Section 7
Sexual Behavior - Emotion

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COGS 17 A04

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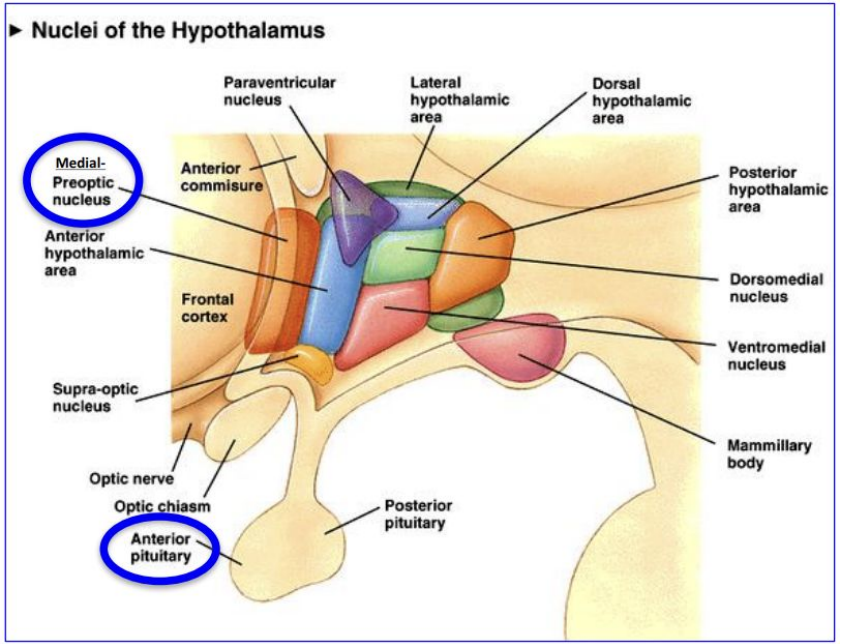
Activating Effects: Males

- Neural and hormonal activation of sexual behavior
- All depend on pre-established organizing effects

Medial preoptic area (MPOA) of Hypothalamus

- releases **GnRH** (Gonadotrophin Releasing Hormone)
  - Anterior Pituitary releases LH and FSH
  - these Gonadotrophins travel through bloodstream → Testes releases testosterone
  - Testosterone feeds back to MPOA to escalate arousal

- Circuit (aka 'Pleasure circuit') includes VTA (Ventral Tegmental Area) → Nucleus Accumbens (NAcc)
  - Releases Dopamine to NAcc in response to sexual stimulation



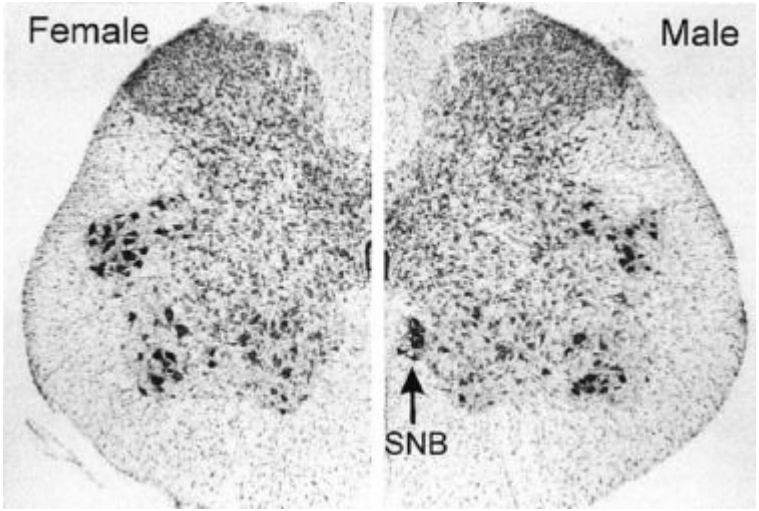
Activating Effects: Males

- Neural and hormonal activation of sexual behavior
- All depend on pre-established organizing effects

Medial preoptic area (MPOA) of Hypothalamus

- stimulates the Basal Ganglia to signal Spinal Nucleus of the Bulbocavernosus (SBN) to cause the rhythmic contractions for ejaculation
- At orgasm, MPOA signals posterior pituitary to release **oxytocin**
- After ejaculation, anterior pituitary releases **prolactin**, leading to a refractory period

- respond to input from medial amygdala which affects aggression and receive Permone input



Photomicrographs depicting the spinal nucleus of the bulbocavernosus (SNB) in adult female (left) and male (right) rats.

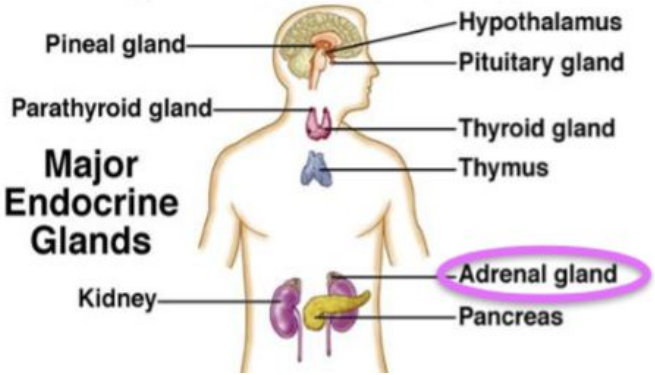
Androgens produced by the perinatal testes rescue SNB motoneurons in males, whereas most SNB cells degenerate in females.

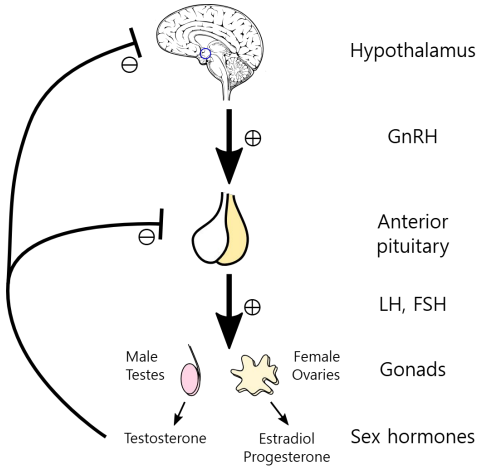
Activating Effects: Female

- **Androstenedione**, an androgen produced by adrenals, for sexual motivation
    - converted into testosterone in bloodstream, activates MPOA

- Then, just as in Males, MPOA → GnRH (Gonadotrophin Releasing Hormone) → LH & FSH → stimulates ovaries and adrenals

- estrogens from ovaries stimulate ventromedial hypothalamus (VMH), most activated during sexual behavior





Activating Effects: Female

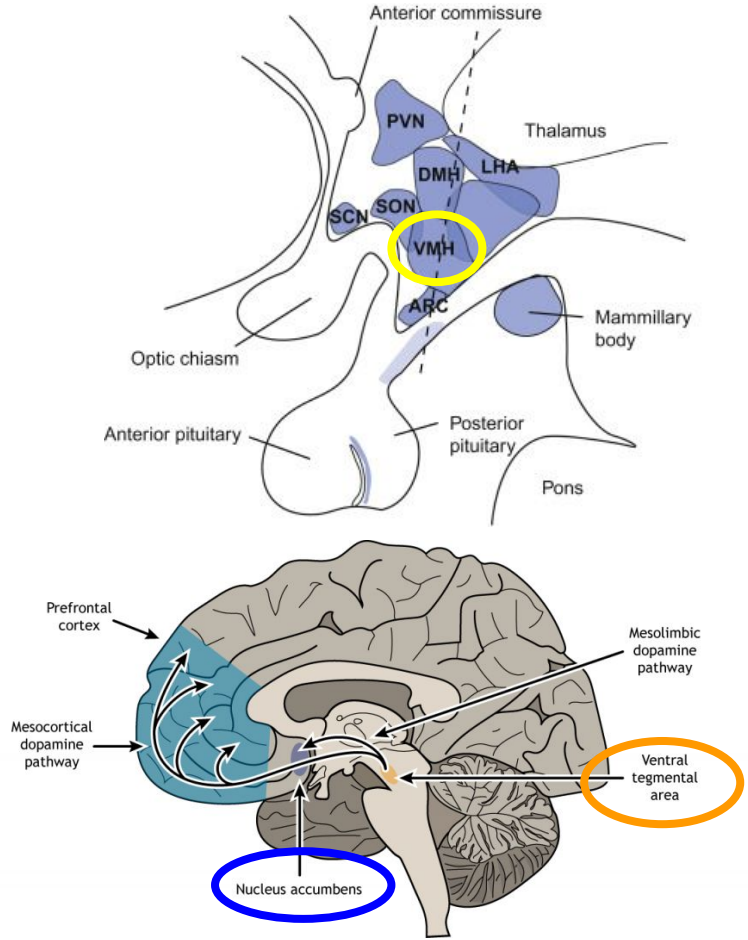
VMH (ventromedial hypothalamus)

- VMH and MPOA stimulate pleasure circuit
  - VTA releases Dopamine to NAcc for reinforcement → Basal Ganglia → SBN for rhythmic contractions (as in males)

- also stimulates Periaqueductal Gray Area which produces Endorphins, in part to suppress pain

- also signals Posterior Pituitary to release **Oxytocin** at time of orgasm
- After sex, females do **not** show same Prolactin (in pregnant females, stimulates milk production) release or Refractory Period.

- also responds to input from Medial amygdala (Pheromones) and from Cerebral Cortex



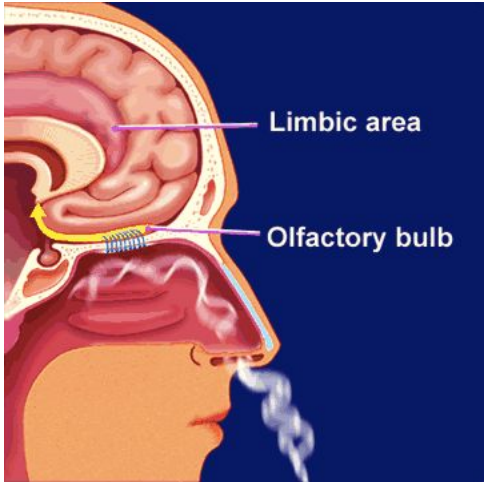
Role of Pheromones in Mediating Sexual Behavior

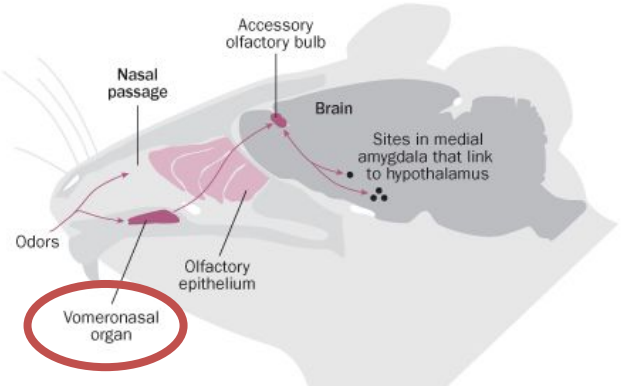
- Limbic (Emotional/Motivation) System plays major role

- **Olfactory bulb** is part of the limbic system: Smell information goes to the amygdala and other parts of the limbic system
  : this is why Limbic system is sometimes called the “Rhinecephalon” (nose brain)

- **Pheromones**: Hormones in sweat which are released into the air to communicate about reproductive states
  - In most mammals, smell controls limbic response
    - Pheromones are detected by specialized olfactory receptors, Vomeronasal Organ which has direct connections to medial amygdala and MPOA

- Unclear if humans (or primates) have a VNO but still respond to pheromones
  - Mice have a more developed VNO and actively respond to pheromones





Emotion

Theories of Emotion

Theories of Emotion

James-Lange Theory (1880s)

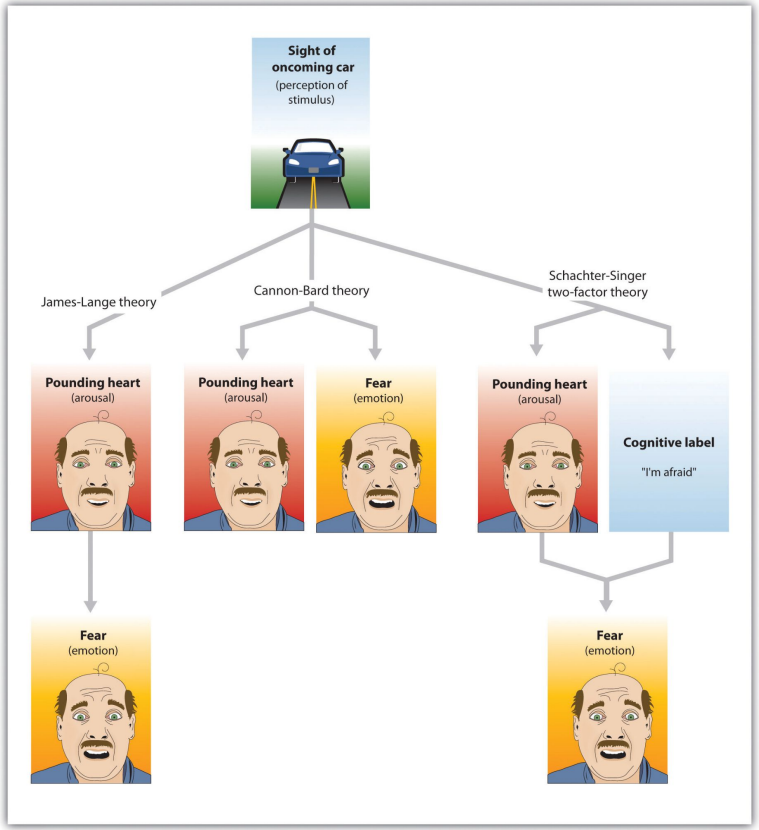
- Emotion = After-the-fact-label assigned to physiological arousal
- Subjective “feelings” are an interpretation we make of our body’s reaction to stimuli

Cannon-Bard Theory (1930s)

- Once threat is perceived, visceral & subjective experience of emotion is simultaneous
- via Perceptual input via Thalamus to Cortex and activation of the ANS (for somatic responses)

Schachter-Singer Theory (1980s)

- Contemporary model based on neuroscience
- Emotion = Interaction between cognitive appraisal and autonomic/limbic activity
- Physiology determines how strong emotion is, but identifying emotion depends on a cognitive appraisal of situation



Emotional Behavior

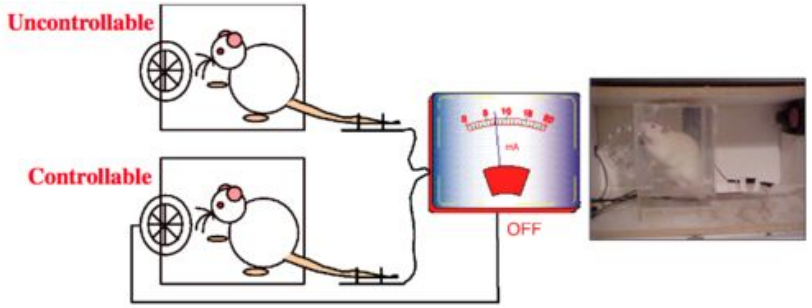
- Judgments of Emotional Stimuli
  - Subjects injected with amphetamine have an exaggerated emotional response to stimuli

- **Facial Feedback**
  - Holding pen in teeth to put face muscles in smile-like configuration → judge comics as funnier
  - Subjects with specific muscle changes without using emotional terms (e.g., “Raise brows”)
    : reported “feeling” appropriate emotions and physiological changes as well (e.g., fear: heart rate up, skin temperature down)

Emotional Behavior

Learned Helplessness

- Condition 1: A rat with a running wheel learns that it can stop the shock stimuli by running in wheel
- Condition 2: The rat without wheel option, becomes depressed ('There's nothing I can do…" or such appraisal of a situation) and developed ulcers from the stress of the shocks
- If the prefrontal cortex is removed, the rate will not become depressed or develop ulcers → appraisal requires higher level cortical activity



Two groups of rats receive tailshock from the same source, The controllable-shock group can terminate the shock by turning a wheel that is mounted in the front of the chamber. The uncontrollable-shock group receives exactly the same amount of shock, but cannot terminate the shock.

Expressing Emotions

Universals

: 6 basic emotions with corresponding facial expressions

Neonatal imitation

- basic emotional expressions mimicked by newborn
- We are pre-wired to practice manipulating the muscles of emotional expression based on behavior of others

… with culture-specific “display rules” for <u>when</u> and <u>whom</u> you may show what kinds and the extent of emotions
→ may depend in part on learned associations

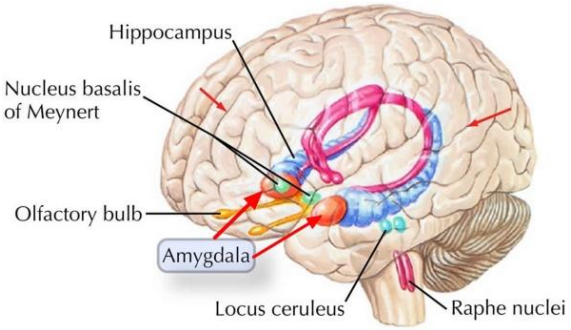
The Limbic System: Amygdala

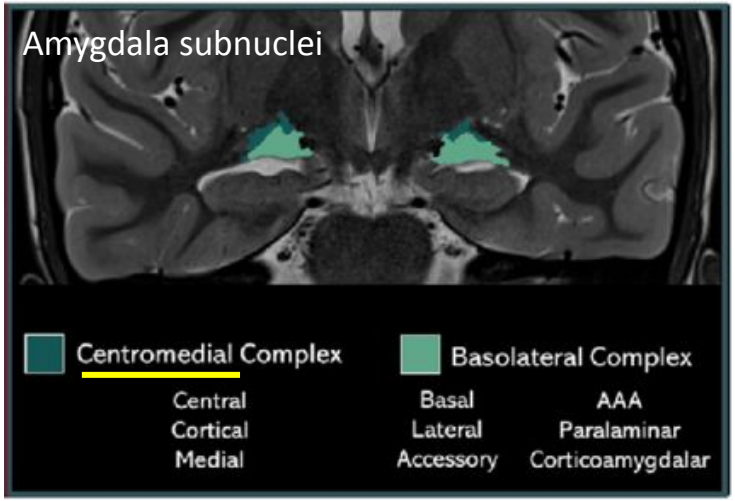
- 'Emotional Center' of the brain: critical in producing & interpreting emotions

- Next to the anterior horn of the hippocampus, directly connected to basal ganglia

- Multiple nuclei with various functions and patterns of connections

1. **Corticomedial** area
   - Direct stimulation leads to anger and rage - most primal emotion that is critical to survival
   - Rabies virus likely affects this area

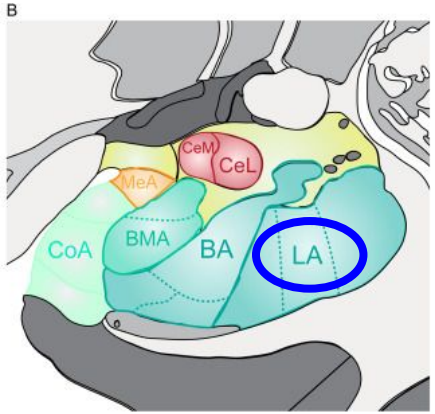




The Limbic System: Amygdala

2. Lateral Nuclei

: Startle reflex (e.g., sudden sound makes rat jump and hunch shoulder, pushing arms from the floor) is influenced by amygdala connections



1) from pain fibers and Visual and Auditory input: to trigger startle reflex, and to detect and learn negative associations

2) to Central gray (= periaqueductal gray) area of midbrain
   - part of tegmentum for motor control, esp. neck muscles
   - e.g., clench these muscles to help protect fragile cervical neurons near surface

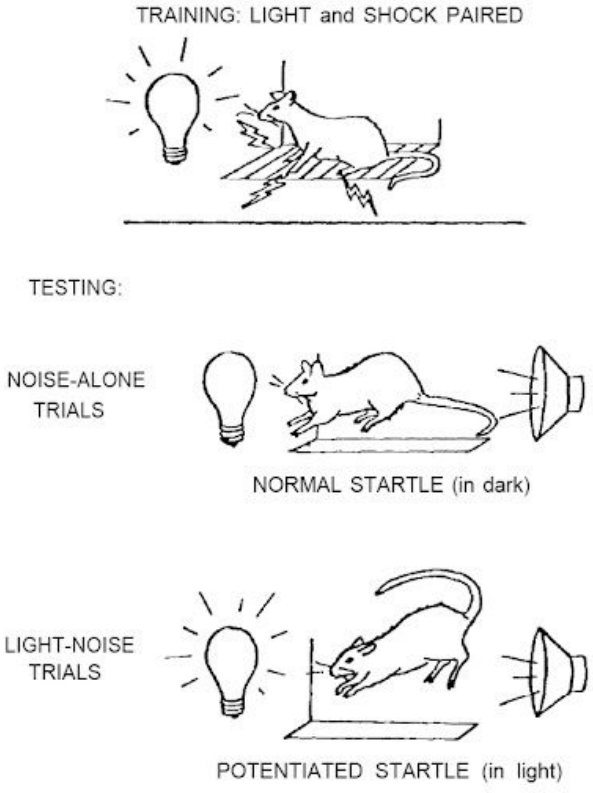
3) to hypothalamus: influences Autonomic NS response (e.g., increase blood pressure, heart rate)

The Limbic System: Amygdala

3. Central and Basolateral Nuclei

- for “conditioned fear” via integrating sensory info (e.g., vision + pain)
- unlearned startle reflex (e.g., loud noise → jump) can be modified via learning
  - light + paired with a noxious stimulus (e.g., shock)
  - light alone does not elicit Startle Reflex
  - but… once association is learned, shock enhances Startle Reflex
  - alternatively, when associated with pleasant stimulus, it will decrease Startle Reflex (e.g., light + soothing warmth→ not jump as high to noise when the light is on)

>> Emotionally-laden stimuli (if it’s not too intense) is remembered better via connections to/from hippocampus



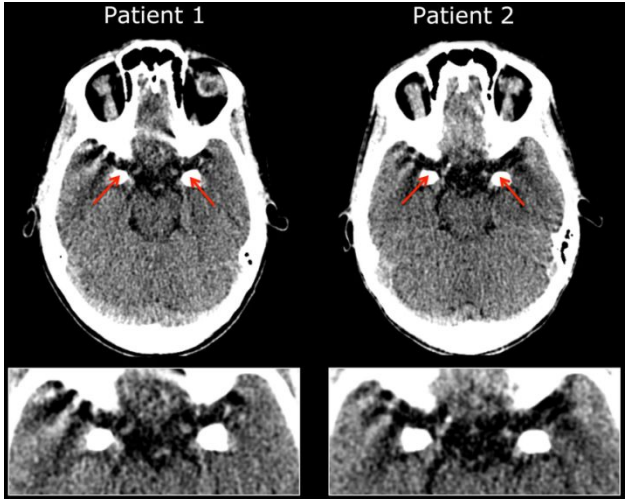
Urbach-Wiethe Disease

- Amygdala is also involved in reading emotions in others
- Urbach-Wiethe involves the calcification of the amygdala which impairs its functions
- Symptoms

1) Patients exhibit a “flattening of affect” with less emotional expression, generally does not experience strong likes/dislikes

2) Impaired ability to recognize facial expressions, esp. fear and untrustworthiness

3) Recognizes individuals, gender, but have trouble naming emotions, judging if face is “approachable” or not

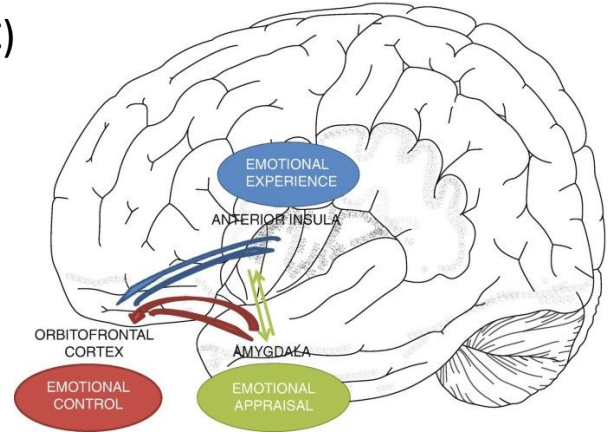


bilateral calcification damage to the amygdala in Urbach–Wiethe patients

Anterior Insula

- on the path from amygdala to the orbitofrontal cortex (OFC)
- connected to hindbrain cranial nerves for control of facial muscles
- includes primary Gustatory Cortex

- vital for **emotional expression in social contexts**

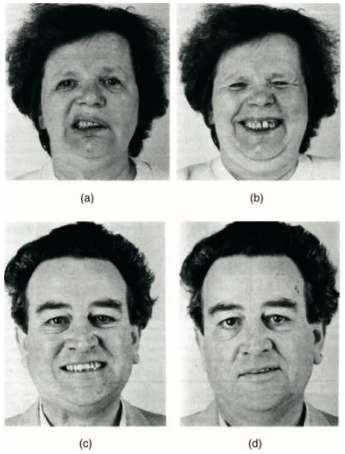


“Emotional Facial Paresis”

- Damage to the left anterior insula
- Can produce a full smile on command but <u>doesn’t</u> spontaneously smile in a funny social situation

vs. “Volitional Facial Paresis”

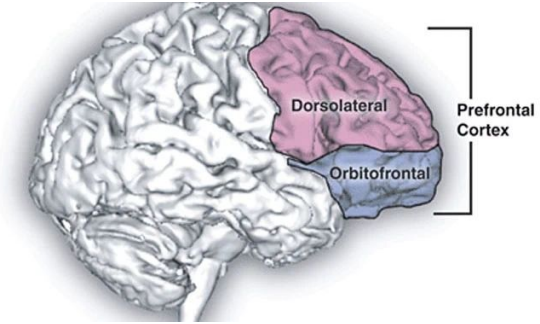
- Damage to the right motor cortex
- <u>Cannot</u> produce a smile on command but can spontaneously smile



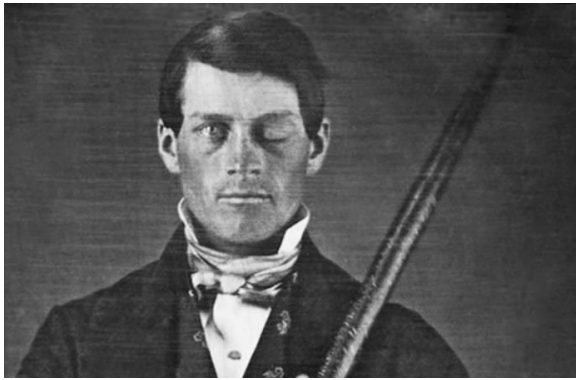
Prefrontal Cortex

- Area anterior to the premotor cortex

- Particularly important for regulating social and emotional behavior (executive functions)
- Damage will lead to loss of inhibition, socially inappropriate behavior, sudden aggression, etc



- **Phineas Gage**
  - Sep 13th, 1848 (25-year-old), was when accident happened where Steel rod damaged most of his prefrontal cortex
  - Cognitive abilities remain intact
  - Personality radically changed, irresponsible, volatile, indifferent to consequences

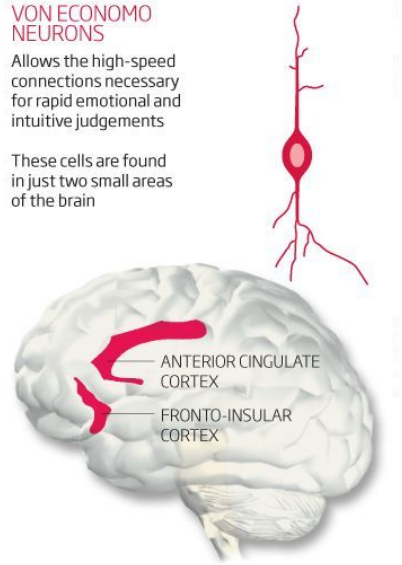


Phineas Gage

Functions of Prefrontal Cortex

- **Theory of Mind**
  - Ability to attribute mental states to self and others
  - Inappropriate reciprocal connections between the OFC and amygdala have been implicated in Autism

- **Von Economo Cells, 'Spindle" Cells**
  - Specialized pyramidal neurons with long fibers, but branch little
  - Found only in large brained animals
  - For communication b/w distant brain areas w/o interference
  - e.g., Anterior Insula with ACC: involved with social risk, cost-benefit analysis



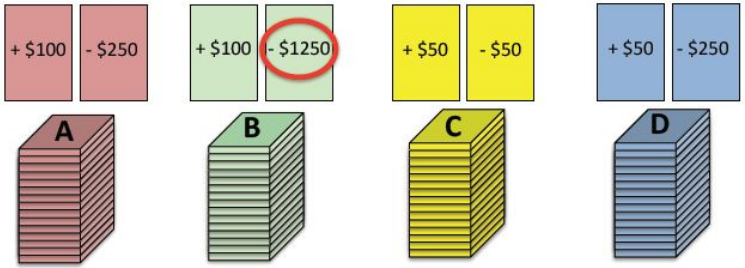
Gambling Task

- Groups: Normal Control, Amygdala-Lesioned, Prefrontal-Lesioned
- Task: Pick cards from one of 4 piles to learn about each pile's payoff/penalty

- Normal Control
  - Shows anticipatory anxiety for picking from Pile B
  - Feels bad at penalty
  - Ultimately learns to avoid Pile B

- Prefrontal Lesioned
  - Does not develop anticipatory anxiety
  - Some negative emotion towards penalties
  - Does not learn to avoid Pile B

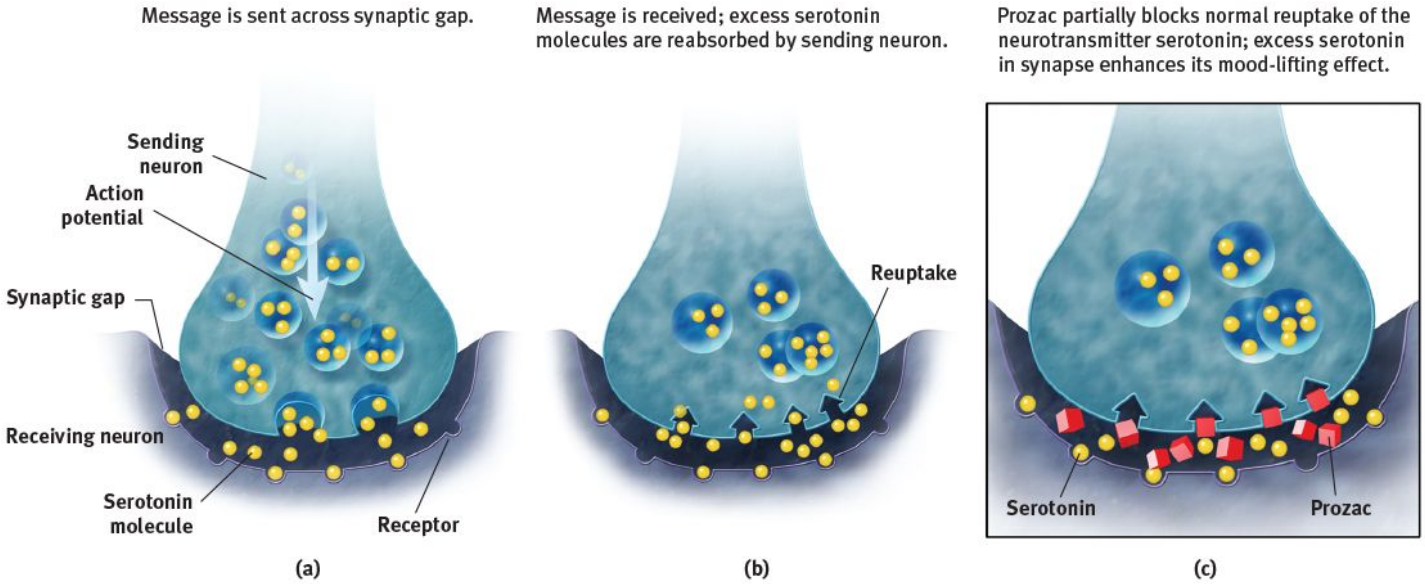
- Amygdala Lesioned
  - No anticipatory anxiety
  - No negative emotion towards penalties
  - Does not learn to avoid Pile B



	Feel Bad at Penalty	Show Anticipatory Anxiety	Shift from Worst (B)	
Normal	+	+	+	
Prefrontal Lesion	+	−	−	Don't Learn!
Amygdala Lesion	−	−	−	

Neurotransmitters and Emotion

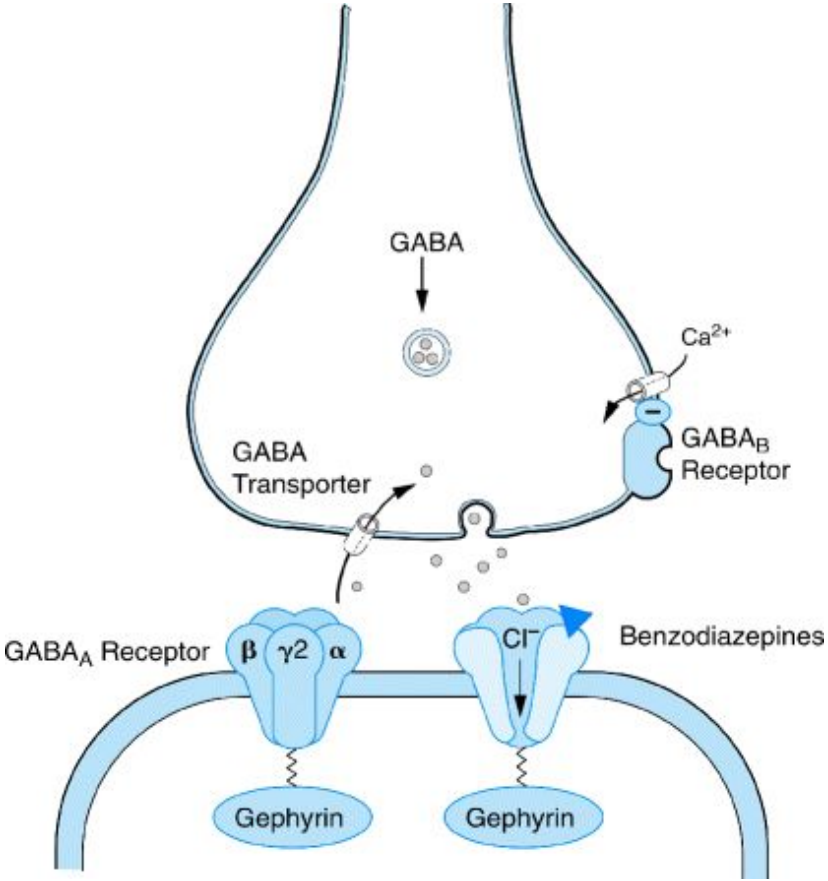
1. **Serotonin (5HT) Turnover**
   - Reuptake & resynthesis, as determined by levels of metabolic byproduct 5-HIAA in blood
   - Low levels of 5-HIAA in bloodstream: linked w/ impulsivity and depression
   - **Antidepressants** like Prozac **blocks reuptake of 5HT**, keeping serotonin active in synapses longer
   - But, long-term use will ultimately make you produce less serotonin



Neurotransmitters and Emotion

2. GABA

- Inhibitory effect on post-synaptic cell by admitting Cl- ions (hyperpolarized cell, more negative)
- in amygdala, this helps suppresses startle reflex and reduce anxiety
- Anti-anxiety drugs like Benzodiazepines (e.g., Valium) act as GABA agonists
    - BZD binds to GABA receptors, increasing inhibitory effect of GABA (more Cl- coming into the cell)
    - enables GABA to bind more easily and for longer to receptor site



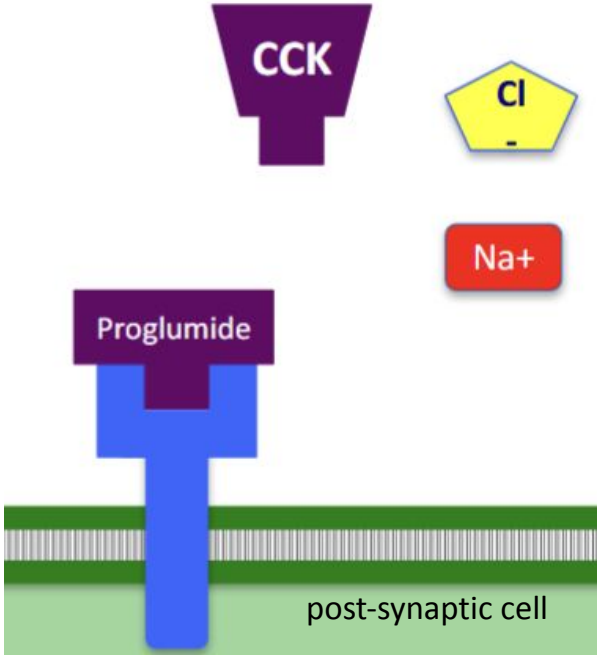
3. Cholecystokinin (CCK)

- Stimulates post-synaptic cells by opening Na+ gates

- CCK in amygdala: involved in learned enhancement of startle reflex
- CCK in hypothalamus: suppresses hunger when blood sugar rises

- Some diet pills are CCK agonists that mimic CCK effects
  - Side effects involve increases levels of anxiety

- CCK-antagonists (e.g., Proglumide) used to treat ulcers can block receptor sites w/o opening Na gates in the hypothalamus. This has a calming effect in the amygdala but promotes overeating



The Science of Emotion in <Inside Out>

So close to the end of the quarter now!