260-2017-10-23-emotion-reward

Rick Gilmore

2017-10-23 08:29:28

Happiness Is...

Happiness-You're A Good Man, Charlie Brown (Lyrics)

Today's Topics

- Biology of emotion
- Happiness/pleasure
- Quiz 3 Friday

Biology of Emotion

- What is emotion?
- What are the types of emotions?
- Biological systems involved in emotion

What is emotion?

- Feelings
- Physiological state
- Actions (now)
- Propensity to act (in the future)

What is cause? What is effect?

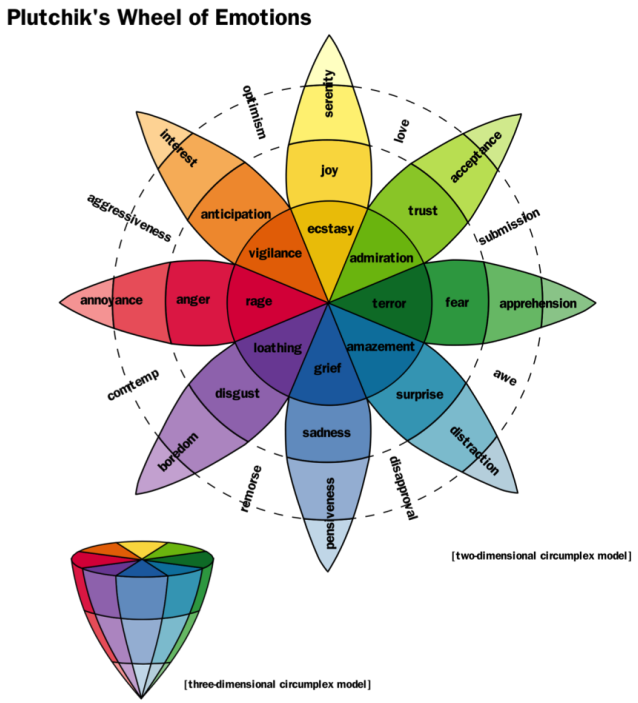
"Do we run from a bear because we are afraid or are we afraid because we run? William James posed this question more than a century ago, yet the notion that afferent visceral signals are essential for the unique experiences of distinct emotions remains a key unresolved question at the heart of emotional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

(Harrison et al. 2010)

Competing views

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

What are the different types of emotions?



(Plutchik 1980)

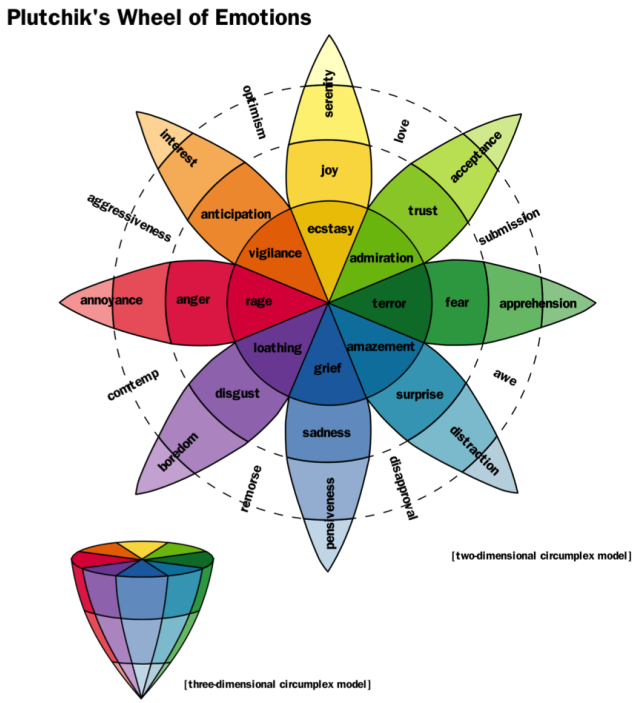
Emotions

- Vary in valence
  - Positive/negative
- Vary in intensity (arousal)
- Vary in action tendency
  - Approach/avoid

Emotions (can) serve biological goals

- Ingestion
- Defense
- Reproduction
- Affiliation

Plutchik



(Plutchik 1980)

Biological goals served by

- Anger
- Fear
- Disgust
- Trust
- Sadness
- Happiness

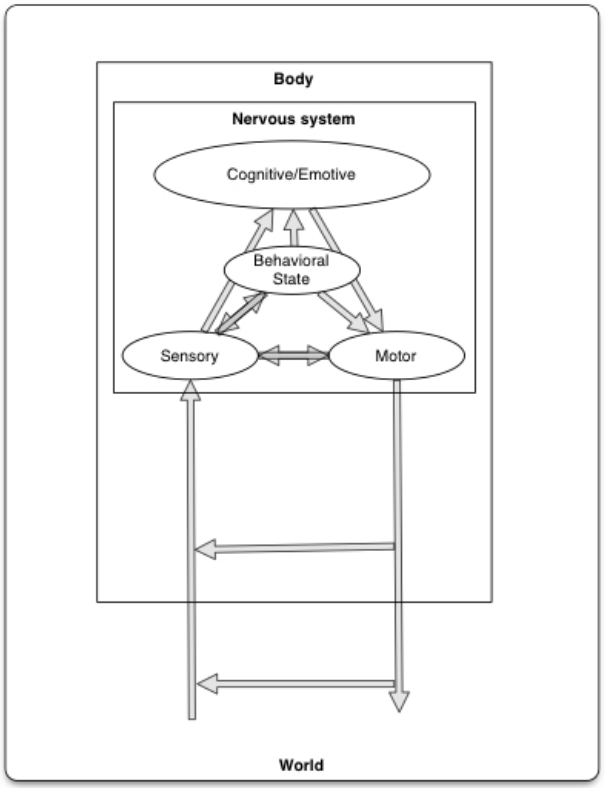
Do emotions serve biological goals?

- Shame
- Guilt
- Pride
- Embarrassment
- Regret

Are 'social' goals ?

- Darwinian view:
- If influence on reproductive outcomes, **yes**.
- Do 'social' goals – shame, pride, etc. – influence reproductive success?

Is emotion different from cognition?



(Swanson 2012)

Pessoa noted that from a network perspective, the amygdala is among the most centrally connected parts of the brain. It's a 'hub', in other words.

(Pessoa 2008)

(Pessoa 2008)

Emotion as "computing"

- Input
- Processing/evaluation
- Output

Emotion as "computing"

- **Input**
- Processing/evaluation
- Output

Emotion as "computing"

- Input
  - External
  - Internal

External Input

Cole, P., Gilmore, R.O., Scherf, K.S. & Perez-Edgar, K. (2016). The Proximal Emotional Environment Project (PEEP). Databrary. Retrieved October 31, 2016 from https://nyu.databrary.org/volume/248.

Emotional "computing"

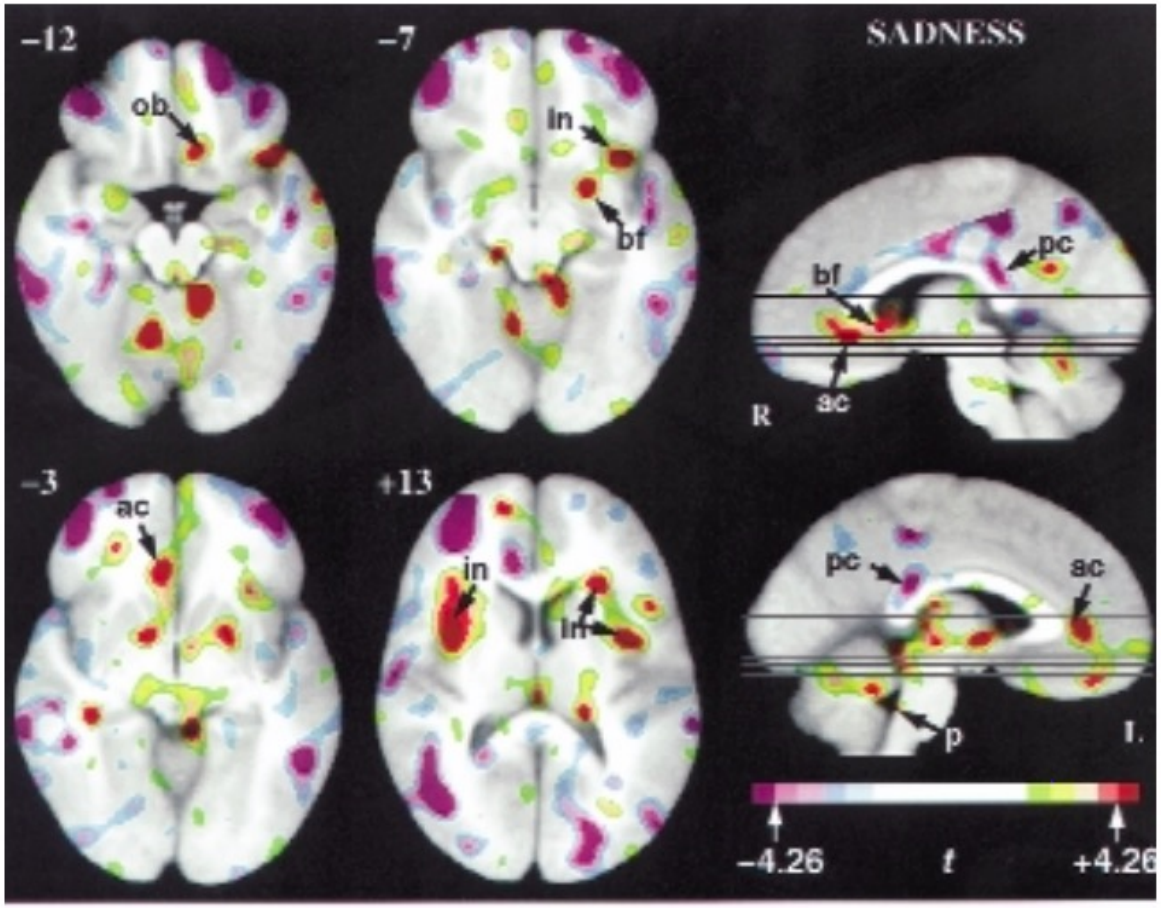
- Input
- **Processing/evaluation**

Emotional "computing"

- Input
- Processing/evaluation
  - Current state + past states (memory)
  - Food/non
  - Threat/non
  - Mate/non; offspring/non

Imagine a time when you were {sad, happy, angry, afraid, neither}…

- PET imaging, n=41 pre-screened adults
- (A. R. Damasio et al. 2000)



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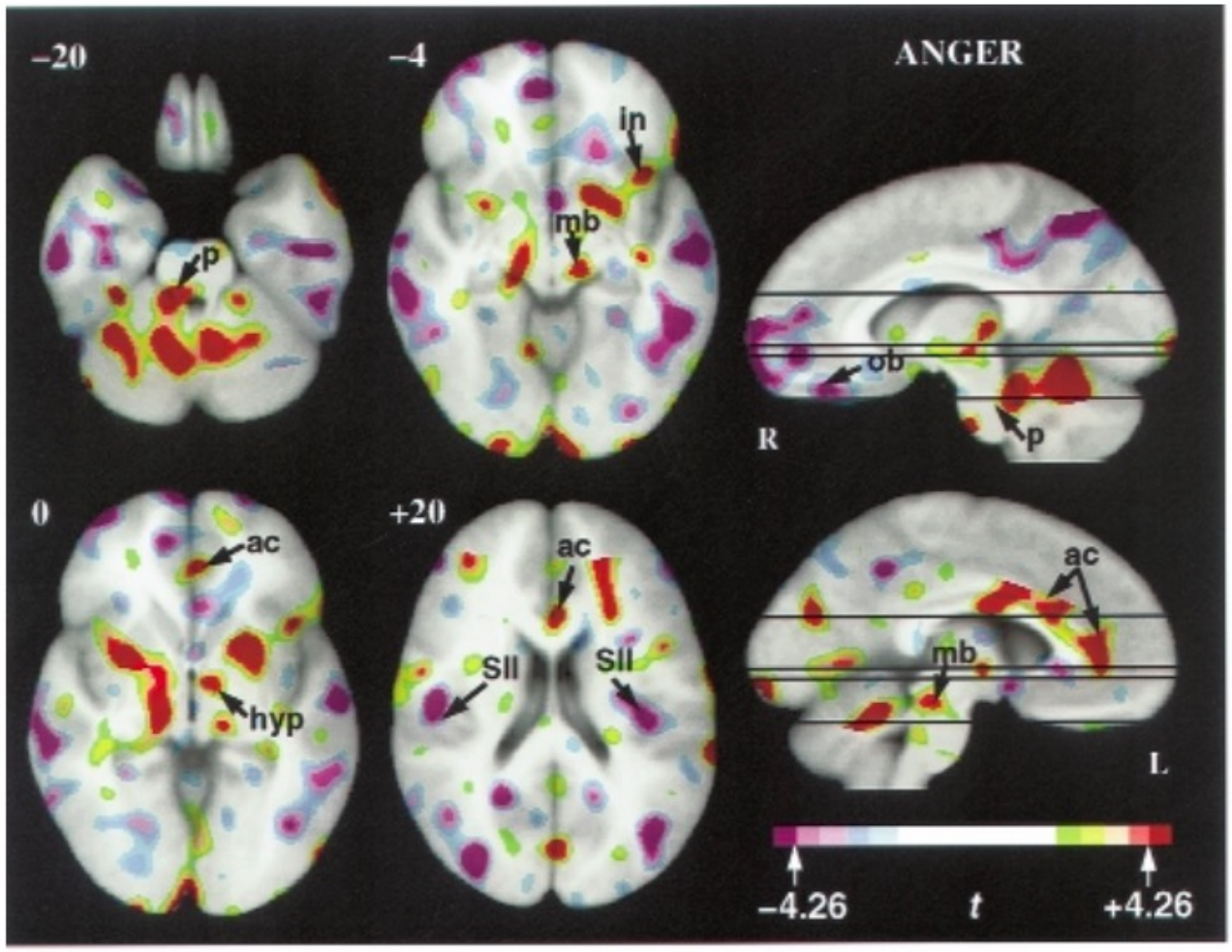

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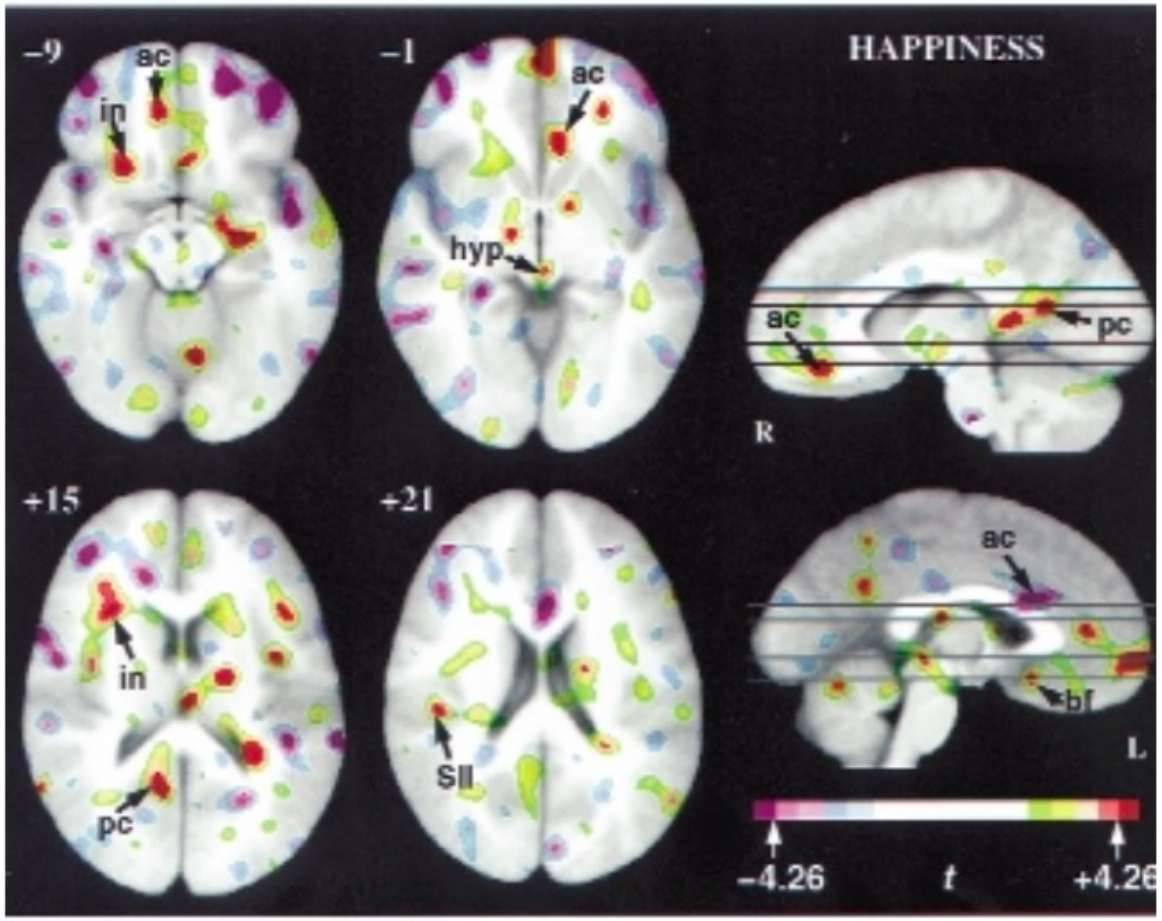

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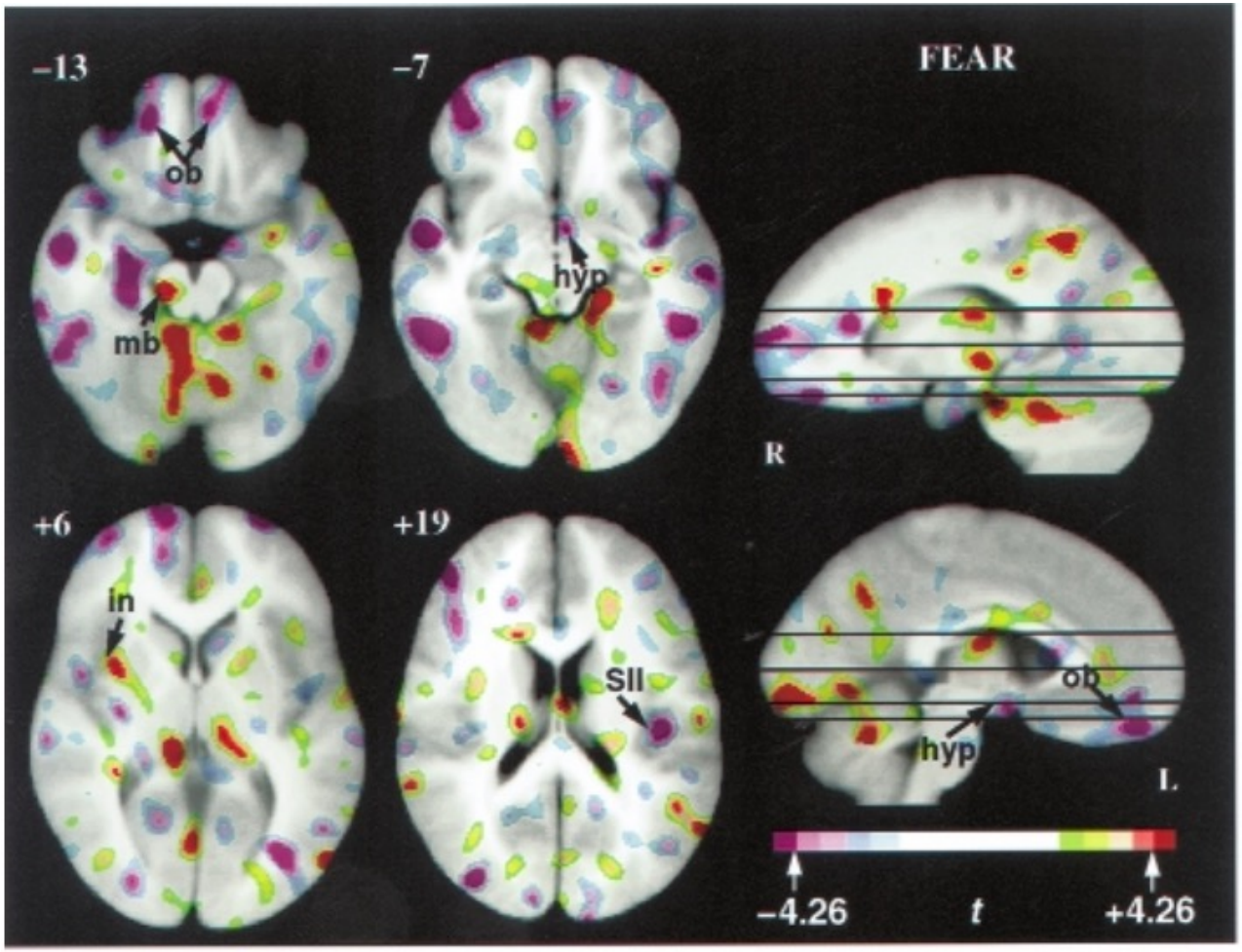


(A. R. Damasio et al. 2000)

(A. R. Damasio et al. 2000)

- Different patterns of activation
- Insula, somatosensory cortex, cingulate cortex, hypothalamus, midbrain

Emotional "computing"

- Input
- Processing/evaluation
- **Output**

Emotional "computing"

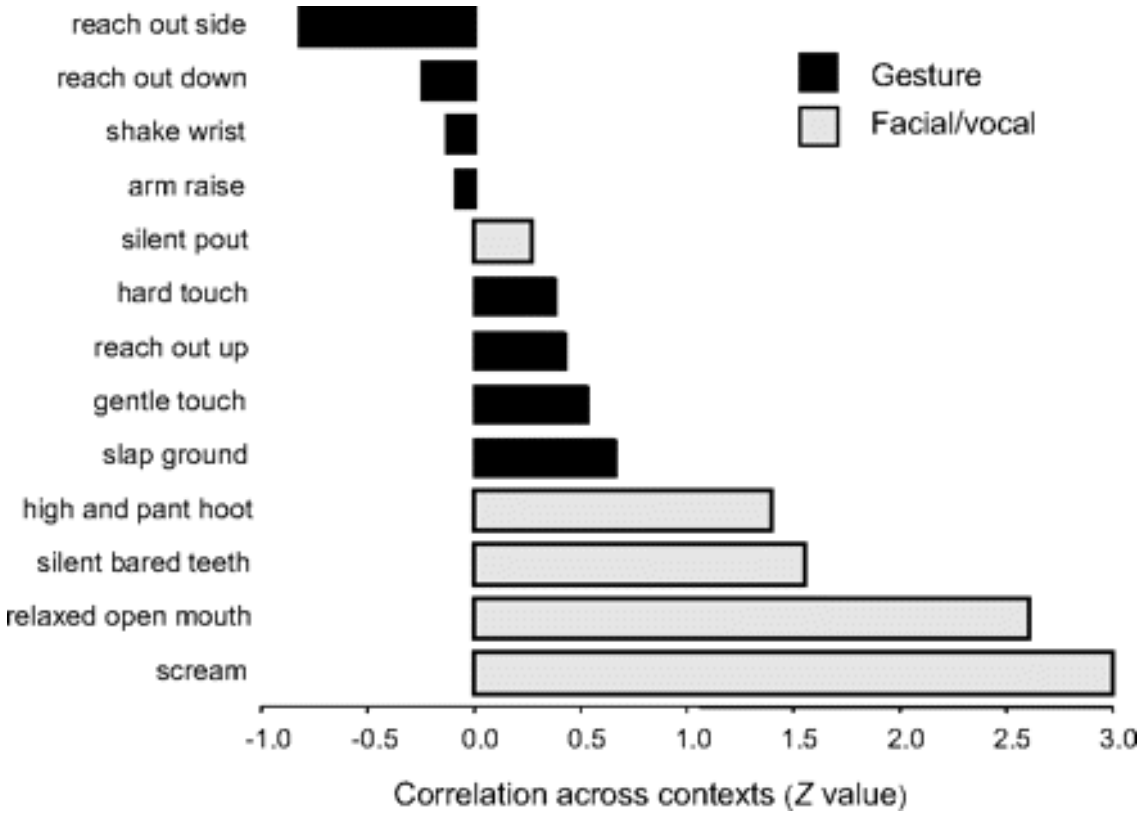
- Output
  - Physiological state
    - Autonomic nervous system
    - Hormones

Emotional "computing"

- Output
  - Actions
    - Locomotion or freezing
    - Facial expression
    - Vocalization
    - Gestures, body posture

(Pollick and Waal 2007)

Are non-human animals consistent in their use of emotion-expressing actions?

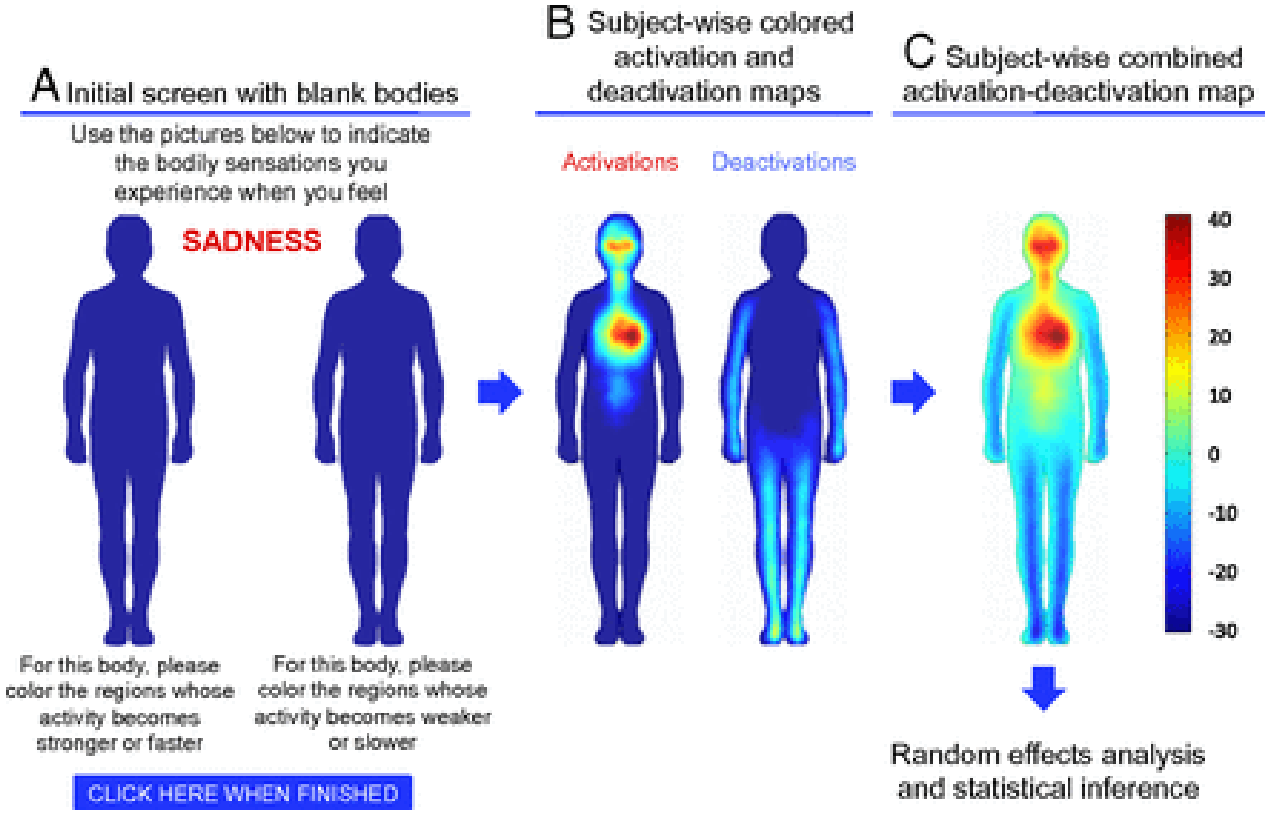


(Pollick and Waal 2007)

Are different emotions processed differently in humans?

- Autonomic responses related to feelings
- Autonomic specificity: emotions autonomically unique vs. autonomically identical? (Levenson 2003)
- Belief in idea stronger than evidence

Bodily maps of emotions



(Nummenmaa et al. 2014)

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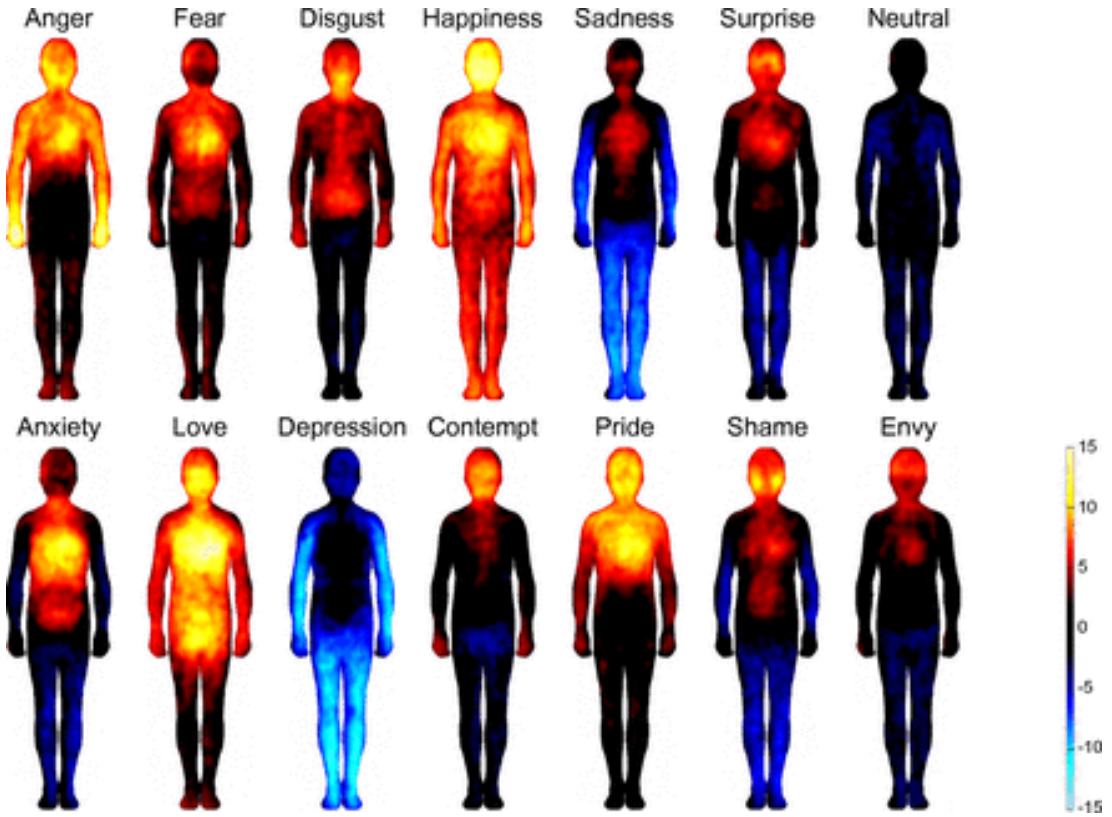


(Nummenmaa et al. 2014)

(Nummenmaa et al. 2014)

Biological systems involved in specific emotions

- Happiness

Components of happiness

- Aristotle
- Hedonia
  - Pleasure
- Eudaimonia
  - Life satisfaction
  - Relates to motivation

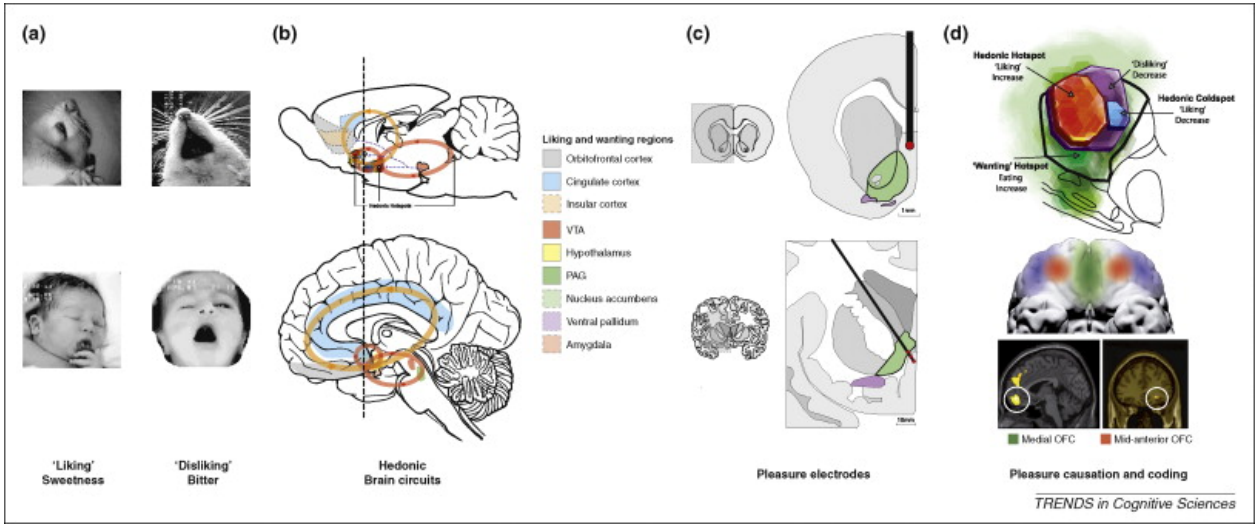
"Computing" 'happiness'

- Inputs
  - External
  - Internal
- Processing
- Outputs
  - Feelings
  - Actions

Brain mechanisms

- Circuits for signaling pleasure and pain
- Similarities across animal species
- Dopamine and endogenous opioid neurotransmitter systems involved

Neuroanatomy of 'happiness'



(Kringelbach and Berridge 2009)

Rewards

- A reinforces (makes more prevalent/probable) some behavior
- Milner and Olds (Milner 1989) discovered 'rewarding' power of electrical self-stimulation
- (Heath 1963) studied effects in human patients.

Electrical self-stimulation

Brain Mechanisms of Pleasure and Addiction

The accidental discovery that electrical stimulation could be pleasurable launched a research program into the circuits that control both pleasure and positive feelings. The electrical stimulation involved a path from the ventral tegmental area (VTA) in the midbrain to the nucleus accumbens (NAc) in the ventral striatum – the anterior-most part of the caudate and putamen nuclei of the basal ganglia.

Other nodes in this "reward" network include…

Here's another view of some of the circuits involved in pleasure/reweard that shows their interconnections. Here, the nucleus accumbens is called the ventral striatum (VS).

The network involved in pleasure/reward involves a distinct set of neurotransmitters: dopamine, opioids, cannabinoids, serotonin and norepinephrine, and acetylcholine.

Researchers in the 1970s first discovered that there were chemicals in the brain that had similar chemical properties to opioid drugs like heroin and morphine. These substances were later shown to be neurotransmitters. So, the brain releases its own substances or endorphins. Endorphins bind to receptors that also bind exogenous drugs like heroin.

Endogenous cannabinoid system

- Cannabinoids, psychoactive compounds found in cannibis
- Cannabinoid CB1 receptors in CNS; CB2 in body, immune system

Later, researchers discovered that the brain has an endogenous cannabinoid system that exogenous substances like marijuana and hashish bind to. Receptors for cannabinoids are found all over the brain and body.

This means that the brain contains its own receptors for substances that are known as drugs of pleasure.

Acetylcholine also plays a role in the pleasure/reward circuit. We've talked about ACh as the primary NT of CNS output, but it is also a neuromodulator that projects widely, including from the nucleus accumbens (basal forebrain BF), and the dorsal raphe (DR: NE), and locus coeruleus (LC: 5-HT) in the brainstem.

Generalizations about happiness/pleasure

- Types of pleasure activate overlapping areas
- Pleasure/happiness engage a network of brain areas
- Pleasure/happiness signaling involves multiple neuromodulators, but DA especially important
- “Reward” pathways activated by many different inputs.

Next time

- Fear
- Stress

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