


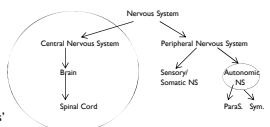
I feel with my brain

Neurobiology & Emotion




Central Nervous System

- Central Nervous System
- 100 billion neurons in the brain
- Each with 10-150 **thousand** connections



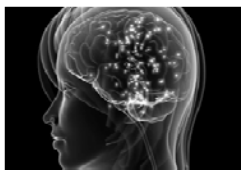
- Different brain regions specialize in 'duties'
- Neurons link within brain and link brain to body
- Longest neuron starts in spinal cord and reaches to big toe



- Information travels via electrical/ chemical means
- Over 50 known neurotransmitters
- Neurotransmitters are active in brain & body



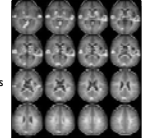
Mapping the Brain

- Structure
 - Autopsy & surgery
 - Neuro-imaging
- Function
 - Disease Outcomes
 - Electrical stimulation
 - Pharmacology



Digression: Ways we study the Brain

- Measures of Brain Structure
 - MRI & CT scans
- Measures of Brain Function
 - Lesion Studies
 - Electrical Activity/ EEG
 - Hard to use in emotion research
 - Functional Magnetic Resonance Imaging & PET scans
 - Size and precise location of structures varies in individuals
 - Large differences in rates of metabolism in individuals
 - Neurochemistry/ Pharmacology

Let's do a brief intro

- Some basics

The search for an emotion organ

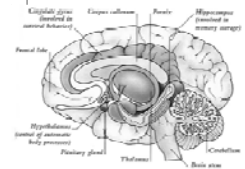
- Recall Cannon's work on cats

Event → [implied: appraisal] → [thalamic arousal] → feelings

- Suggested the Thalamus as 'the organ'
- Thalamus generated emotion
- Cortex inhibited it

- Hess' work on primates

- Suggested it was the hypothalamus

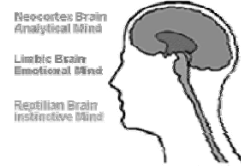


The search for an emotion system

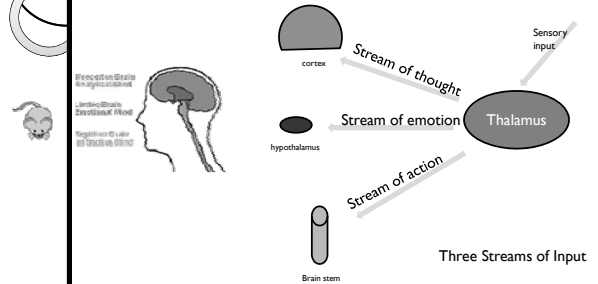
- Paul Maclean, 1952, 1993

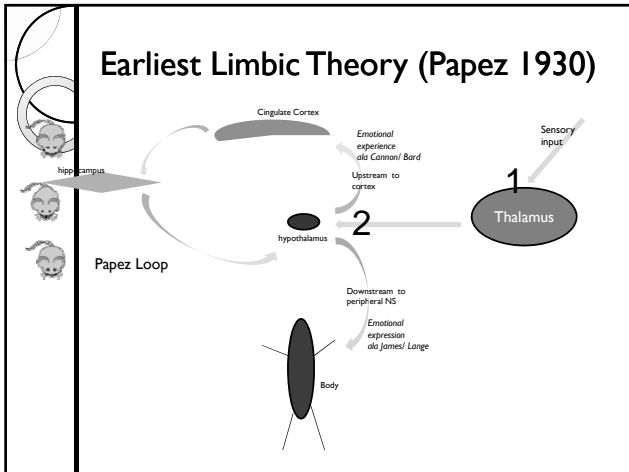
- Primate/ Cortex
- Mammalian/ Limbic
- Reptilian/ Brain Stem

- limbic regions have been linked to emotional responses
- Not clear it's a truly distinct region



Papez, 1937 Inspired MacLean





Are there 3 distinct regions?

- Lower structures of the brain have been proven to be involved in emotion – a limbic region

But

- The separate levels of brain have been hard to define
- The functions of the regions are not clearly separated

Perhaps

- Limbic System is better thought of as a guide rather than as a literal brain region
 - Emotion probably evolved earlier than cognition and may at times (but not always) function independently

Modern Emotion System Theories

- Cingulate cortex
- Fornix
- Mammillary bodies
- Hippocampus
- Amygdala
- Septum/ Nucleus Accumbens
- Ventral tegmental area (VTA)

Sometimes also included:

- Hypothalamus
- Thalamus
- Basal ganglia


Studying the Amygdala

- Electrical Activity
 - Stimulate amygdala – fear
 - (stimulate septum, another limbic region – approach)
- fMRI activity
- Lesions/ Disease/ Surgery
 - Klüver-Bucy Syndrome – removal/ damage of temporal lobes, including amygdalae
 - Monkeys/ Rats/ Humans
 - Temporal Lobe Stroke
 - Correctly rate pleasant and unpleasant photos
 - Don't show the attendant physiological arousal

How can you not love a face like that?


Amygdala and Rats

- Joseph LaDoux
- NYU neuroscientist



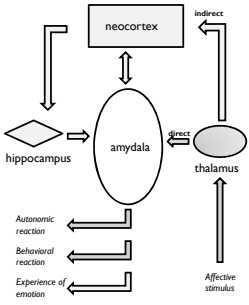
Joseph LaDoux, with his band 'The Amygdaloids'

- Rat and shock paradigm
 - Learn the emotional significance of events
 - Fear is quick to learn/ slow to extinguish
- With amygdala and hypothalamus present – learn fear
 - True even if cortex has been removed !!
 - amygdala 'processes' sensory input w/o cortical input
- With amygdala anesthetized, limited fear response

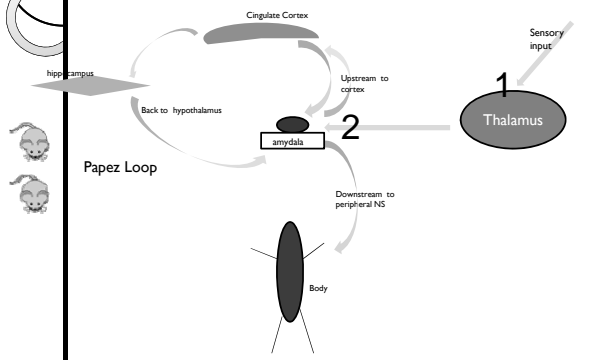


LaDoux's important discovery!

- Amygdala Emotional Appraisal Function
- Two routes
 - Direct/ no cortical involvement
 - Fast/ primary/ implicit
 - Expression of emotion
 - Indirect/ involves cortex
 - Slower/ secondary/ explicit
 - Explicit memories created
 - Experience of emotion




Remember this? (Papez 1930)



Papez Loop

Amygdala & Social Aggression

- Pribram, 1954
 - Removed Amygdala of dominant monkey
 - Fell to the lowest position
- Has been used to treat antisocial behavior in criminal humans (1960's)
 - Inject solution to kill all/ part of amygdala
 - Reduces aggression, hyperactivity/ seizures
 - Legal in some states/ tight restriction



Conclusions & Summary

- Amygdala key in directing attention to potentially unpleasant stimuli
- Key in emotions of anger & fear
- Key in aggressive social behavior



Is it really that complex?

And...

- It can process input both cognitively and non-cognitively

The Amydala's friend Hippocampus

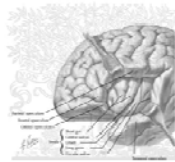
Hippocampus means seahorse in Greek

- The hippocampus is "the great 'integrator'"
 - Integrates pieces of a memory
 - Self in space
 - Self across time
- Amygdala helps hippocampus integrate emotional elements into memories – and 'tag' emotional memories for rapid retrieval
- Formation of vivid episodic memory (and some believe factual memory also)
- Interesting...



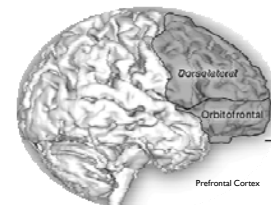
Insular Cortex (Insula)

- Experience of disgust/ fear
 - (same location for sense of taste)
- Appears to be sensitive to visceral sensations
 - Can you relate this to James' theory?
 - Interestingly, also associated with 'mirroring' another's emotion via empathy



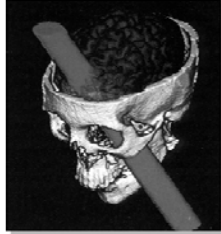
Prefrontal Cortex

- Executive function, regulation
- Inhibition of impulses
- Use of emotion in decisions
- When damaged
 - Damasio, 2002
 - Prefrontal patients (accidents)
 - Flat emotional/ poor decision-making
 - Impulsive/ low empathy
 - One example



Phineas Gage

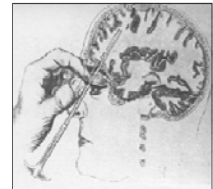
- Railroad worker
- Accident/ iron rod pierced his brain
 - 9 cm hole in skull
- Damaged orbitofrontal cortex
- After –
 - erratic emotions/ rage,
 - irreverent,
 - impatient



Your next Halloween costume?

Frontal Lobotomy... Ouch!

- Developed in 1949
- Used significantly after WWII
- Largely abandoned as a procedure
- Cutting the links between the prefrontal cortex and the limbic region
 - Blunted affect and lessened anxiety, as we would guess
 - Loss of emotional component of thought
 - But also, led to lowered inhibition & morality



Understanding the Prefrontal Cortex

- Linked to inhibition of emotion/ behavior
- Linked to use of emotion to guide decision-making
- When it is damaged
 - creates insensitivity to rewards and consequences
 - inability to *anticipate* the emotional outcomes
 - inability to *properly weight* others' emotional reactions
 - No motivation to inhibit
- Creates overwhelming indecision

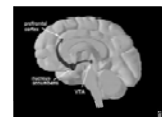


PFC vulnerable during accidents



Chocolate Anyone?

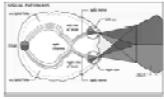

- Nucleus accumbens
- VTA (ventral tegmental area)
- Activated by anticipation of rewards
- fMRI study
 - Saw shapes tell the probability and size of a possible gambling win or loss
 - N.Accumbens active to size of win (but not loss)
 - Prefrontal active to probability of win



Reward Circuitry

Brain Lateralization


- **Facial** emotion recognition in right brain
 - Faces flashed to left visual field recognized more
- **Right brain**
 - Develops earlier/ attuned to emotional processing
 - Initially separate from the left brain (verbal & analytical)
- **Valence is lateralized**
 - Davidson, 1992
 - EEG studies – punishments register in right brain; rewards in left
 - Schiff (1994) – squeeze ball in left hand 45 seconds - sadness
 - 'lead with the right' --- reward/ approach will be left brained

Are the colors right?


Very interesting...

- Lateralization
 - most likely aided survival
 - Negative/ positive separated
 - Different hemispheres
 - Different structures in limbic system
 - Different action choices (approach/ avoid)




Neurochemicals

- Three overlapping families
 - Synaptic release – rapid, specific
 - Hormones – slower, long lasting
 - Neuromodulators – diffuse
- Drugs mimic neurochemicals
- have effects on emotion
- Can be used for altering emotion



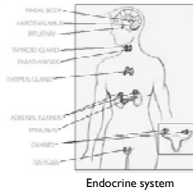
Neurotransmitters

Type	impact	
Acetylcholine	Excitatory & Inhibitory	Parasympathetic nervous system, brainstem
GABA Gamma aminobutyric acid	Inhibitory	Brain
Dopamine	Excitatory	Brain, smooth muscle
Norepinephrine	Excitatory	Brain, smooth muscle
Serotonin	Excitatory	Brain, smooth muscle
Beta Endorphins	Inhibitory	Brain, spinal cord



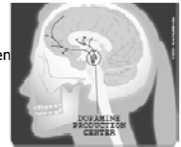
Hormones

Type	Triggered by	Impact
Vasopressin	Low BP	Re-absorption of water
Cortisol	Stress	Activate PSN
Oxytocin	Gentle Touch	Caregiving & Love
Adrenaline	Stress	Activate PSN



Dopamine

- Animal research (rats)
 - Desire/ motivation for rewards
 - Release of dopamine in nucleus accumbens
- Liking/ gratification by rewards
- Release of opiates in nucleus accumbens



Application to attachment

Application to addiction/ watch this

Serotonin

- Produced by brain stem
- Used broadly throughout brain and body
- Been implicated in mood
- Increased serotonin via SSRI's
 - improves mood
- People with low levels of serotonin (measure by metabolites)
 - Become more impulsive/ inhibit negative impulses less
- Drugs that increase serotonin
 - Positively impact mood and sensory experiences



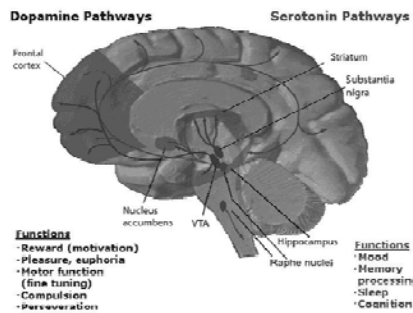
Gut Instincts?

- Serotonin stimulates
 - Movement of food in digestion
- Peptide called CCK (cholecystokinin)
 - Released in intestines in response to fats – lead to satiation
 - In small amounts it inhibits meal frequency/ size
 - In larger amounts it stimulates fear and panic attacks



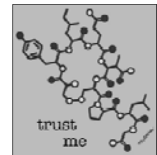
Of Note, many gastrointestinal peptides also influence neurons in CNS. There are many neuronal neurotransmitters in the gastrointestinal tract. Emotional upset can show up in the guts.

To summarize



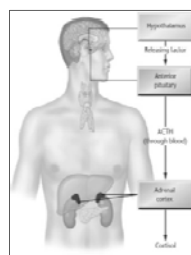
Oxytocin

- Peptide that functions as both neurotransmitter and hormone
- Impact many regions
 - Limbic/ hypothalamic areas, brain stem, PSNS
- Result
 - Results in warm, relaxed feelings and affection
- One German Study (intranasal administration)
 - Procedure not allowed in U.S.
 - In economic lab games, more trusting of others



Cortisol

- Remember our discussion of this?
- Released after moderate exposure to stress
- Engages the SNS via the HPA axis
- Long Term Exposure
 - Lower immune systems
 - Create blood sugar imbalances
 - Raise your blood pressure
 - Weaken muscle tissue
 - Decrease bone density
 - Reduce neuronal regeneration in hippocampus
 - Increase fat to stomach areas



WE CAN START TO ANSWER SOME OF THESE QUESTIONS

- What is and what is not an emotion? How are moods and feelings different?
- Is there emotion-specific physiology?
- Are there universal antecedents to emotion? Universal emotions?
- What is the function of emotion?
- Can emotion be unconscious? Can we control it?
- What is the relationship between cognition/ learning/ memory and emotion?
- How does emotion develop and can we alter our emotional responses as adults?
- How can we foster our own happiness and other positive states?

