260-2017-03-20-emotion-reward

Rick Gilmore

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Happiness Is...

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 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 *all* emotions serve biological goals?

- Shame
- Guilt
- Pride
- Embarrassment
- Regret

Are 'social' goals *biological*?

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

Is emotion different from cogntion?

(Swanson 2012)

Is emotion different from cogntion?

(Pessoa 2008)

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)

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.

(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.

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.

Or food.

Emotional "computing"

- Input
- **Processing/evaluation**

Emotional "computing"

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

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)

…The study distinguished 31 manual gestures and 18 facial/vocal signals. It was found that homologous facial/vocal displays were used very similarly by both [bonobos and chimpanzees], yet the same did not apply to gestures. Both within and between species gesture usage varied enormously. Moreover, bonobos showed greater flexibility in this regard than chimpanzees and were also the only species in which multimodal communication (i.e., combinations of gestures and facial/vocal signals) added to behavioral impact on the recipient.

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

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 *reward* 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

"Reward" circuitry in the brain

(Nestler and Carlezon 2006)

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.

Nodes in the "reward" circuit

- Ventral tegmental area (VTA) in midbrain
- Nucleus accumbens (nAcc)

- Hypothalamus (Hyp)
- Amygdala (Amy)
- Hippocampus (HP)
- Dorsal Raphe Nucleus/Locus Coeruleus (DR/LC)
- Prefrontal cortex (PFC)

Other nodes in this "reward" network include…

Nucleus accumbens and dorsal striatum

(Kohls et al. 2012)

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).

Psychopharmacology of 'happiness'

- Dopamine
- Opioids
- Cannabinoids
- Serotonin, Norepinephrine
- ACh

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

Endogenous morphine-like NTs (endorphins) from hyp, NST

(Clapp, Bhave, and Hoffman, n.d.)

Researchers in the 1970s first discovered that there were *endogenous* 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 *endogenous morphine-like* substances or endorphins. Endorphins bind to receptors that also bind exogenous drugs like heroin.

Endogenous cannabinoid system

- CB1 receptors in CNS; CB2 in body, immune system

(Flores, Maldonado, and Berrendero 2013)

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.

Brain contains its own systems for drugs of 'pleasure'

- Endogenous opioids (endorphins)
- Endogenous cannabinoids

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

ACh projections in the CNS

(Cock, Vidailhet, and Arnulf 2008)

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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