

# PSYCH 260/PSYCH BBH

Emotion

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2022-03-22 08:03:42



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# Announcements

- Quiz 3 today, after class until 10 pm
- Exam 3 next Thursday, March 31

# Today's Topics

- Wrap up on [schizophrenia](#)
- Biology of emotion
- Happiness/pleasure and reward
- Fear & stress

# Biology of Emotion

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

# What is emotion?

- Feelings
- Physiological state

# Emotions as actions

<https://www.biomotionlab.ca/html5-bml-walker/>

# 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, Gray, Gianaros, & Critchley, 2010)



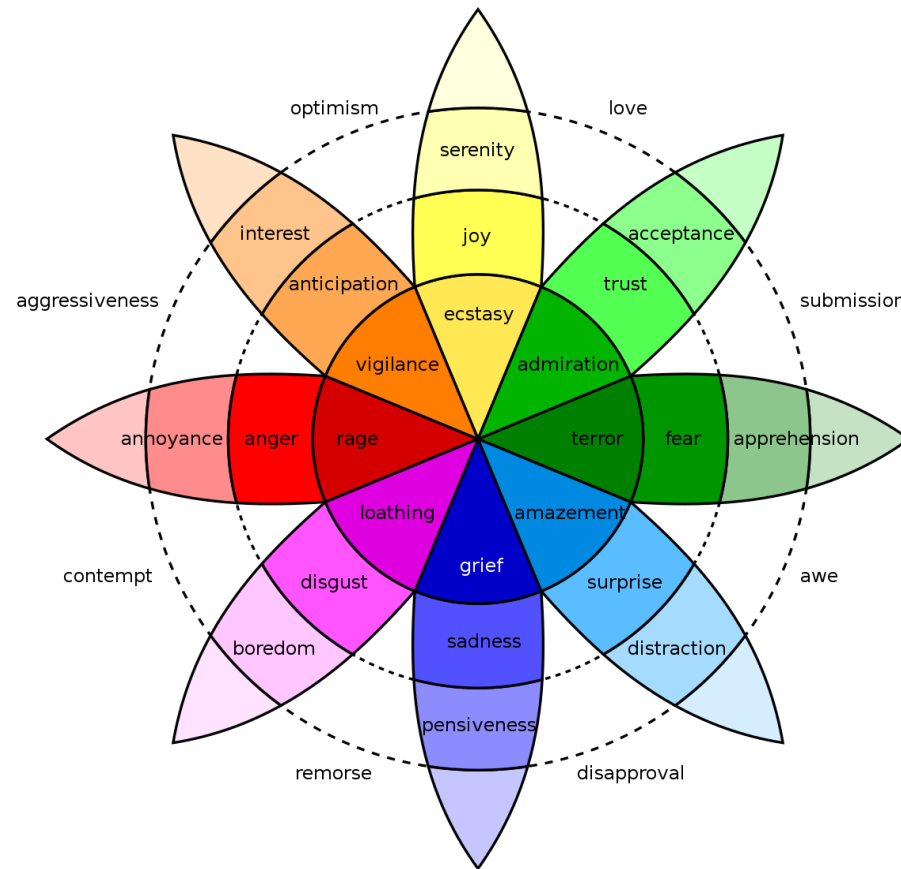
# Competing views

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

# Competing views

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

# What are the different types of emotions?



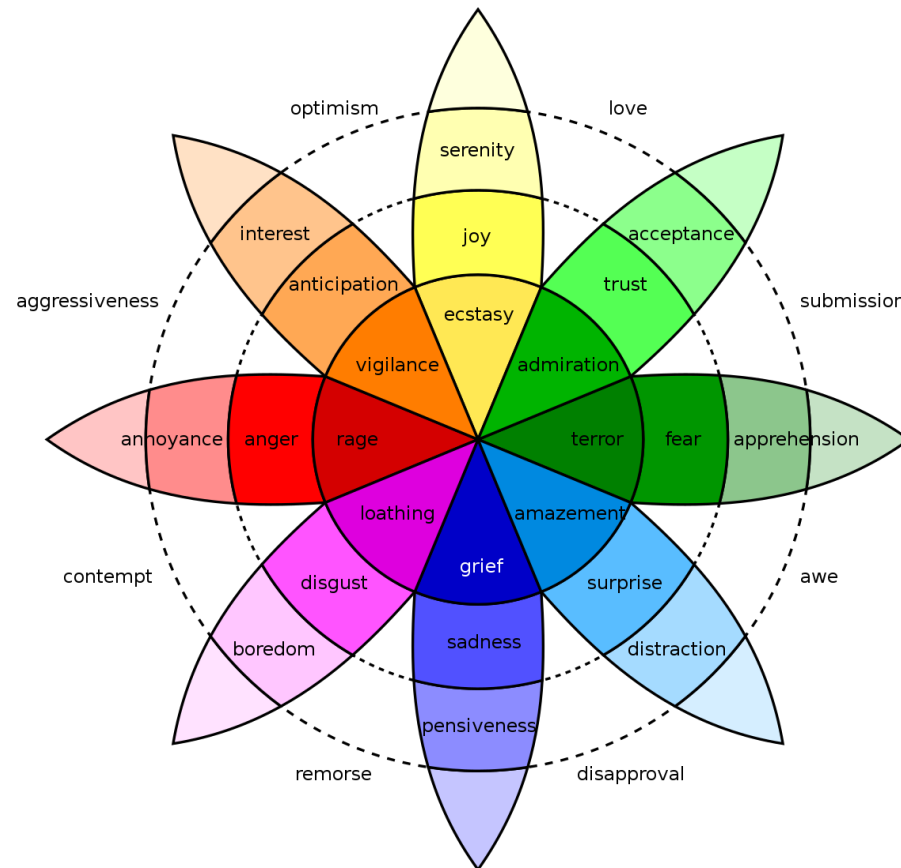
(Plutchik, 1980)

# Emotions

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

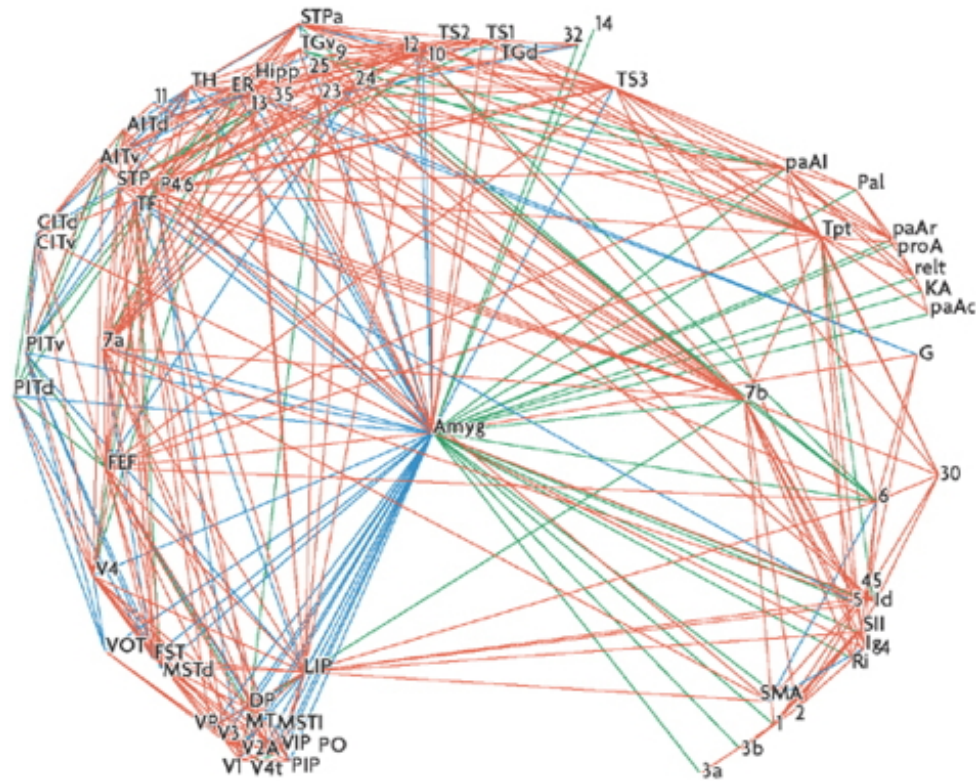
# Emotions (can) serve biological goals

- Ingestion
- Defense
- Reproduction
- Affiliation



(Plutchik, 1980)

# Is emotion distinct from cognition?



(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.*



## (Pessoa, 2008)

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# Emotion as “computing” (or information processing)

- Input
  - Internal states
  - External world
- Processing/evaluation
- Output
  - Internal states
  - External world

Happiness and reward

# Components of happiness

- [Aristotle](#)
- Hedonia
  - Pleasure
- Eudaimonia
  - Life satisfaction
  - Relates to motivation

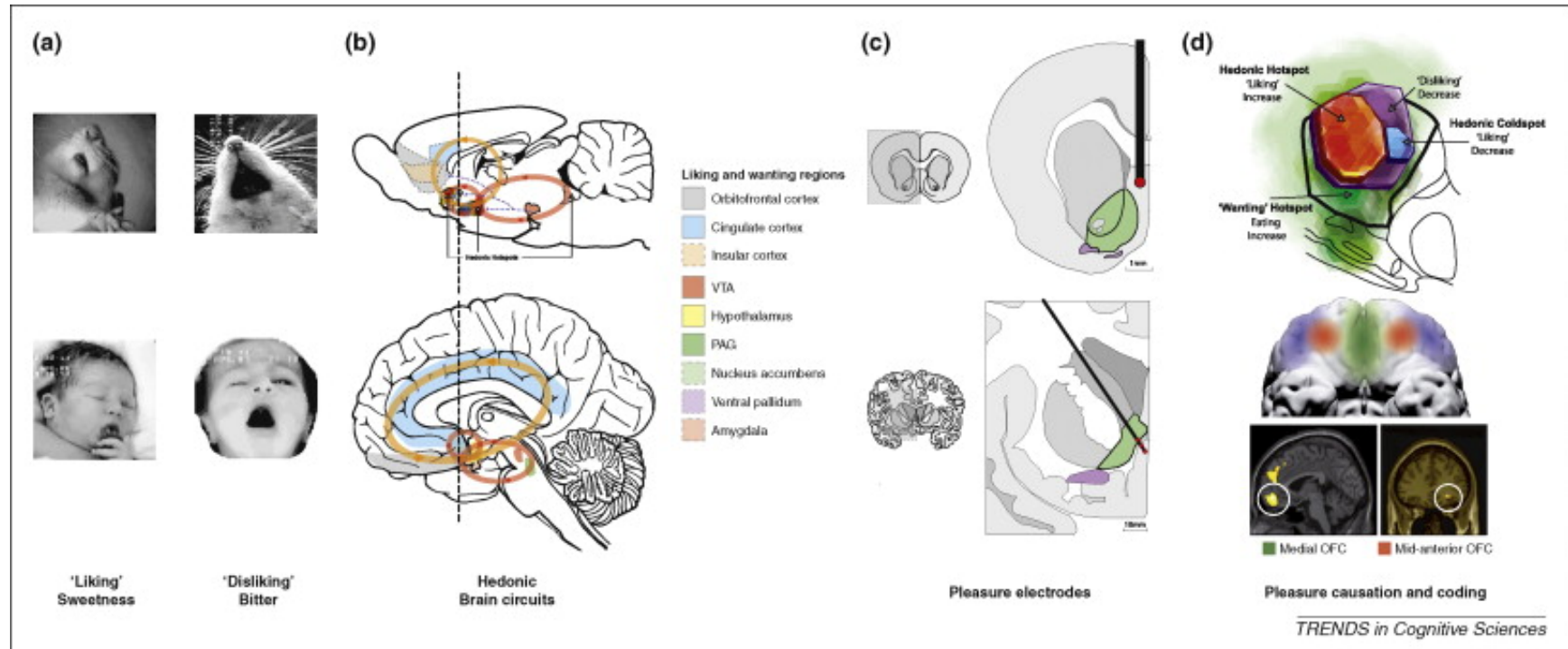
# “Computing” pleasure

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

# Brain mechanisms

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

# Neuroanatomy of pleasure



[\(Kringelbach & Berridge, 2009\)](#)

# Rewards

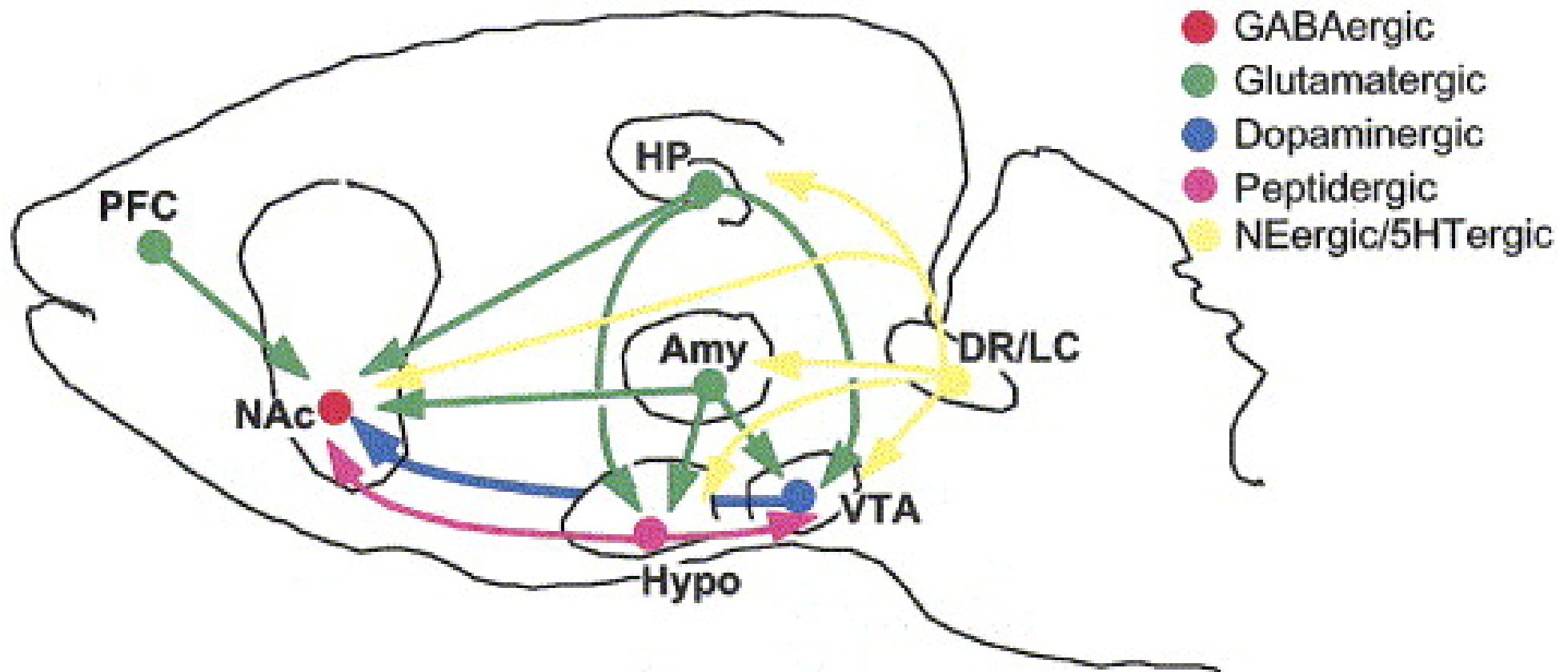
- A *reward* reinforces (makes more prevalent/probable) some behavior
- Milner and Olds ([Milner, 1989](#)) discovered 'rewarding' power of electrical self-stimulation
- ([Heath, 1963](#)) studied effects in human patients.



# Electrical self-stimulation



# “Reward” circuitry in the brain

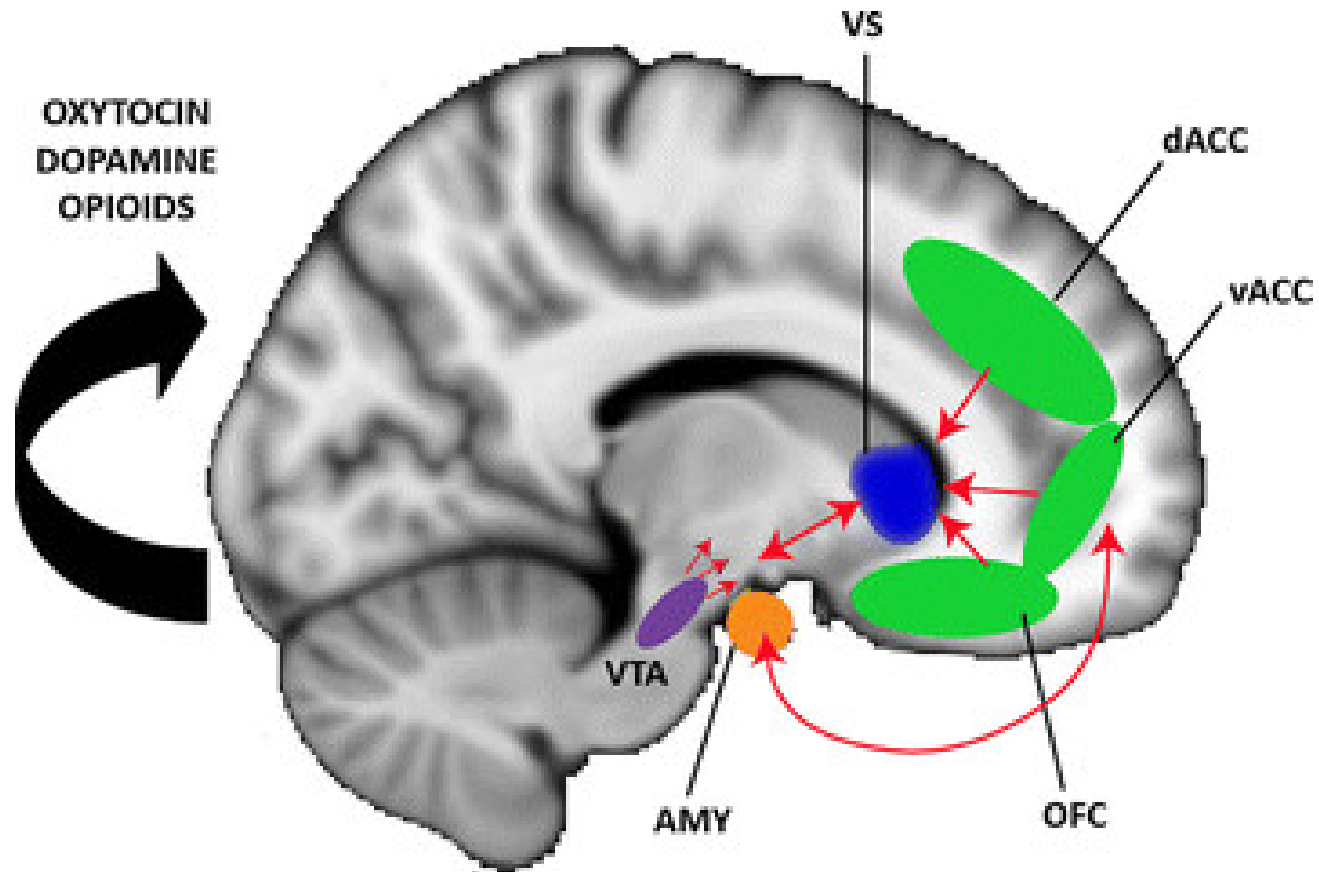


[\(Nestler & Carlezon, 2006\)](#)

# Nodes in the “reward” circuit

- Ventral tegmental area (VTA) in midbrain
- Nucleus accumbens (nAcc), ventral striatum
- Hypothalamus (Hyp)
- Amygdala (Amy)
- Hippocampus (HP)
- Dorsal Raphe Nucleus/Locus Coeruleus (DR/LC)
- Prefrontal cortex (PFC)

# Nucleus accumbens and dorsal striatum

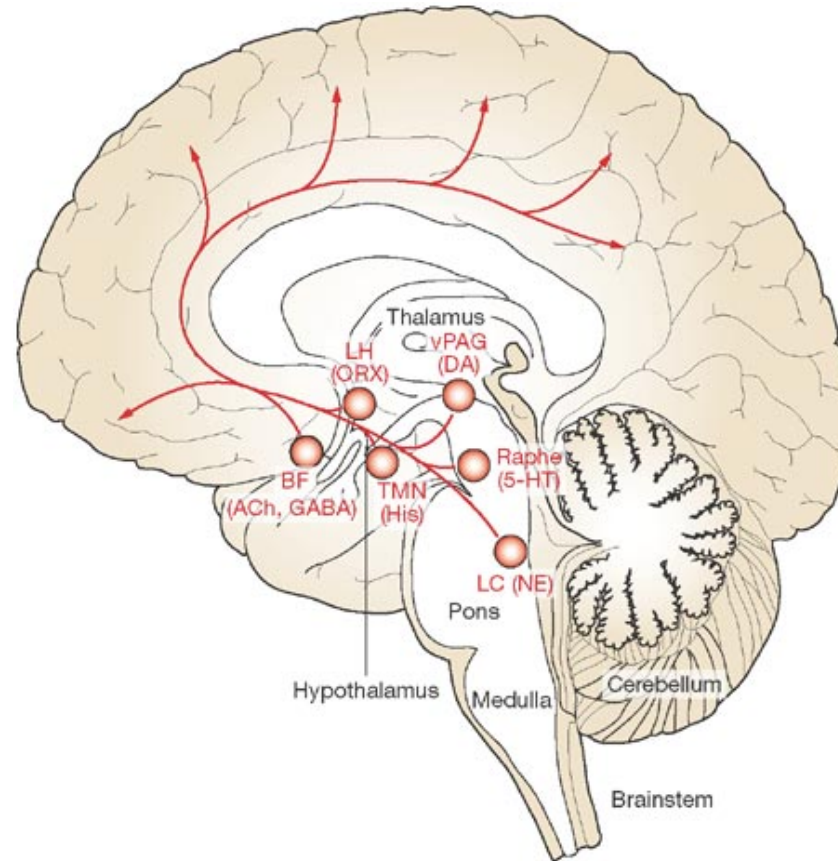


[\(Kohls, Chevallier, Troiani, & Schultz, 2012\)](#)

# Psychopharmacology of 'happiness'

- Dopamine
- Serotonin, Norepinephrine
- ACh

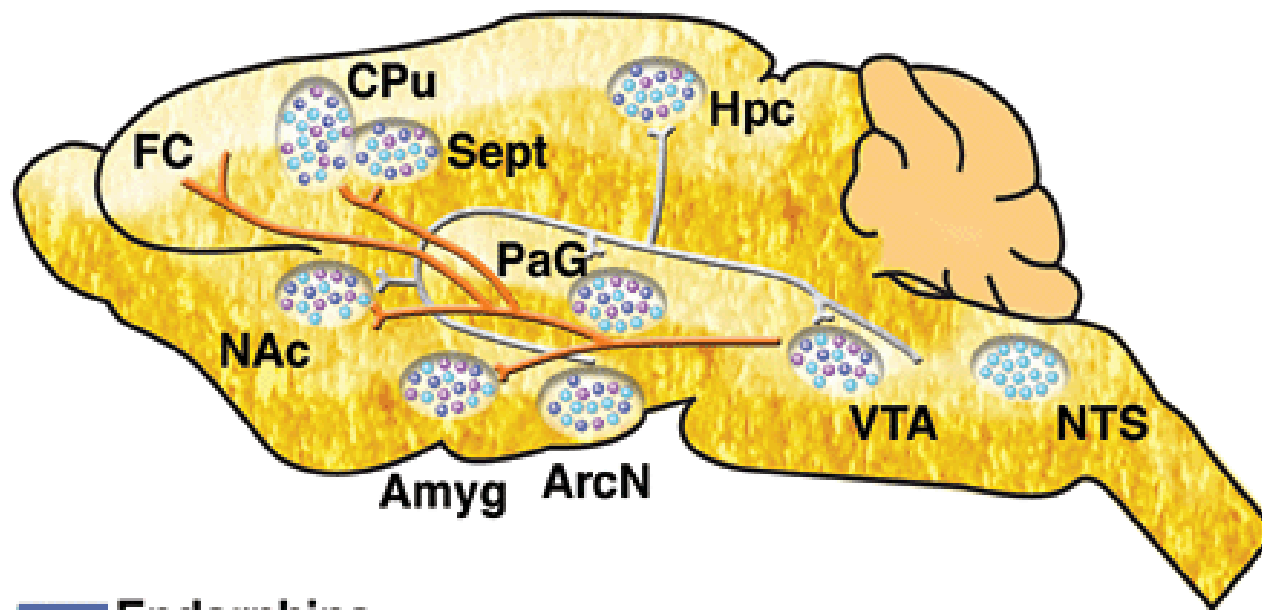
# ACh projections in the CNS



[\(Cock, Vidailhet, & Arnulf, 2008\)](#)

# Brain contains its own systems for binding drugs associated with 'pleasure'

- **Endorphins**: Endogenous morphine-like compounds
  - e.g., morphine, heroin, oxycontin (oxycodone) are opioids



- Endorphins
- Enkephalins
- Dynorphins
- Mesolimbic dopaminergic system

(Clapp, Bhavé, & Hoffman, n.d.)



# Comparative risk

*"A comparative risk assessment of drugs including alcohol and tobacco using the margin of exposure (MOE) approach was conducted. The MOE is defined as ratio between toxicological threshold (benchmark dose) and estimated human intake. Median lethal dose values from animal experiments were used to derive the benchmark dose. The human intake was calculated for individual scenarios and population-based scenarios..."*

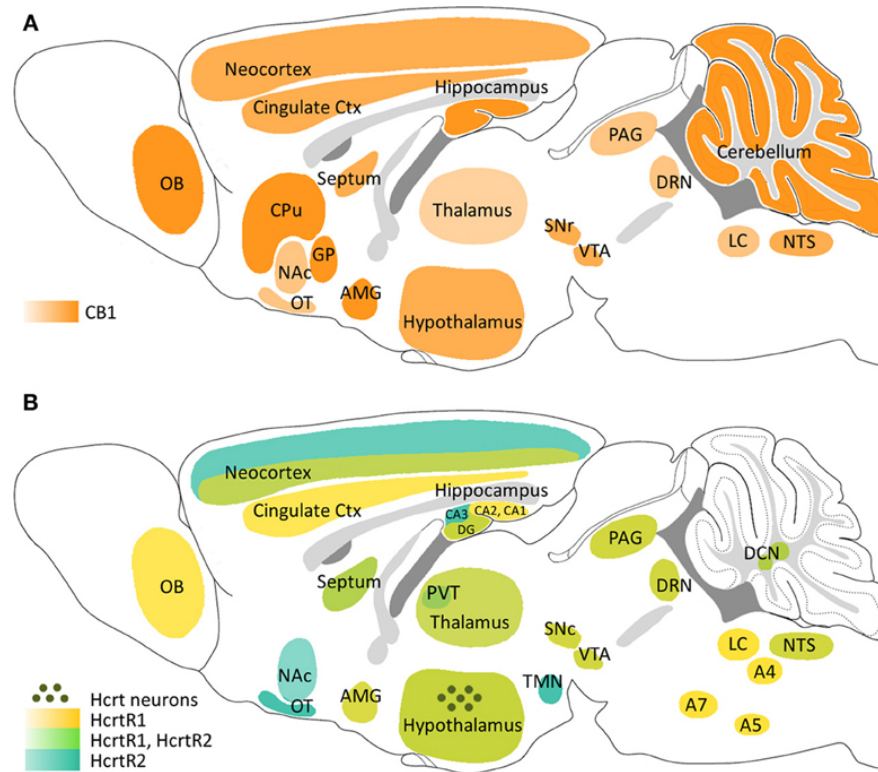
(Lachenmeier & Rehm, 2015)

*"...For individual exposure the four substances **alcohol, nicotine, cocaine and heroin** fall into the "high risk" category with  $MOE < 10$ , the rest of the compounds except THC fall into the "risk" category with  $MOE < 100$ ."*

(Lachenmeier & Rehm, 2015)

# Brain contains its own systems for binding drugs associated with 'pleasure'

- Endogenous cannabinoids
  - Cannabinoids == psychoactive compounds found in cannabis
  - Cannabinoid receptors: CB1 in CNS; CB2 in body, immune system



(Flores, Maldonado, & Berrendero, 2013)

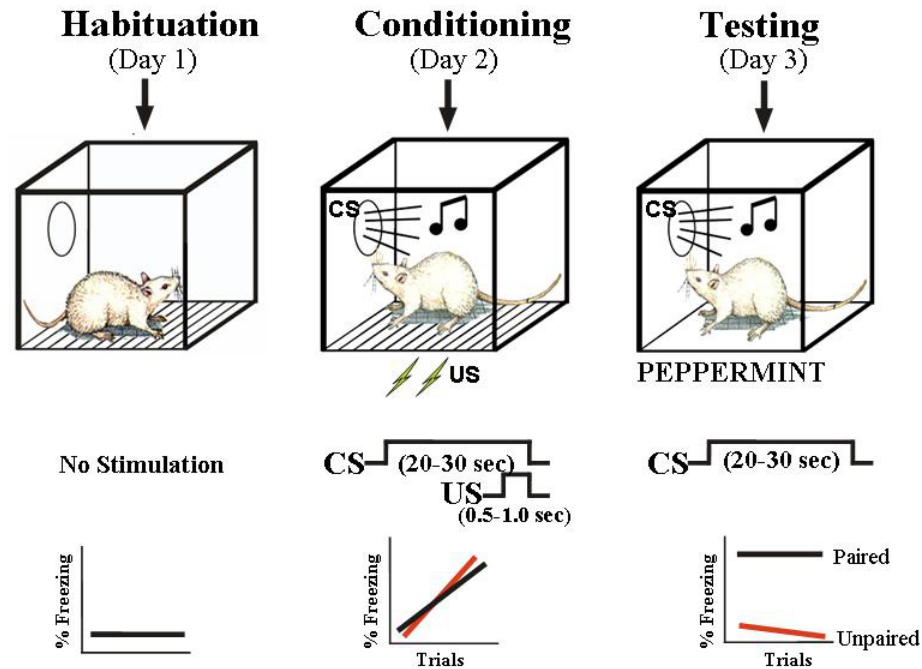
# Generalizations about happiness/pleasure

- 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
- Some exogenous substances bind to endogenous receptor systems

Fear and stress

# Inducing “fear-like” behavior in animals

## Pavlovian Threat Conditioning Paradigm



[http://www.cns.nyu.edu/labs/ledouxlab/images/image\\_research/fear\\_conditioning.jpg](http://www.cns.nyu.edu/labs/ledouxlab/images/image_research/fear_conditioning.jpg)

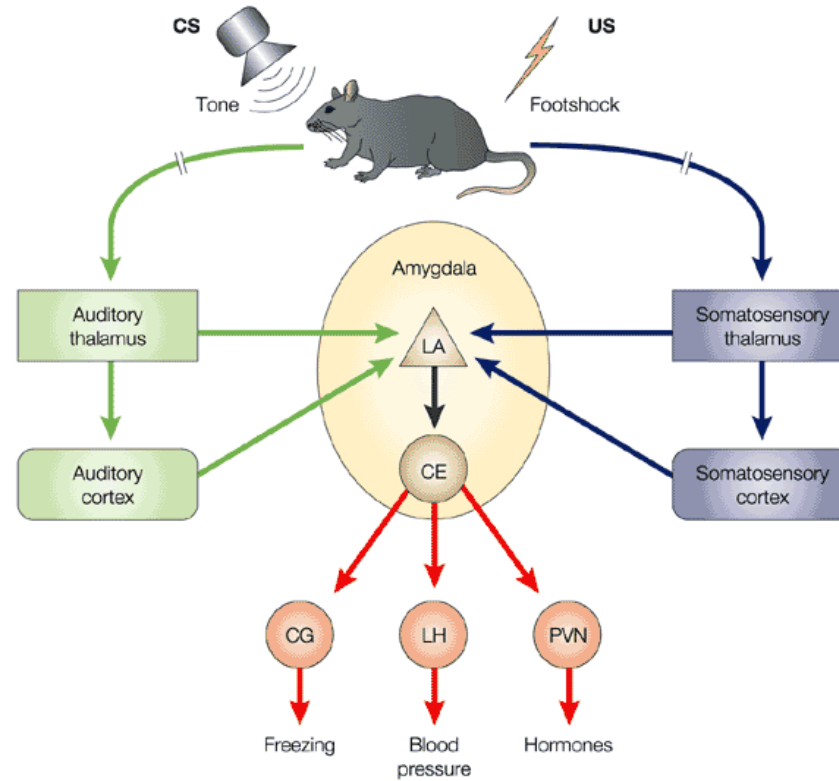
# Rat vs. Human

Measures in Animal Model	DSM-III: Generalized Anxiety
Heart rate increase	Heart pounding
Salivation decrease	Dry mouth
Stomach ulcers	Upset stomach
Respiration change	Respiration increase
Scanning & vigilance	Scanning & vigilance
Startle response increase	Jumpiness, easy startle
Urination	Frequent urination
Defecation	Diarrhea
Grooming	Fidgeting
Freezing	Apprehensive expectation

Adapted from [\(Davis, 1992\)](#)



# Amygdala circuits



Nature Reviews | Neuroscience

[\(Medina, Repa, Mauk, & LeDoux, 2002\)](#)

# Amygdala's inputs

- Convergent inputs
  - Thalamus ("direct" or "fast")
  - Cerebral cortex ("indirect" or "slow")

# Amygdala's outputs

- Project to
  - CG (central gray matter) of tegmentum: behavior
  - LH (lateral hyp): ANS
  - PVN (paraventricular n. of hyp): hormones
- Fast-acting, involuntary responses
- Lesions of amygdala impair 'fear conditioning'

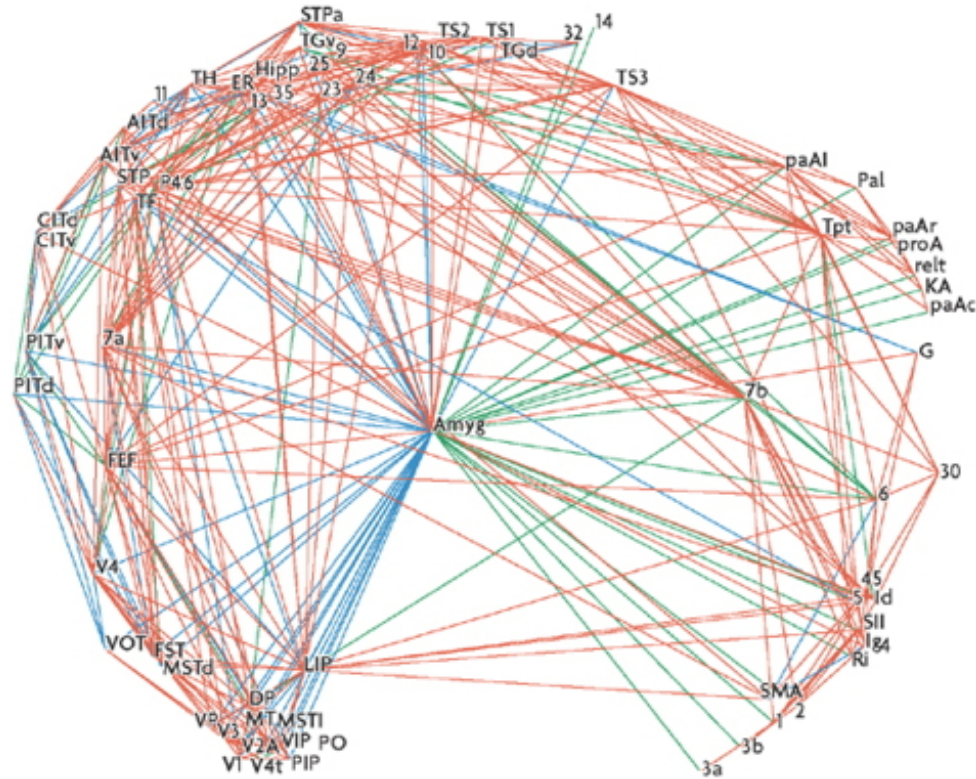
# Cerebral cortex role

- Response discrimination?
  - Cortex lesions cause generalized not cue-specific fear response
- Fast, crude responses vs. slower, detailed ones
  - That's a stick, not a snake!
  - Prefrontal cortex and response inhibition

# But, are we really studying learned 'fear'?

- Amygdala connected to other 'affective' nodes in neural network
- Emotion not just about subjective feelings

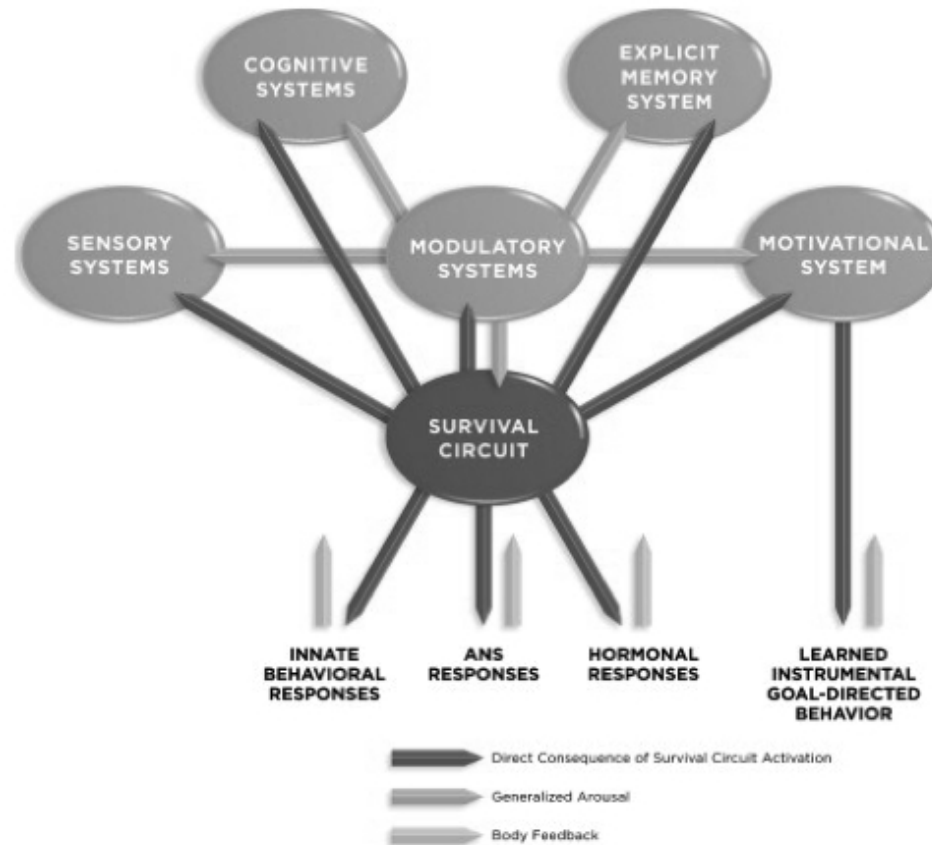
# Amygdala as processing hub



Nature Reviews | Neuroscience

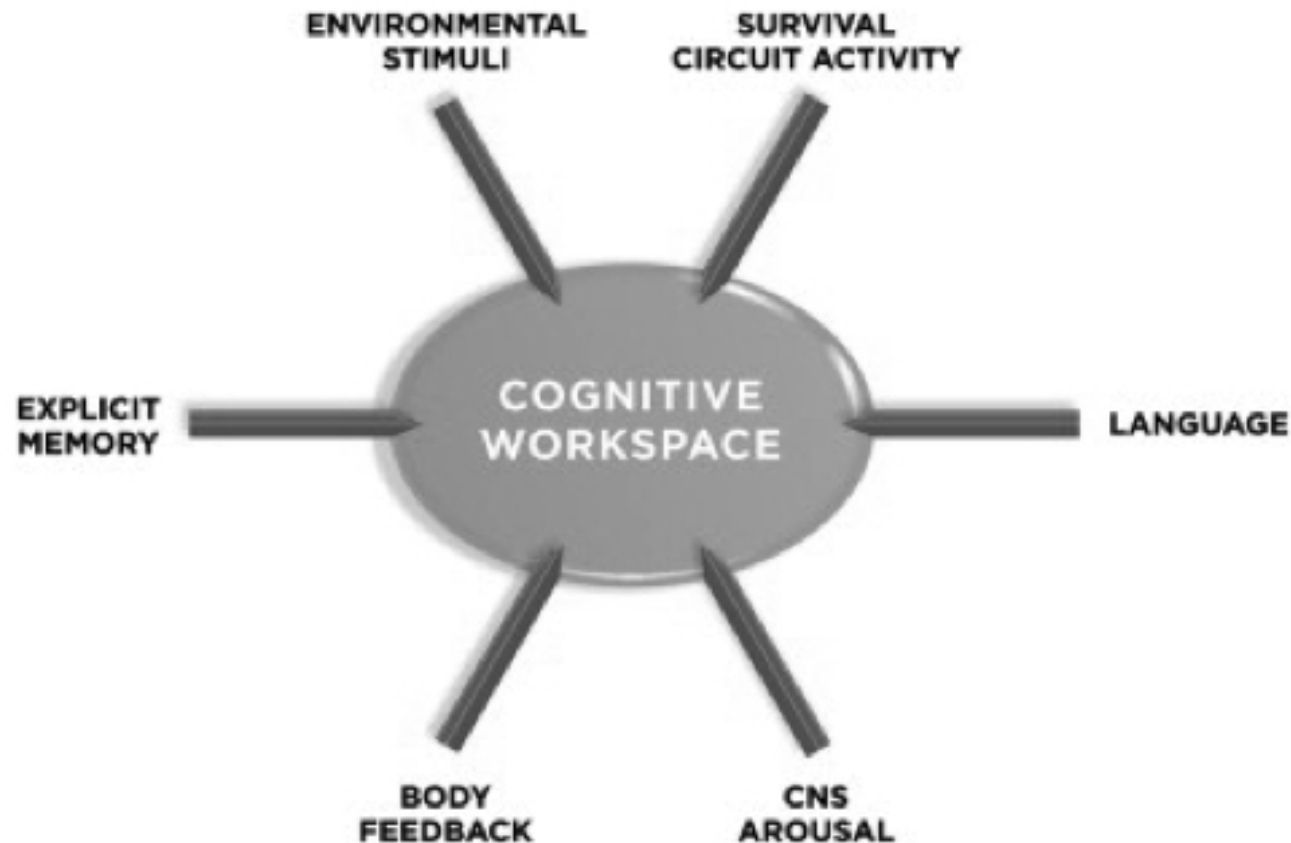
(Pessoa, 2008)

# Amygdala as key hub in circuit for survival



[\(LeDoux, 2012\)](#)

# Emotion as global physiological/behavioral “state”



[\(LeDoux, 2012\)](#)



# Stress



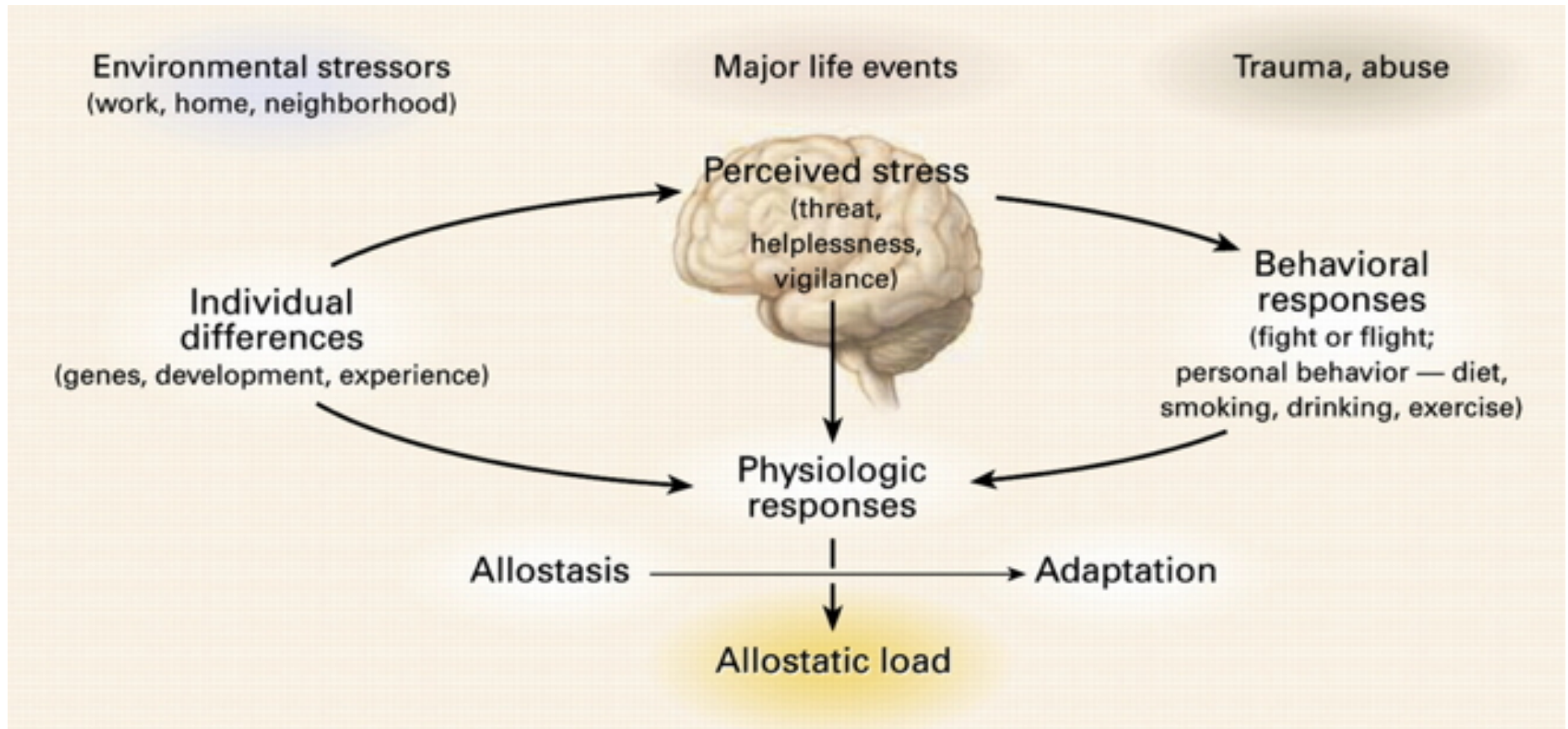
# Stressors linked with biological imperatives

- Sustenance
  - Hunger, thirst
- Well-being/defense
  - Threat

# Stressors linked with biological imperatives

- Reproduction
  - Rejection
- Affiliation
  - Loneliness

# Stress and the brain



[\(McEwen, 2007\)](#)

# Regulating internal states

- Homeostasis
  - Regulation of physiological variables (blood  $O_2$ ) via negative feedback, [\(Cannon, 1929\)](#)
- Allostasis
  - Regulation is active process, anticipatory, varies by circumstance, target levels also vary
- (Sterling & Eyer, 1988), [\(Ramsay & Woods, 2014\)](#)

# Brain under stress

- Acute stress
  - Short duration
  - Fast action required
  - HPA (Cortisol), SAM (NE/Epi) axes
- Brain detects threat
- Mobilizes physiological, behavioral responses

# Brain under stress

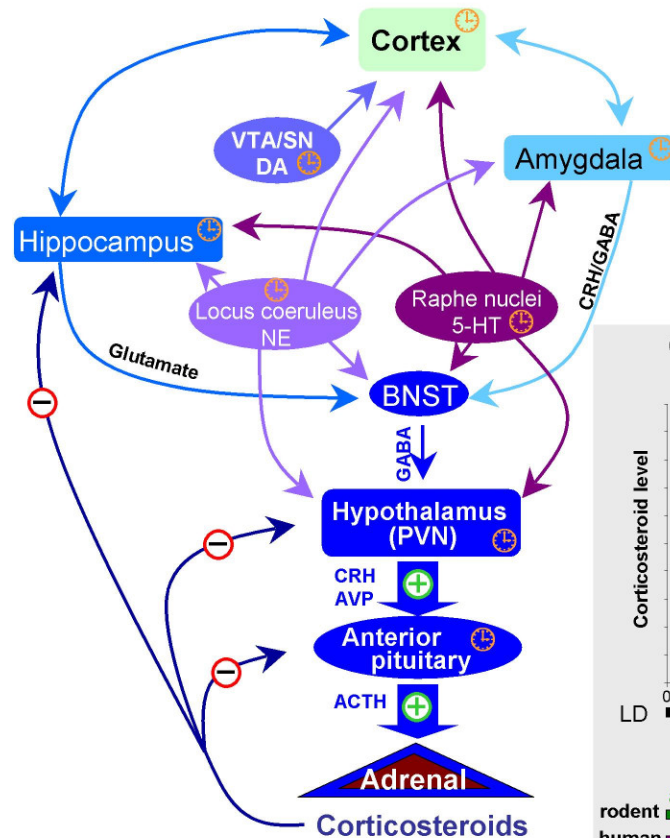
- vs. **Chronic** stress
  - Long duration, persistent

# Glucocorticoids

- Adrenal cortex releases hormones
  - Cortisol (hydrocortisone)
    - Increases blood glucose levels
    - Suppresses immune system
    - Reduces inflammation
    - Aids in metabolism
  - Receptors in brain and body



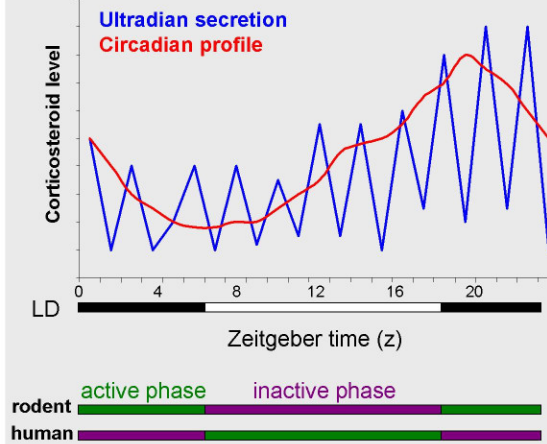
# Cortisol and the brain



## rapid behavioral responses

- memory consolidation and retrieval
- fear and anxiety
- aggression
- locomotion
- vigilance and gating
- reward

## Circadian and ultradian rhythms of corticosteroid secretion



<http://www.molecularbrain.com/content/figures/1756-6606-3-2-1-l.jpg>

# Glucocorticoid cascade hypothesis

- Cort receptors in hippocampus, amygdala, hypothalamus
  - Hippocampus regulates HPA axis via hypothalamus
- Prolonged cortisol exposure reduces hippocampus response
  - Reduces volume, connectivity in hippocampus
- Hip critical for long-term memory formation
  - Chronic stress impairs long-term memory

# But, cortisol -> stress link not straightforward



The screenshot shows the PLOS ONE website interface. At the top, there is a navigation bar with the PLOS ONE logo, links for 'Subject Areas', 'For Authors', and 'About Us', a search bar, and links for 'plos.org', 'create account', and 'sign in'. Below the navigation bar, the article is identified as an 'OPEN ACCESS' and 'PEER-REVIEWED' 'RESEARCH ARTICLE'. The title of the article is 'Higher Perceived Stress but Lower Cortisol Levels Found among Young Greek Adults Living in a Stressful Social Environment in Comparison with Swedish Young Adults'. The authors listed are Åshild Faresjö, Elvar Theodorsson, Marios Chatziarzenis, Vasiliki Sapouna, Hans-Peter Claesson, Jenny Koppner, and Tomas Faresjö. The article was published on September 16, 2013, with a DOI of 10.1371/journal.pone.0073828. On the right side of the article title, there are statistics: 2,086 VIEWS, 3 SAVES, and 117 SHARES. An 'advanced search' link is also visible.

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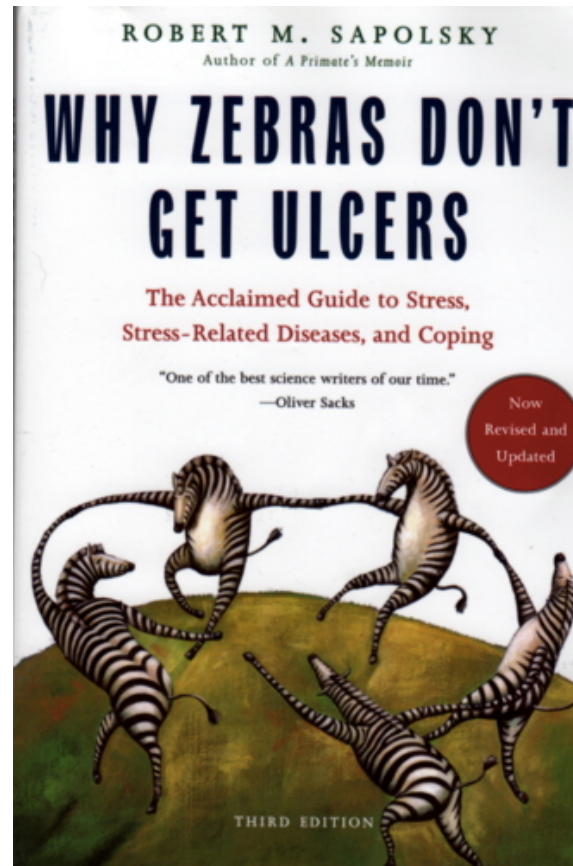
Published: September 16, 2013 • DOI: 10.1371/journal.pone.0073828

[\(Faresjö et al., 2013\)](#)

# Stress and coping across the animal kingdom

- Pain thresholds lower (sensitivity greater) when a mouse's cage mate is also in pain
- Rats will cooperate to release distressed cage mate, foregoing food rewards
- [\(Sapolsky, 2016\)](#)

# Why Zebras Don't Get Ulcers



# Your (zebra) stress ain't like mine

- Phasic (short-term) vs. chronic (long-term)
- Physical stress (hunger, thirst, injury, disease) vs. social stress

# Main points

- Biological approach to emotion
  - Behavior
  - Physiological states
  - Subjective feelings
  - Adaptive function
- Networks of brain systems, multiple NT systems

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