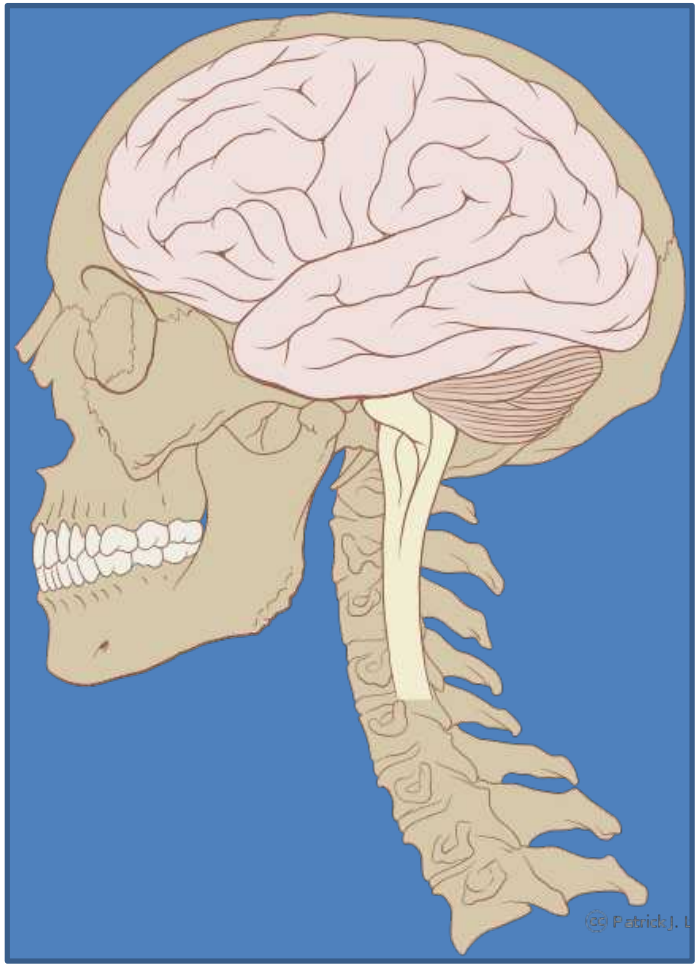
Basic Nervous System anatomy

Neurobiology of Happiness

The components

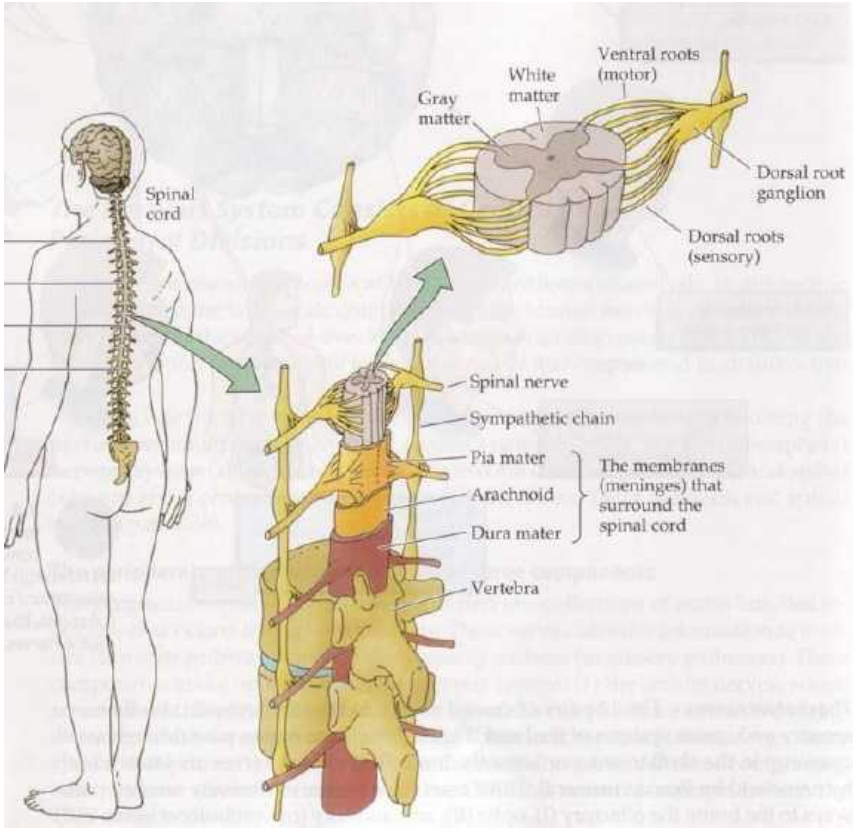
- “Central” Nervous System (CNS)
  - Brain
  - Spinal Cord
- “Peripheral" Nervous System (PNS)
  - Somatic Nervous System
  - Autonomic Nervous System (ANS)
    - Sympathetic branch
    - Parasympathetic branch

The Brain



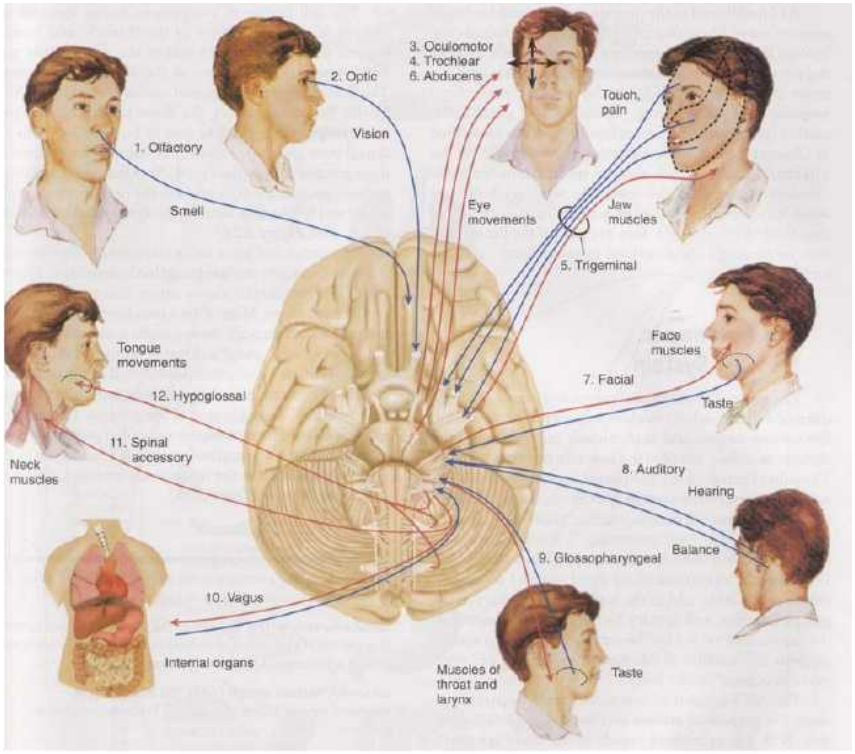
- Executive/Regulatory center of the body
- Composed of roughly 100 billion specialized cells (called neurons), plus other 'support' cells (called glial cells)
- Functionally organized:
  - Cortex (the outer layer)
  - Sub-Cortical Systems

Spinal Cord



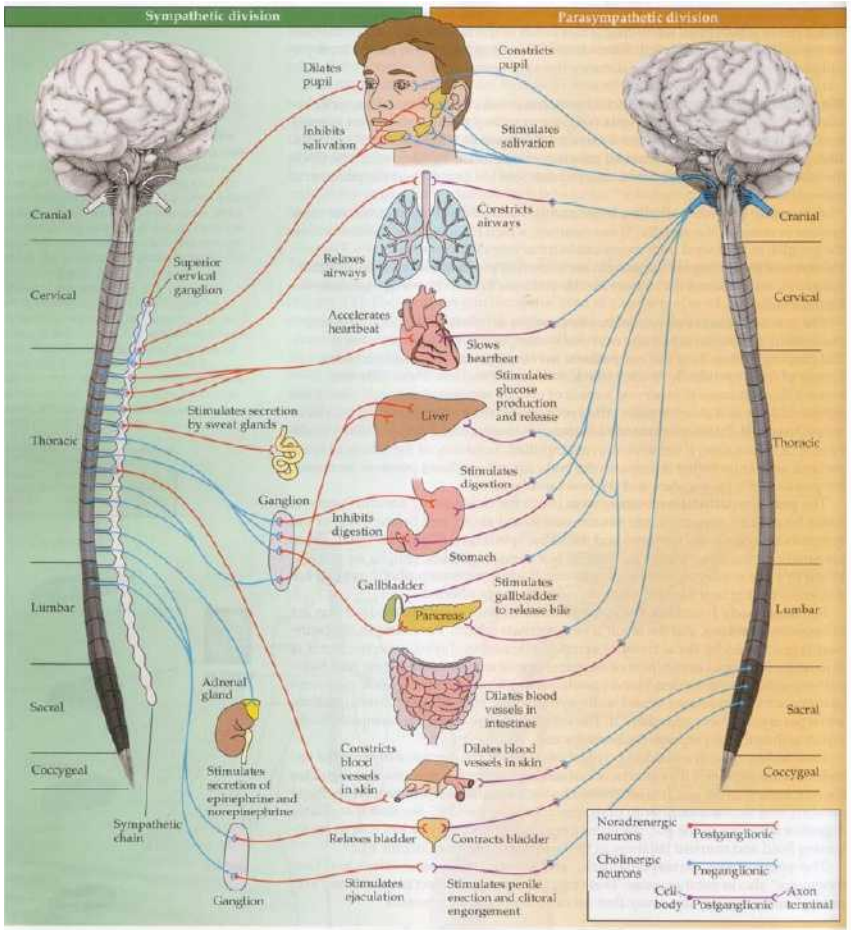
- Carries projections from brain,
- Also contains whole circuits which are functionally independent from the brain
  - For example, when you touch something hot, a system in your spine pulls your hand away. The brain only knows about it afterward

Somatic Nervous System



- Includes “cranial” and “spinal” nerves.
- We won’t get in depth into this part of the body

The Autonomic Nervous System



- Sympathetic & Parasympathetic Branches are the “accelerator” & “brakes” of the stress response, respectively

Sympathetic Functions

- Nerves project from spine to internal organs, like the heart, lungs, liver, digestive tract, etc.
- Stimulation of the Sympathetic system involves increased heart rate, dilated airways, increased sweating, inhibition of digestion and reproduction…
- This is your “Fight/Flight” system.
- Chronic Stress = Chronic Sympathetic Activation

Parasympathetic Functions

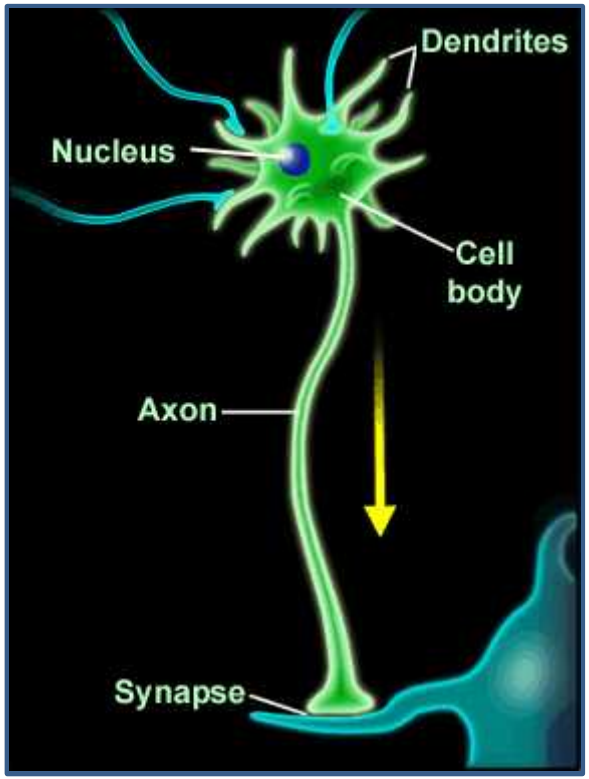
- Nerves project from spine to the same internal organs as Sympathetic system
- Has opposing effects to sympathetic system:
  - Reduces heart rate, constricts airways, facilitates digestion, reproduction, rest.
- Take a deep breath. Feel your heart slow down? That's your parasympathetic system at work!
  - NOTE: Hugging provides manual stimulation of the parasympathetic system

How it works…

- Neurons
- Synapses
- Neurotransmitters

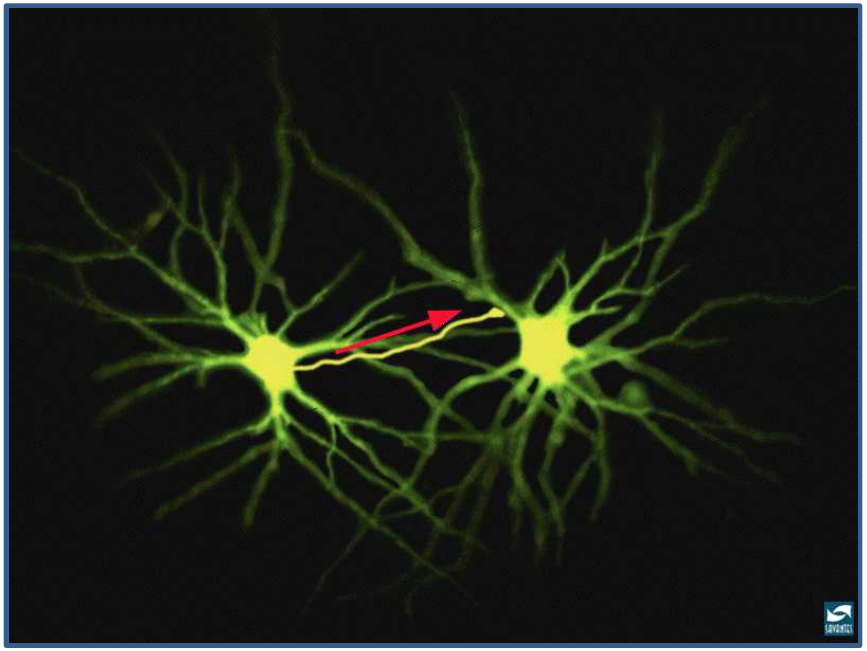
The Neuron

- Brain has, on average, 100 billion neurons
- There are roughly 15,000 synapses (connections between neurons) per neuron
  - That makes 1.5 quadrillion connections!



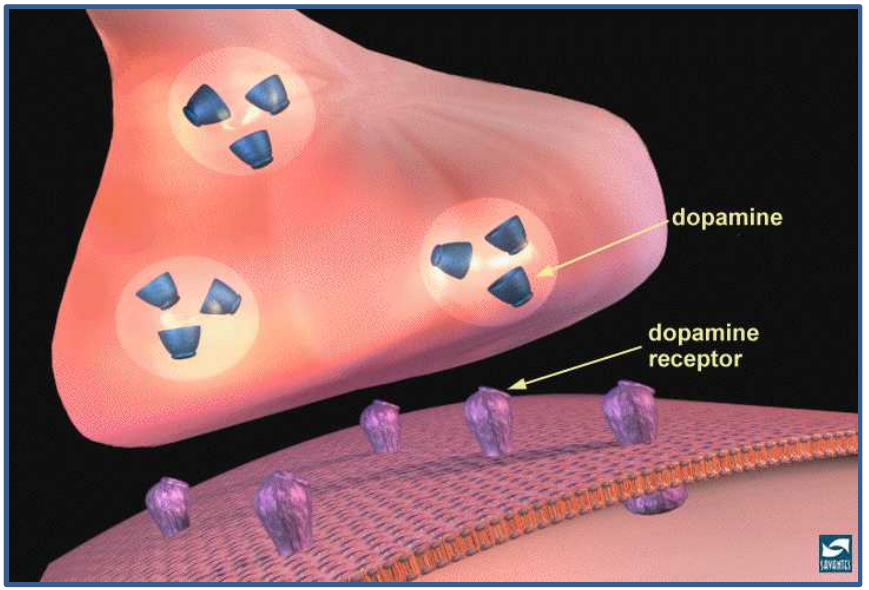
The Synapse

- Here is a picture of two neurons, with an arrow pointed at one of many synapses
- In the tiny junction between the two cells, one neuron releases chemicals (called neurotransmitter). This is how neurons ‘talk’



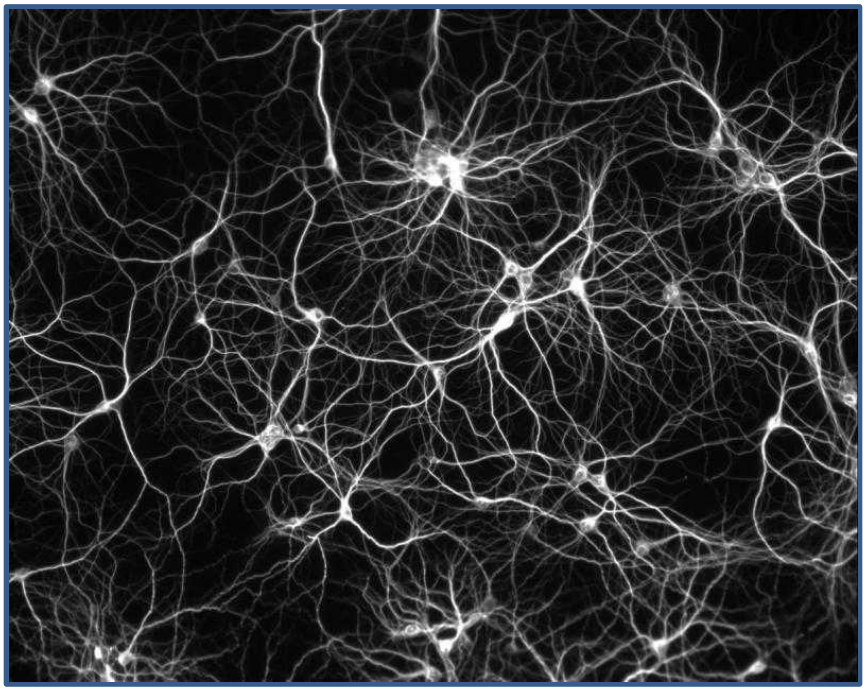
The Synapse

- Here is a close-up of a synapse
- When enough neurotransmitter is released from one neuron into the synapse, the second neuron “fires,” meaning an electric charge flows from one end to the other, and it will in turn release neurotransmitter to another neuron.



The Synapse

- Each neuron can “fire” up to 500 times per second
- This is part of how information is encoded in the nervous system – a more intense stimulus results in a greater firing rate
- Neurons form simple circuits to perform calculations



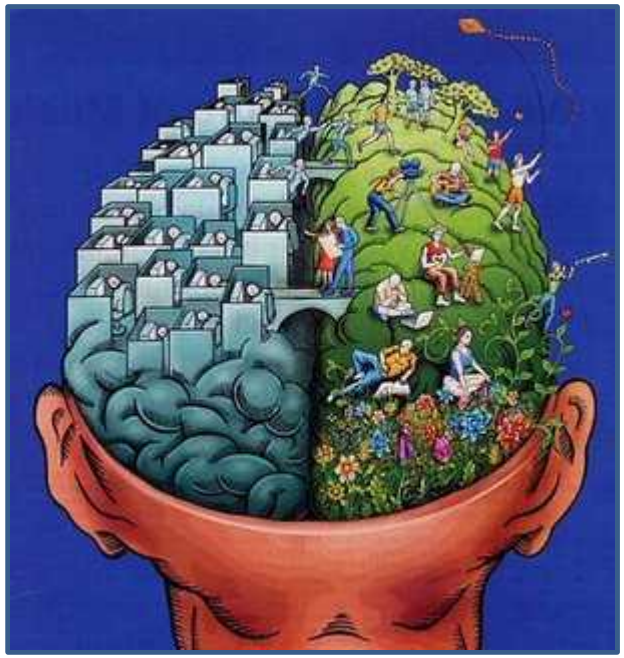
Neurotransmitters

- Chemical messengers in the nervous system
- There are many different kinds, each with many specialized receptors
- Common examples: dopamine, oxytocin, GABA, opioids

The Brain: Gross Structure

- Two Hemispheres
- Cortex (outer layer) & Sub-Cortex
  - We're only going to talk about a very small part of the whole picture

2 Brains? Hemispheric Specialization

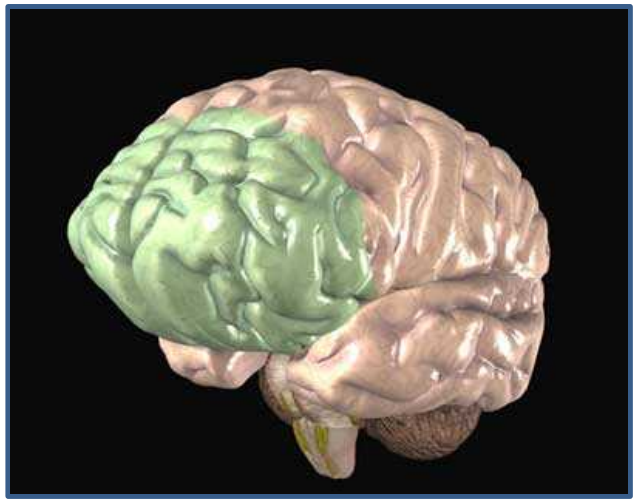


- The different sides of the brain – the left and right hemispheres – differ functionally
- They are integrated by a band of neurons called the corpus callosum
- Left has been associated with linear, logical function and language; controls the right side of the body
- Right has been associated with analogical reasoning, emotion and spatial imaging; controls the left side of the body

In the absence of a corpus callosum…

- If an object is presented in the left visual field (in which case it's processed by the right hemisphere) of an individual without a corpus callosum, they cannot name the object, since the language center is in the left hemisphere
- There are a lot of amusing anecdotes about 'split-brain' individuals whose hemispheres answer the same question differently. E.g., one man's left hemisphere liked Richard Nixon, while the right did not

The Pre-Frontal Cortex



- Most commonly understood as the executive center of the brain
- Different areas are necessary for different functions

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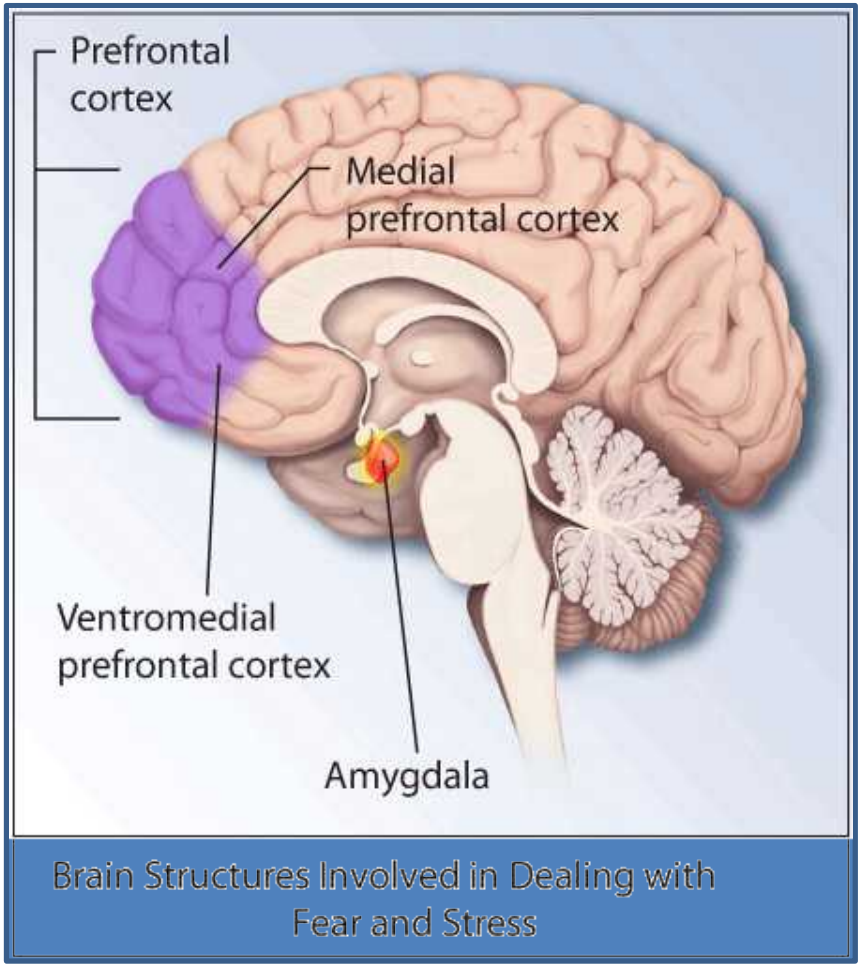
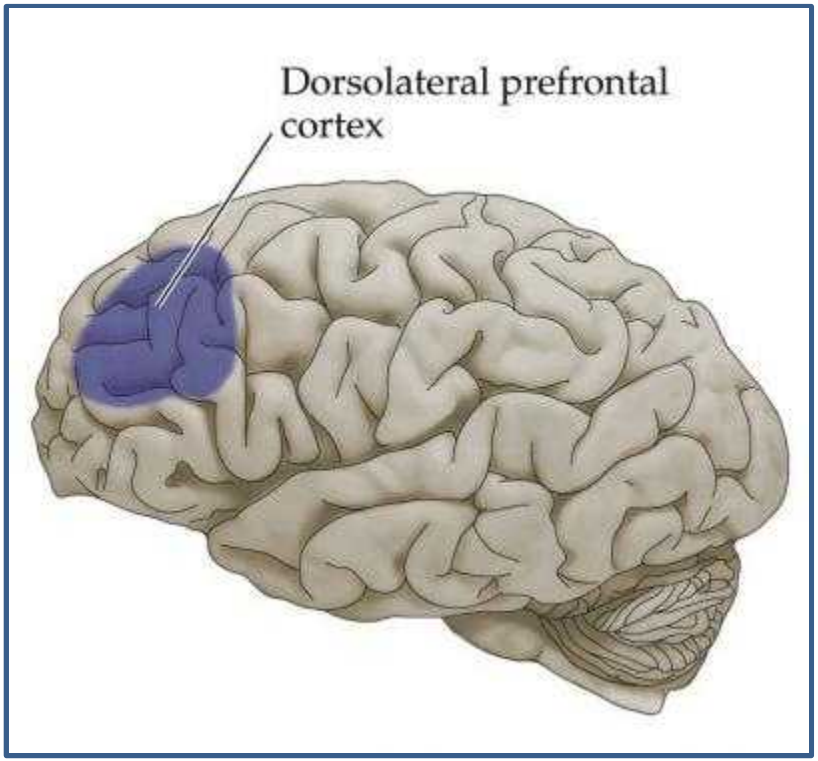
PFC “Big 4”

- **The Medial PFC (mPFC)**
- Involved in response flexibility, social attunement, self-reflection and fear extinction
- Stress damages this area badly



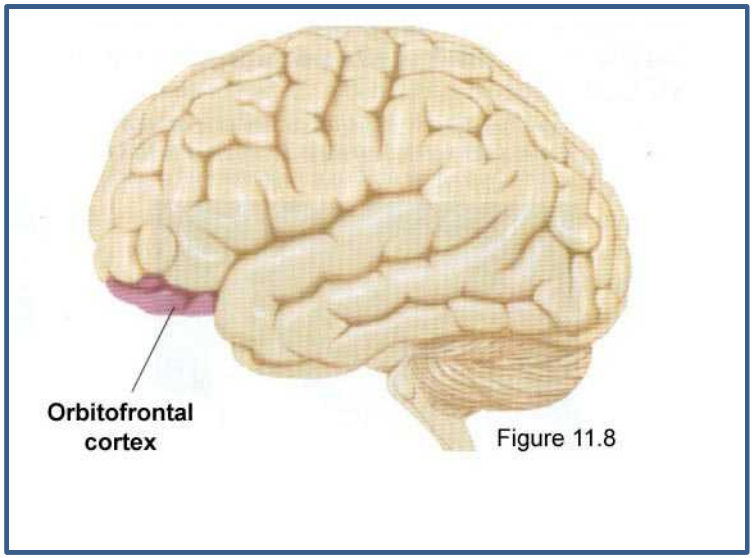
PFC “Big 4”

- **Dorsolateral PFC (dlPFC)**
- Important for planning, holding objects “online” in your mind, executive functioning



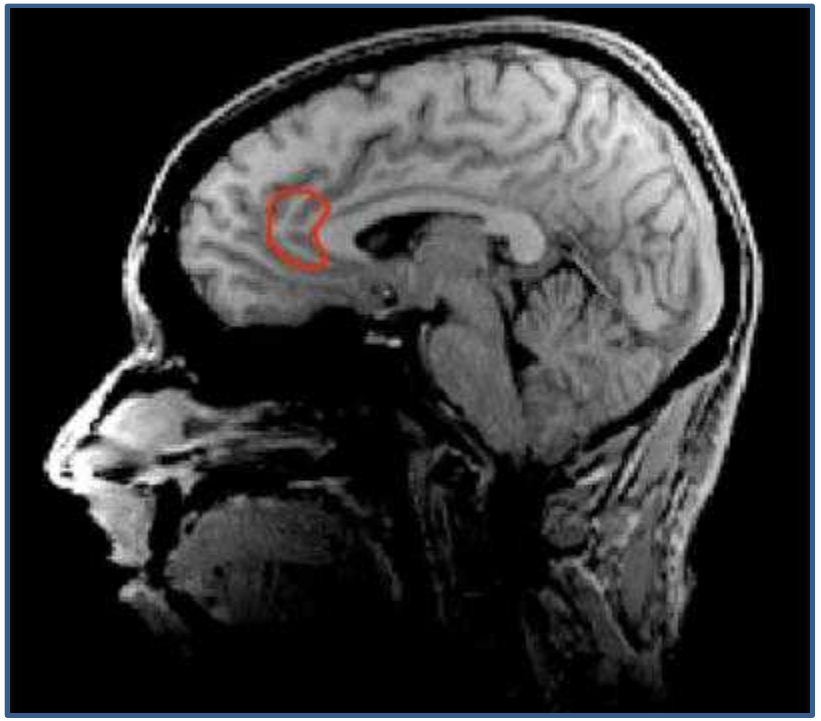
PFC “Big 4”

- **Orbitofrontal Cortex (OFC)**
- Important for reward processing, regret (OFC damage abolishes regret!), regulating social emotion like embarrassment and ‘big picture’ decision-making



PFC “Big 4”

- Anterior Cingulate Cortex
- Necessary for response inhibition, error detection, behavioral flexibility, emotion regulation



Sub-cortical regions of interest

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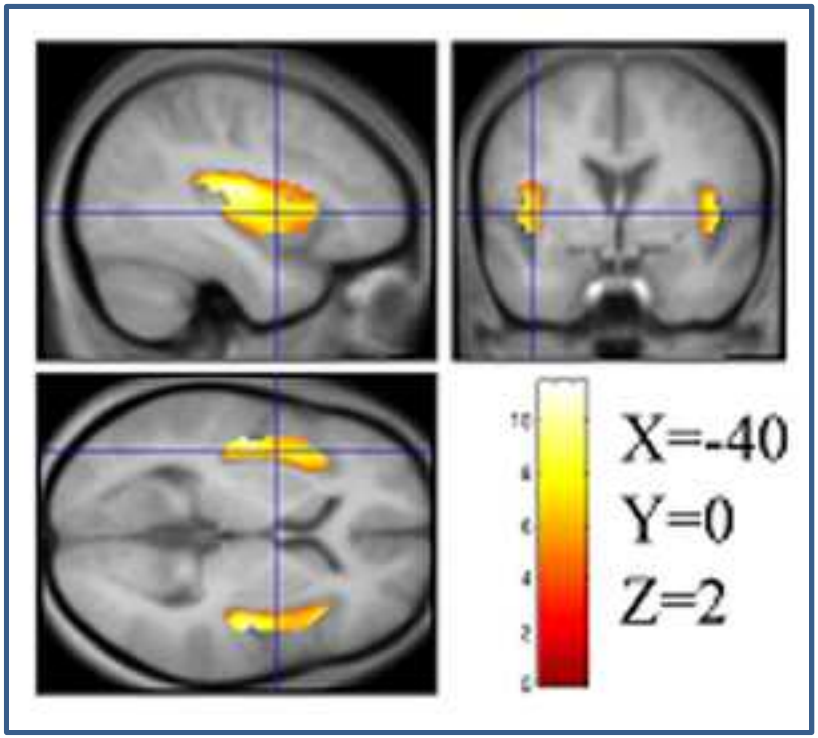
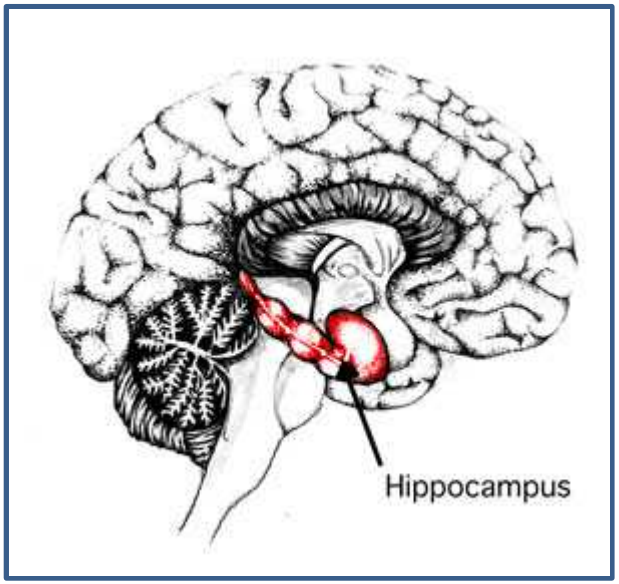
- Insula
- Hippocampus
- “Limbic” system
  - Thalamus
  - Hypothalamus
  - Amygdala

Insula



- Buried deep, as you can see
- Important for “interoception” (sense of state of internal organs), processing emotions like disgust

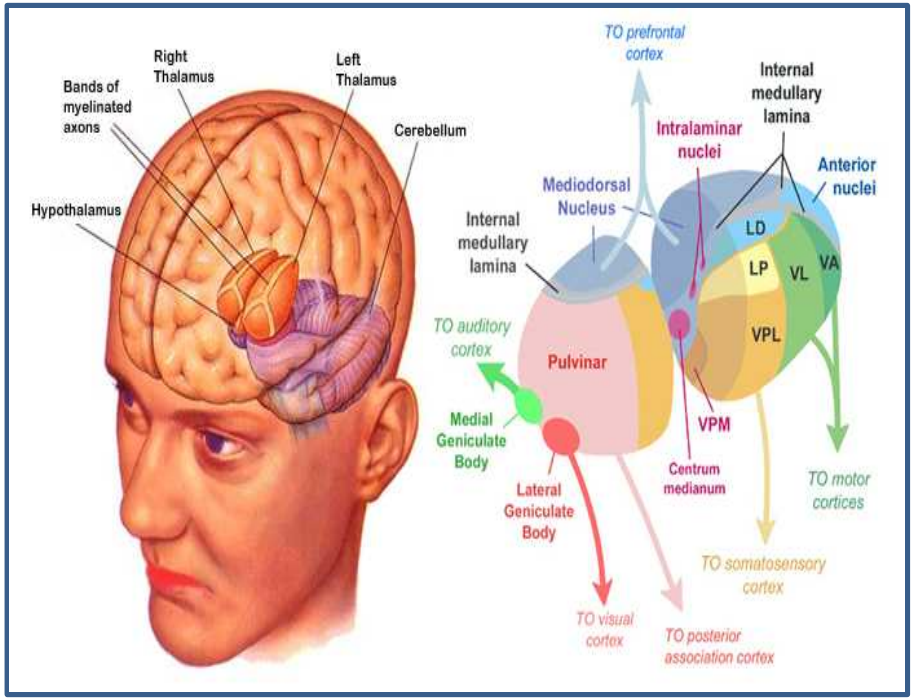
Hippocampus



- The memory center of the brain
- Without the hippocampus, people cannot make new memories.
- One of 2 parts of the adult brain that keeps growing new cells (stress very quickly ceases new cell growth)

Thalamus

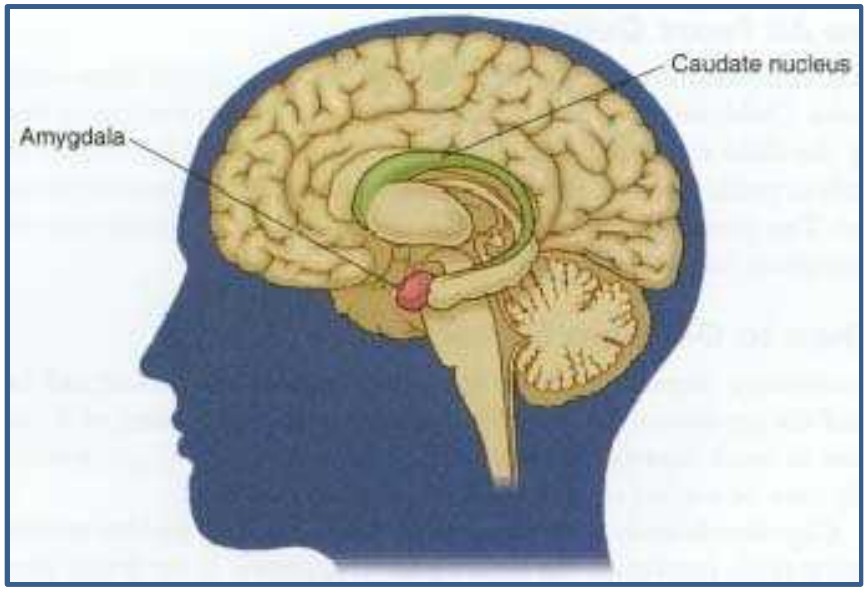
- The ‘relay’ station of the brain. All inputs pass through here, to be routed wherever needed



Hypothalamus

- Key body regulator. Initiates hormone secretion in processes like the stress response, reproduction and hunger/satiety

Amygdala



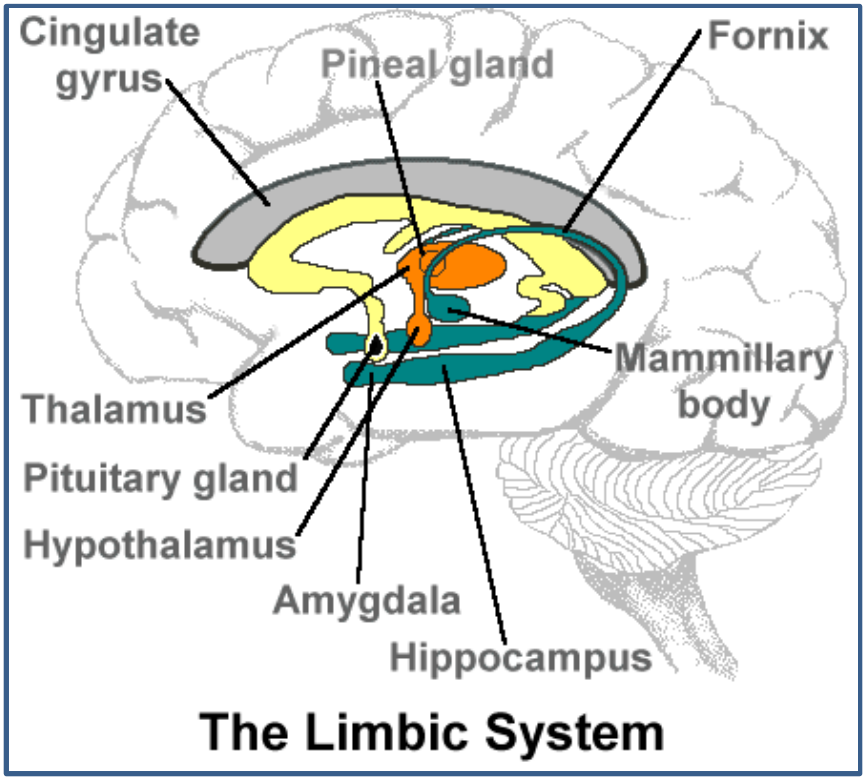
- The fear center of the brain
- Also necessary for encoding emotional importance to any memory
- Crucial for “fight or flight” response

Emotions

- The body's built in assessment system
  - Inextricably linked with memory and cognitive appraisal of stimuli
  - Includes both our "online" experience and the resulting body responses
- The 5 'basic' emotions and their functional correlates
  - This is only one theory. We're using it for convenience
- Happiness, sadness, fear, anger, and disgust

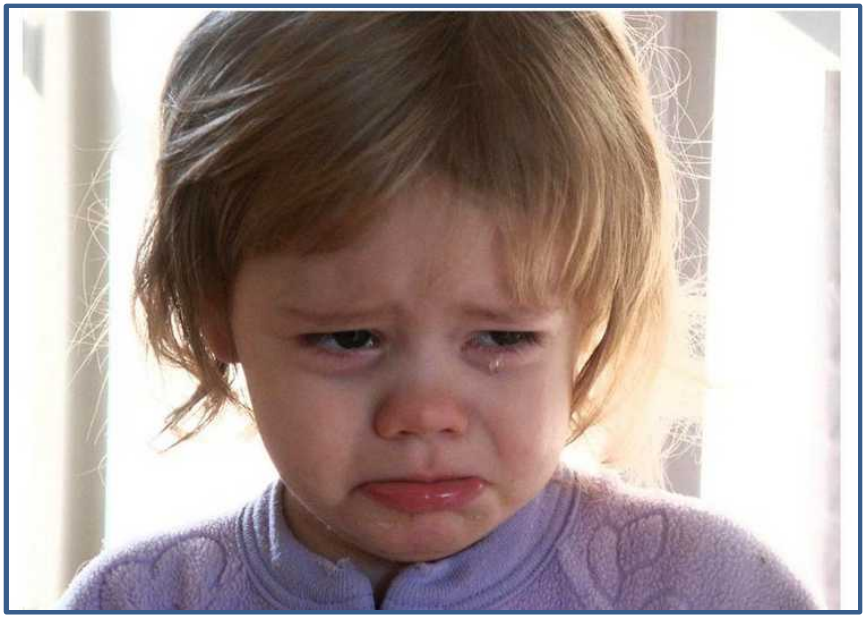
The Limbic System

- Associated with the bulk of activity during emotional experiences



Sadness

- The anterior cingulate cortex (ACC) is especially active during experiences of sadness
  - Interestingly, we see the same activity in the ACC during emotional pain as with physical pain
- The right hemisphere is more active during a sad experience

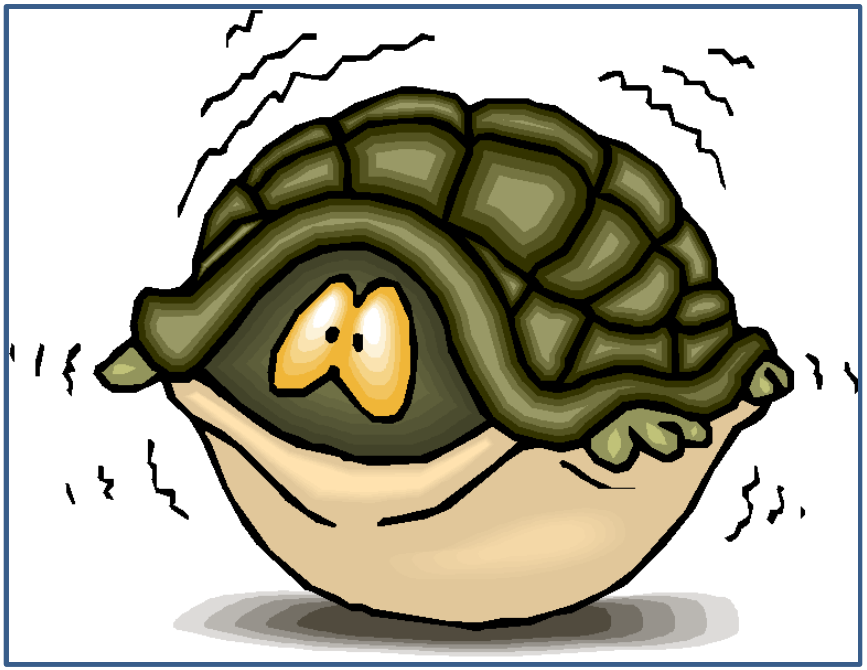


Disgust

- The insula is necessary for the experience of disgust
- The internal organs play a huge role in the disgust experience; that feeling of the stomach turning is actually the stomach turning.

Fear

- The amygdala is the primary player in fear processing
- Also, the hypothalamus initiates the stress response in reaction to the perception of danger



Anger

- The ability to regulate anger decreases with decreasing activity of areas like the OFC
  - Violent criminals have reduced OFC volume and activity
- Also, the ACC is important in processing anger and the behaviors that anger can embody, like aggression
- The amygdala is crucially involved here, too

Happiness

- The parasympathetic nervous system is more active when one is happy
  - The neurotransmitter “oxytocin” correlates with elevated levels of feelings of trust, friendship, maternal care
  - Activity in one nerve in particular, the vagus nerve, correlates strongly with happy feelings like compassion
- The left hemisphere is more active during a happy experience

Questions??