

Lecture 10: Emotion

Theories of Emotion Emotion is hard to study and even to define...

James-Lange Theory (1880s) ...is the label we give after-the-fact to autonomic arousal and associated behavior

- i.e. Our subjective “feelings” are an interpretation we make of our body’s reaction to stimuli

Cannon-Bard Theory (1930s) Once threat perceived, visceral & subjective experience of emotion is simultaneous

- Via perceptual input via Thalamus to Cortex & activation of the ANS (for somatic responses)

Schacter-Singer Theory (1980s) ...is the interaction between cognitive appraisal and autonomic/limbic activity

- Physiology determines how strong emotion is, but ID’ing emotion depends on a cognitive appraisal of situ
- Feedback between variety of brain regions involved (e.g. Prefrontal Cortex, Amygdala, Hypothalamus, etc!)
- That is, influence moves both bottom up (visceral to cognitive) AND top-down (cognitive to visceral)

Behavioral and neurological data support aspects of all of these:

- e.g. Subjects given arousing drug (e.g. amphetamine) - or placebo - and shown scary, funny, or sad images
 - Aroused subjects all reported stronger emotion, but type reported varied with stimuli
- e.g. Subjects hold pen-in-teeth vs. pen-in-lips while judging comics; Rate them funnier if teeth exposed
- e.g. Direct subjects to make specific changes in facial muscles (e.g. Raise brows, pull them together, raise upper eyelids, tighten lower eyelids, stretch lips horizontally) w/o mentioning an emotion
 - When asked, subjects reported “feeling” appropriate emotion (e.g. Above expression => fear)
 - Expressions also produced changes in heart-rate, skin temp, etc. (e.g. Fear: heart up, temp down)
- e.g. Even in rats, individual’s cognitive appraisal will influence it’s autonomic response
 - **Learned Helplessness** under duress can lead to overactive Parasympathetic Rebound,> ulcers
 - 2 rats yoked together, both receive same shocks to tail, until 1 runs in its wheel (other: no wheel)
 - Rat who runs does NOT develop ulcers, but rat w/o active response DOES (even tho = shock)
 - But if non-active rat has Prefrontal lesion, does not appraise self as helpless, does not develop ulcers

COMPLEX! Emotion plays role in all evaluative (discrimination, motivation, learning) & communicative processes

- May depend in part on learned associations, but basic emotional expressions mimicked by newborn humans
 - So, from its inception, emotional expression is **shaped by social interaction**
- PLUS: Facial expressions of basic emotions are similar across cultures, although “display rules” vary

Many brain areas are implicated in the generation and control of emotional behavior...

- Including array of structures of Limbic System, and the Thalamus, the Hypothalamus, and the Frontal Cortex
- Here, we will focus on role of **Amygdala** (part of Limbic System) and **Frontal Cortex**

NOTE: Much more research has been done on responding to aversive stimuli than to attractive ones

- We will discuss circuits involved in “positive reinforcement” in lecture on Learning & Memory

Amygdala - Stimulation of particular regions (most of which interact with each other) leads to typical reactions

- Corticomedial Area => Primed to **Attack**, prolonged inclination toward aggression
 - e.g. Rabies, from a virus that attacks, especially, temporal region of brain => extreme aggression
- Lateral Nuclei => **Startle Reflex** Sudden loud noise => Freeze, Tense neck to protect spine, Inc heart rate
 - Startle Reflex is influenced by Amygdala connections...
 - => from Pain fibers, and Visual and Auditory input, to detect and learn negative associations
 - => to Central Gray Area of Midbrain = Part of Tegmentum for motor control, esp of neck muscles
 - => to Hypothalamus => Influences Autonomic NS response (e.g. inc blood pressure, heartrate, etc)
 - Recall that 2 of the Hypothalamic “4 Fs” = Fighting & Fleeing
- Central & Basolateral Nuclei => **Conditioned fear**, via integration of sensory info (e.g. vision + pain)
 - Unlearned Startle Reflex (e.g. loud noise > !!) can be further conditioned (modified via learning)
 - If visual stim (e.g. light) is paired w/noxious stimulus (e.g. shock) light alone comes to elicit fear
 - Once association is learned, paired signal **enhances the reflex** (i.e. jump higher to noise if light on)
 - In fact, any unpleasant stimulus (e.g. disturbing photo, sound or odor) presented simultaneously, whether or not previously paired with unconditioned (noxious) stimulus, enhances Startle Reflex
 - Alternatively, a paired signal previously associated w/**pleasant** stimulus will **decrease** Startle Reflex
 - e.g. Light paired w/soothing warmth >> Not jump as high to noise if light is on
- All of above aid memory of emotionally-laden stimuli, via connections to/from Hippocampus
 - i.e. Emotion-provoking (esp aversive) images or words, if not *too* intense, remembered better than neutral
- Contemporary research on Amygdala focused on **shared emotion**
 - Amygdala active not just when feel/express but also when observe emotion in others
 - e.g. In many primates, infants *learn what to fear* by watching/imitating mother’s reaction

- **Urbach-Wiethe Disease** = degenerative calcification in Amygdala, (or other damage) can lead to...
 - Impaired ability to **recognize Facial Expression**, especially fear and untrustworthiness
 - Patients recognize individuals, gender, but trouble naming emotion, judging if face is “approachable”
 - May be related to disinterest in eyes; forced to consider eyes only, judgments are a bit better
 - Patients generally placid, do not experience strong likes/dislikes, act less timid in strange environment
- Overall, Amygdala seems particularly involved in mediating critical soc (e.g. aggression, mating) interactions and learning/responding to these and other potentially threatening or exciting stimuli

Anterior Insular Cortex (medial to anterior Temporal Lobes; also includes primary Gustatory Cortex)

- Damage => impairs recognition & production of Disgust; Co-opted in humans as a social reaction
- This area also connected to hindbrain cranial nerves for control of facial muscles
 - Damage=>Patients can show teeth voluntarily, but cannot spontaneously smile
= **Emotional Facial Paraesis**
- Contrast to Primary Motor Cortex for facial area and/or its connections to facial nerves
 - Damage=> Patients can spontaneously smile, but cannot show teeth voluntarily
= **Volitional Facial Paraesis**

Frontal Cortex - Has many reciprocal connections with Amygdala, moreso than any other cortical area

- Important in expressing, inhibiting and reading emotion...
 - **Prefrontal Cortex** Damage > loss of inhibition, socially-inappropriate behavior, sudden aggression
 - Famous example: **Phineas Gage**, survived steel rod through cheek, in/out of Prefrontal Cortex
 - Cognition ok but “personality” radically changed, irresponsible, volatile, indifferent to consequences
 - Contemporary work implicates Prefrontal in **Theory of Mind** = attribute knowledge, emotion to others
 - Inappropriate Prefrontal-Amygdala interaction may be critical in **Autism** (involves ToM deficits)
 - ? May result from premature devel of Prefrontal, *before* sufficient connections with Amygdala?
 - **Gambling Task**: Consider diff performance of Normals, Amygdala-Lesioned & Prefrontal-Lesioned subjects
 - Task: Pick cards from 4 piles to learn about each pile’s payoff/penalty profile
 - 2 have good payoffs but very bad occasional penalties. Other 2 have smaller payoffs & smaller penalties
 - After some experience with this task...
 - Normals feel anxiety before taking from bad piles & shift to better, even before can explain decision
 - Prefrontal-Lesioned – Do not develop anticipatory anxiety or shift, tho show neg emotion at penalty
 - Amygdala-Lesioned - No anticipatory anxiety, no shift, no feeling negative emotion at penalty
 - **Von Economo** (“Spindle”) Cells
 - Long fibers, but branch little – for communication between distant brain areas w/out intervening influence
 - Found only in large-brained animals (humans, elephants, whales)
 - e.g. Connect Anterior Insula with Anterior Cingulate (social risk, cost/benefit analyses)

Neurotransmitters implicated in the generation and control of emotional behavior:

Serotonin (5HT) Turnover = reuptake & resynthesis, as determined by levels of metabolite **5-HIAA** in blood

- **Low** Serotonin Turnover associated with increased levels of impulsive behavior including...
 - Sudden aggression, rapid cocaine addiction, no pause at choice pts, poor delayed gratification, etc.
 - Also associated with (esp seasonal disorders that can lead to) depression & suicide
 - Recall that drop in Serotonin associated w/crankiness that arises when overdue to begin sleep cycle
- Anti-depression drug **Prozac** blocks 5HT re-uptake, prolonging synapse
 - Though problematic long-term, since, when use less serotonin, produce less, exacerbating problem

GABA = Inhibitory NT, hyper-polarizes cell by admitting **Cl⁻ ions**, affects emotion in Amygdala & Hypothalamus

- Most anxiety-reducing (axiolytic) drugs are Benzodiazepines (e.g. Valium, Xanax), act as **GABA-agonists**
 - Most GABA receptor sites also bind Benzo’s, enables GABA to bind more easily and longer
 - Note: Decreases both own experience of anxiety and how perceive anxiety in others!
- In contrast, **blocking** of GABA sites in Amygdala can lead to **Panic Attacks**

CCK - Stimulation of (excitatory) CCK sites in Amygdala => enhanced Startle Reflex

- CCK an NT/Hormone also involved in appetite suppression, released after eating when blood sugar rises
 - Some diet pills are CCK-agonists w/side effect of anxiety; Antagonists calming, but promote overeating