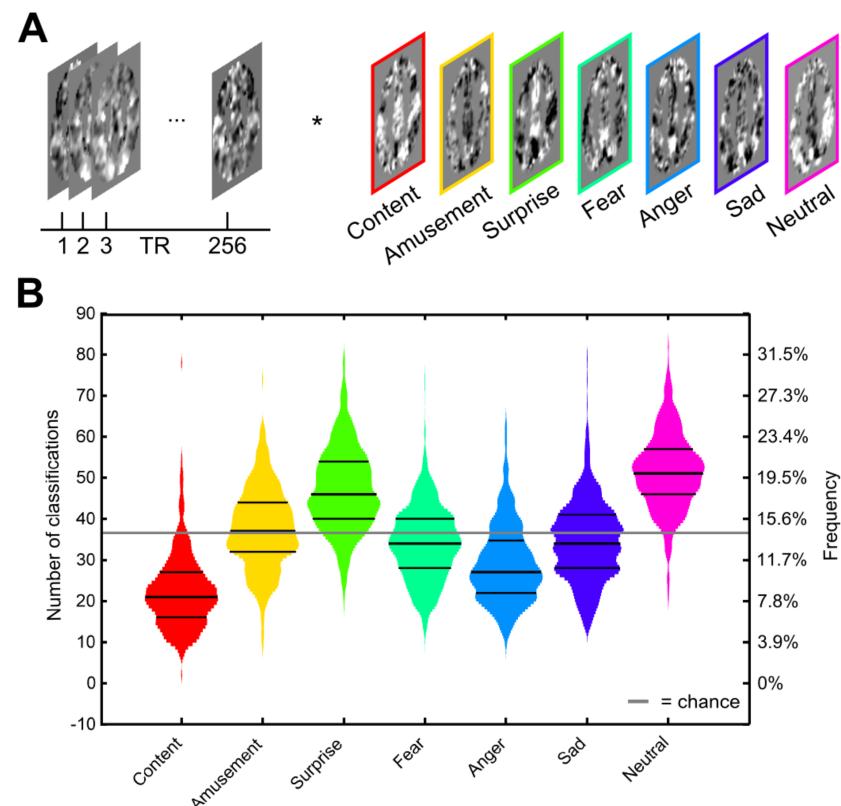
(Lindquist et al., 2012)

# Emotions as distributed activation states



(Kragel, Knott, Hariri, & LaBar, 2016)

# Emotions as distributed activation states

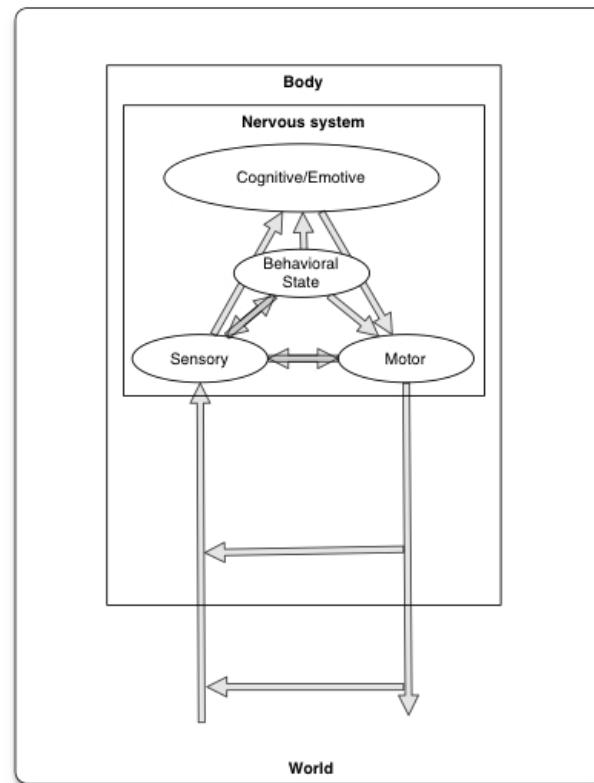


(Kragel et al., 2016)

# Questions

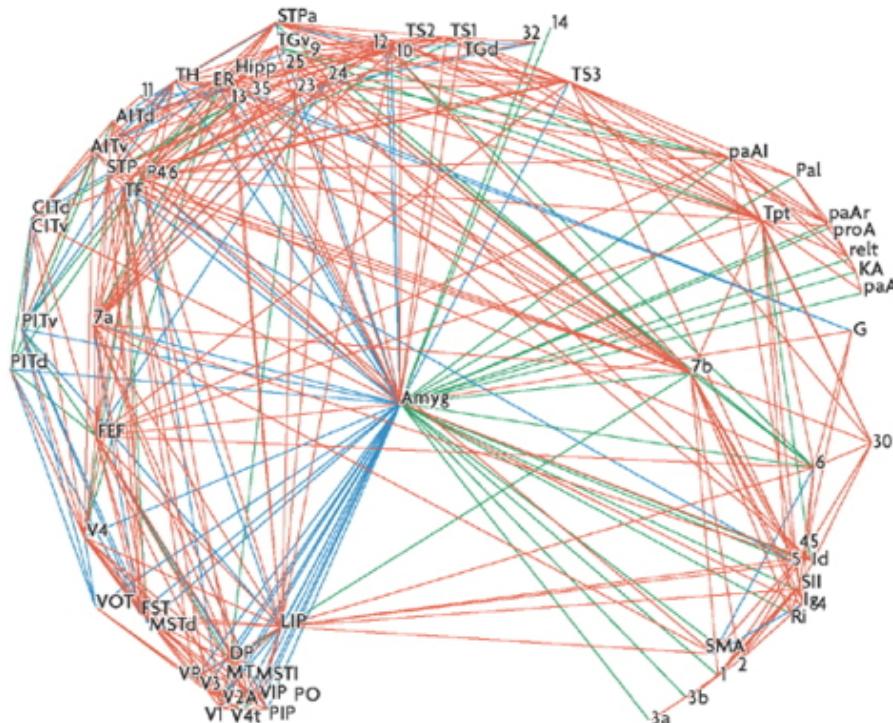
- Is emotional experience discrete/unidimensional?
- Are physiological responses (ANS, endocrine, brain activity)?

# Is emotion different from cognition?



(Swanson, 2012)

# Is emotion different from cognition?



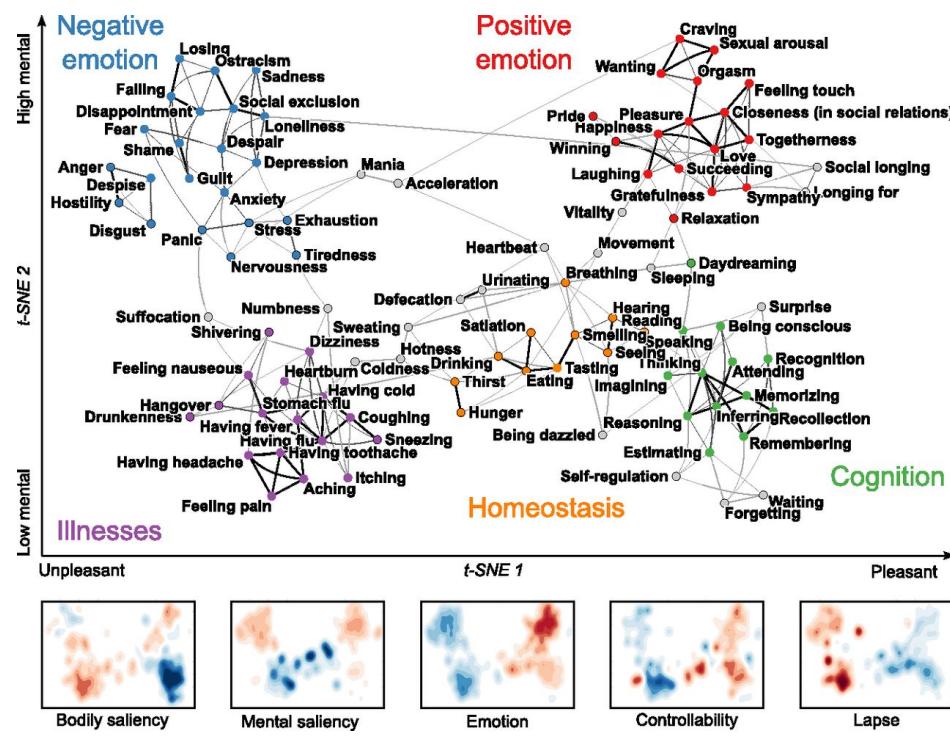
Nature Reviews | Neuroscience

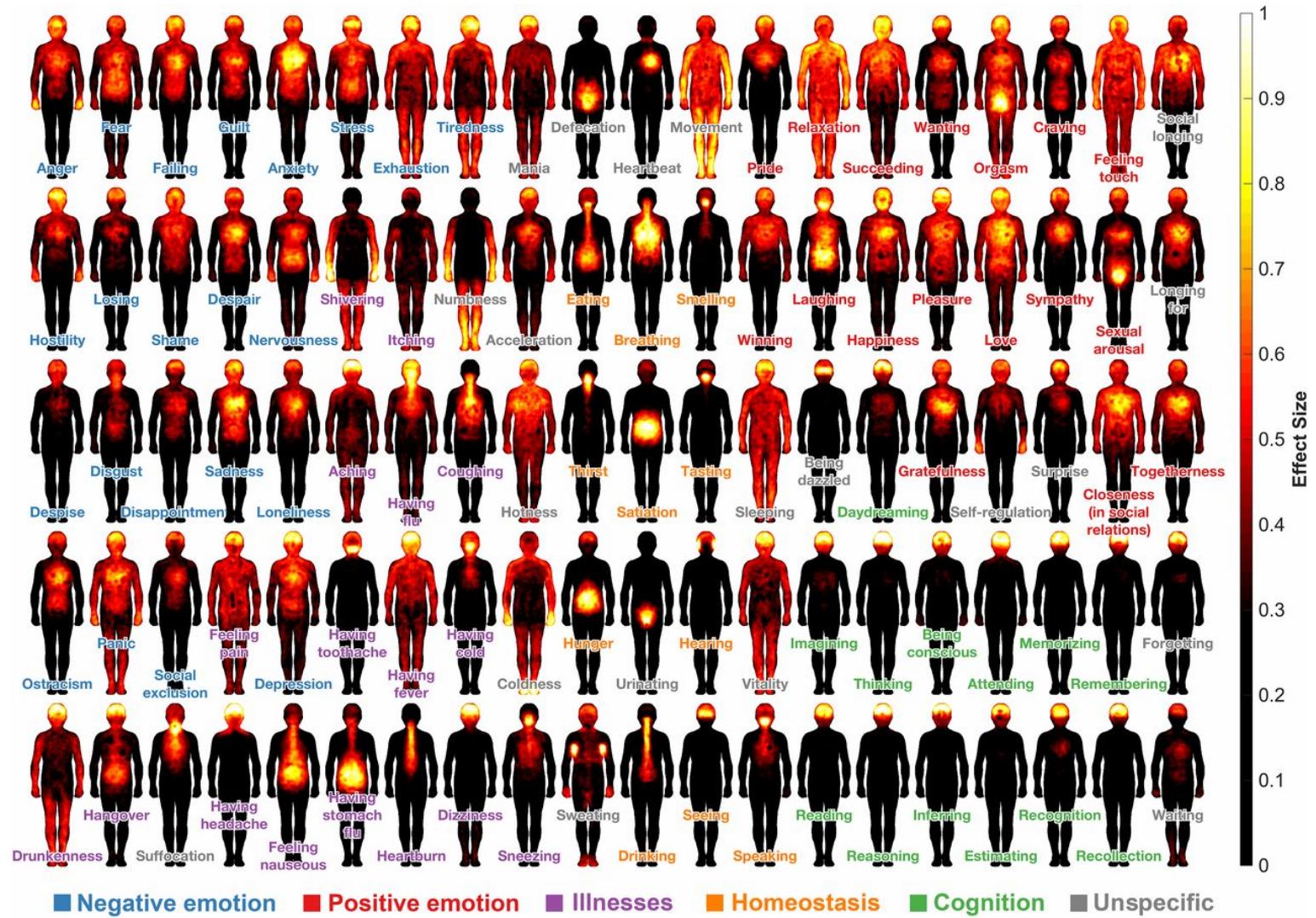
(Pessoa, 2008)

## (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."*

# (Nummenmaa, Hari, Hietanen, & Glerean, 2018)





(Nummenmaa et al., 2018)

*"Our data provide a detailed map of the human feeling space, where subjective feelings were strongly coupled with bodily sensations, and nearly all subjective experiences were qualified by emotional tone. Subjective states were best described on a 2D map with five distinct feeling clusters.*

*Representational similarity analysis revealed strong correspondence between the mental feeling space and the corresponding bodily sensations, basic dimensions of subjective experience, as well as similarity between neural and bodily sensation maps across different subjective feelings. Altogether these findings show that feeling states are categorical, emotional, and embodied."*

(Nummenmaa et al., 2018)

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