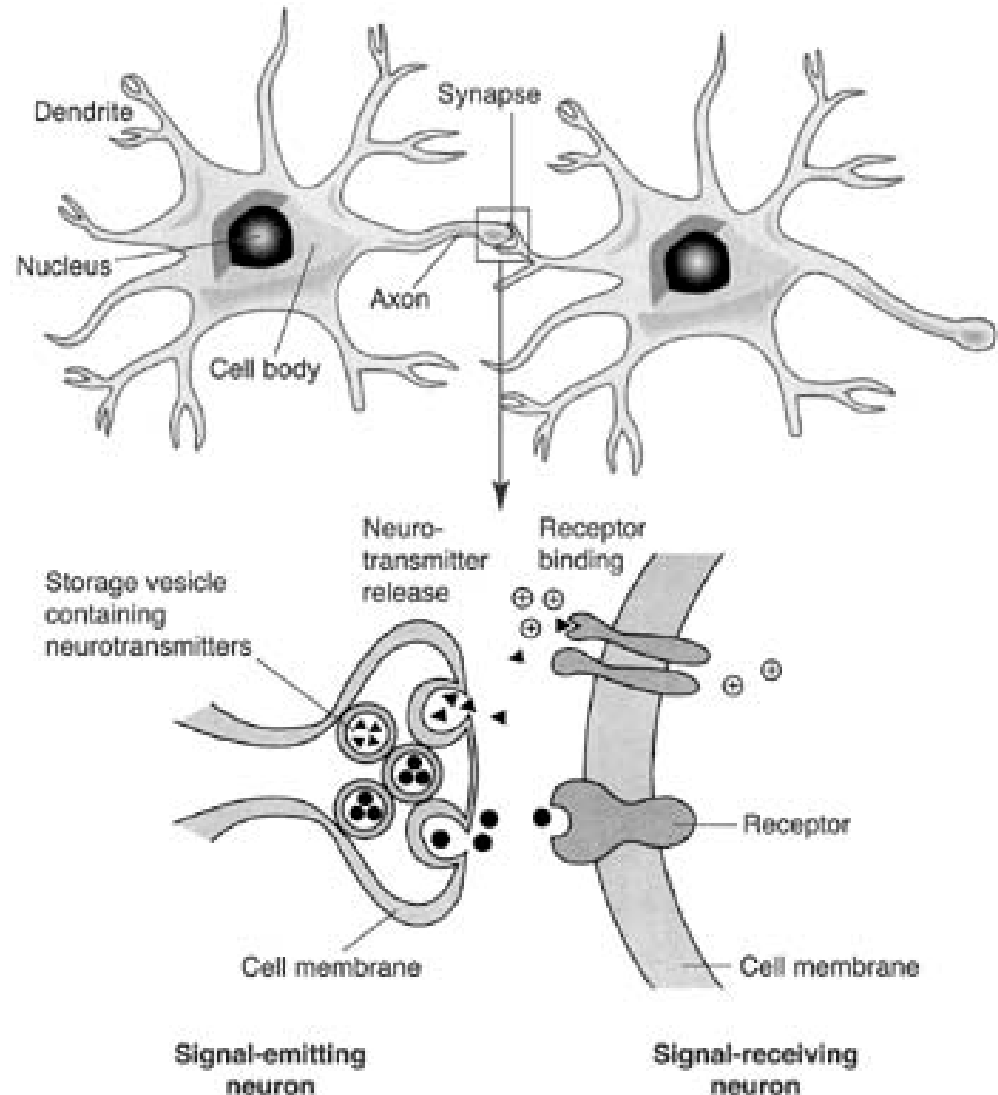


# Brain Basics

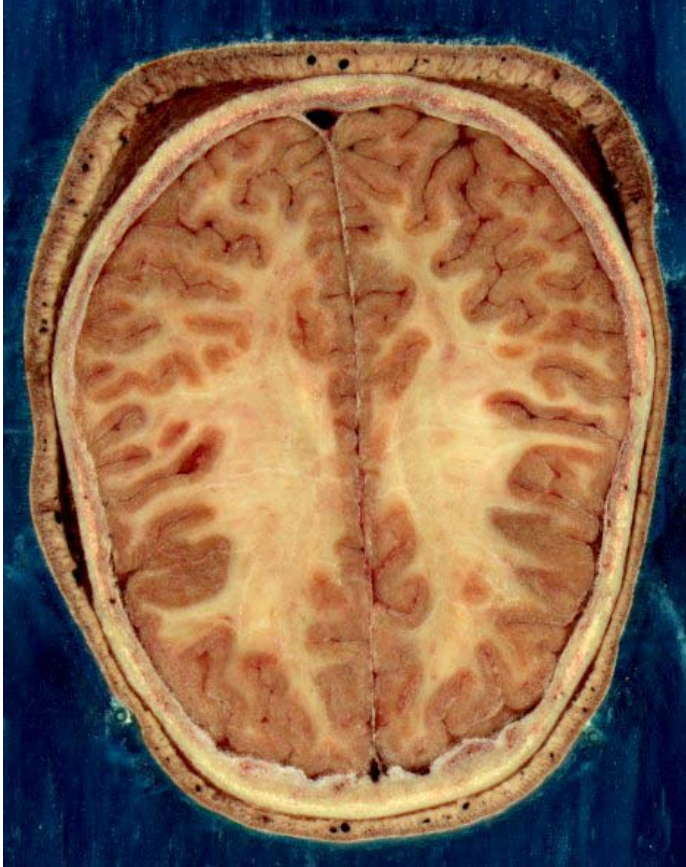
Introduction to Cognitive Science

# Neurons

- Human brain:
  - ~100 billion ( $10^{11}$ ) neurons
  - ~100 trillion ( $10^{14}$ ) neural connections
- Dozens of different neurotransmitters ... Why?
  - And why neurotransmitter in the first place; why not a hard-wired connection?
- Doesn't fit a simple 'neurons fire or not is like 1's and 0's in a computer' story
- Is information-processing done by chemicals or inside neuron?



# 'Gray' vs 'White' Matter



Axons have a myelin sheath.

The myelin sheath helps the signal travel along the axons.

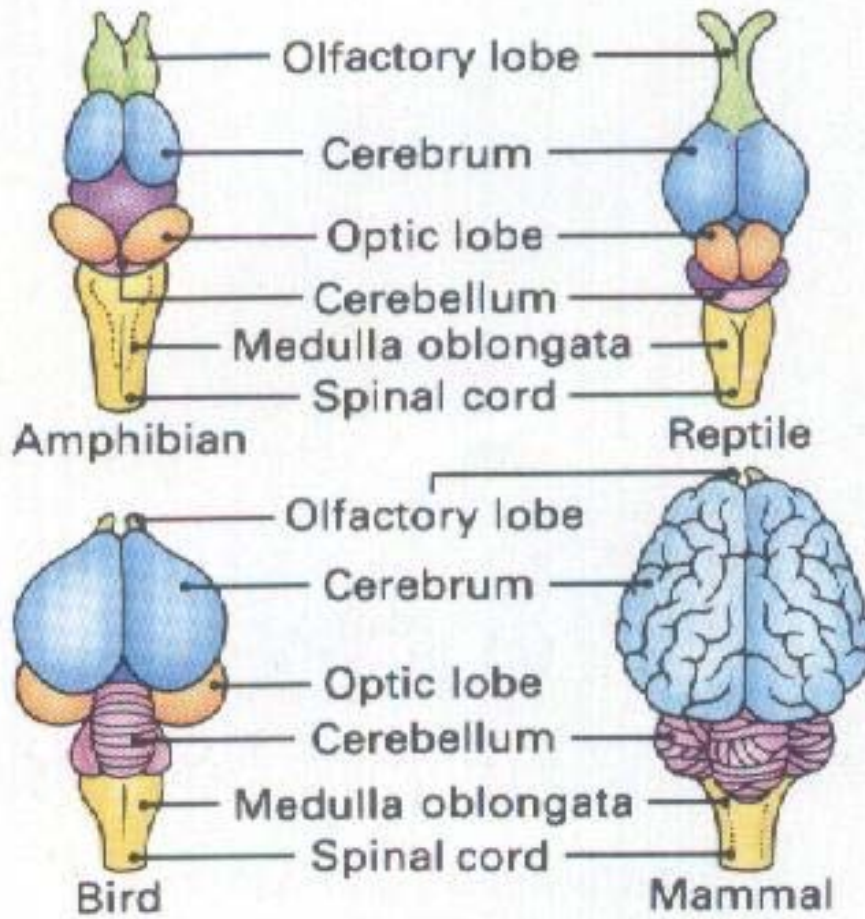
This myelin sheath will look 'white', while the neuronal bodies look 'grey'.

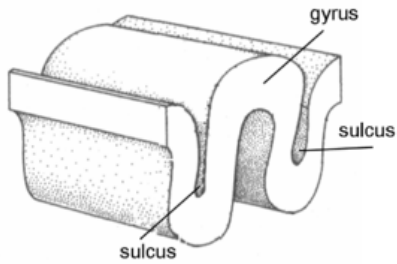
In a brain, there is more gray on the outside (the cortex, basically) and more white on the inside, suggesting that there are more and longer connections on the inside and/or that the inside serves to connect some of the outside regions of the brain

# Basic Anatomy

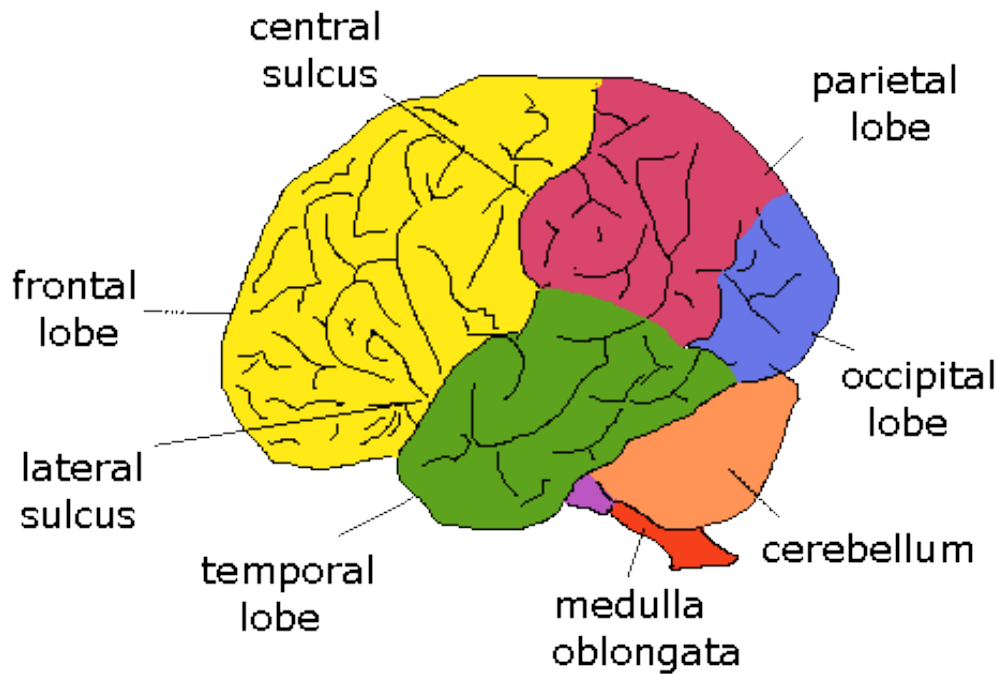
- 4 Main parts of brain
  - Cerebrum: ‘Cognition’: reasoning, planning, decision making, ‘complex’ behavior
  - Cerebellum: Coordination of behavior: posture, balance, walking
  - Limbic System: emotion and memory
  - Brain Stem: basic body regulation: breathing, heartbeat, sleep, most basic sensory/motor control, e.g. eye movement

# Brains of Different Animals





# Cerebrum: 4 lobes



exterior of the cerebrum from the left side

## Frontal Lobe:

executive control, reasoning,  
decision making, sense of ethics

## Parietal lobe:

integration sensory information,  
visuo-spatial processing,  
movement, numbers

## Occipital lobe:

visual processing

## Temporal lobe:

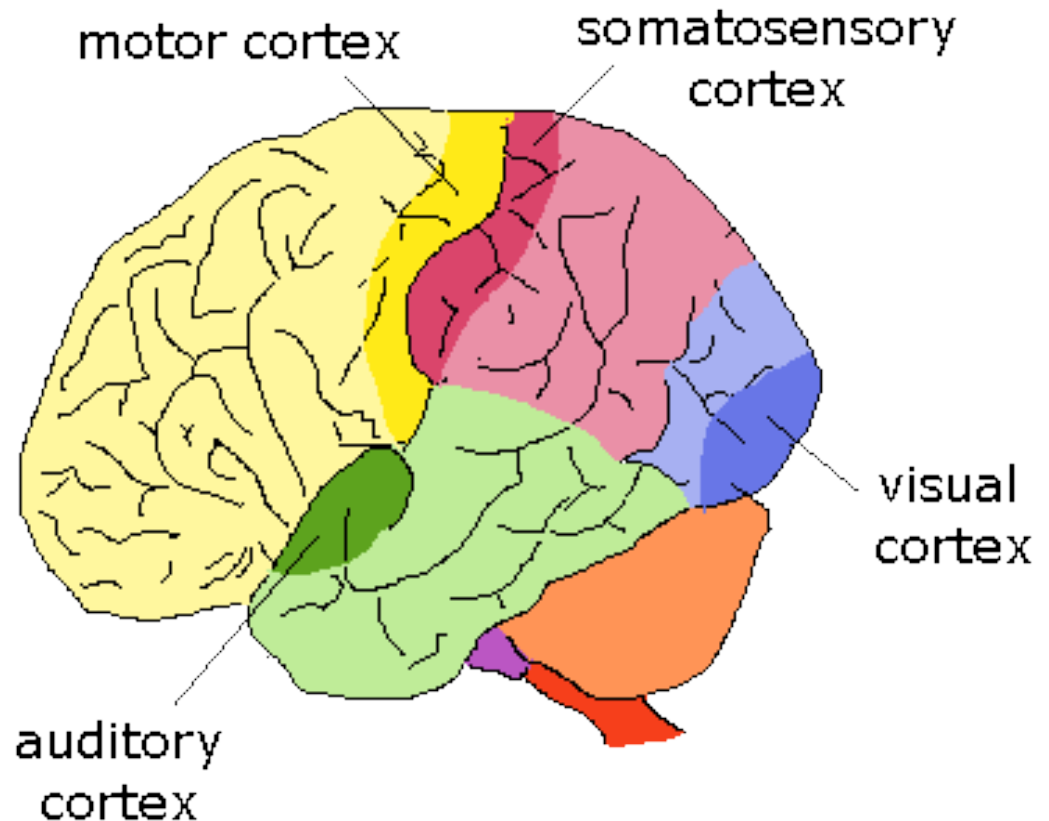
auditory processing,  
semantics, language

# Cortex

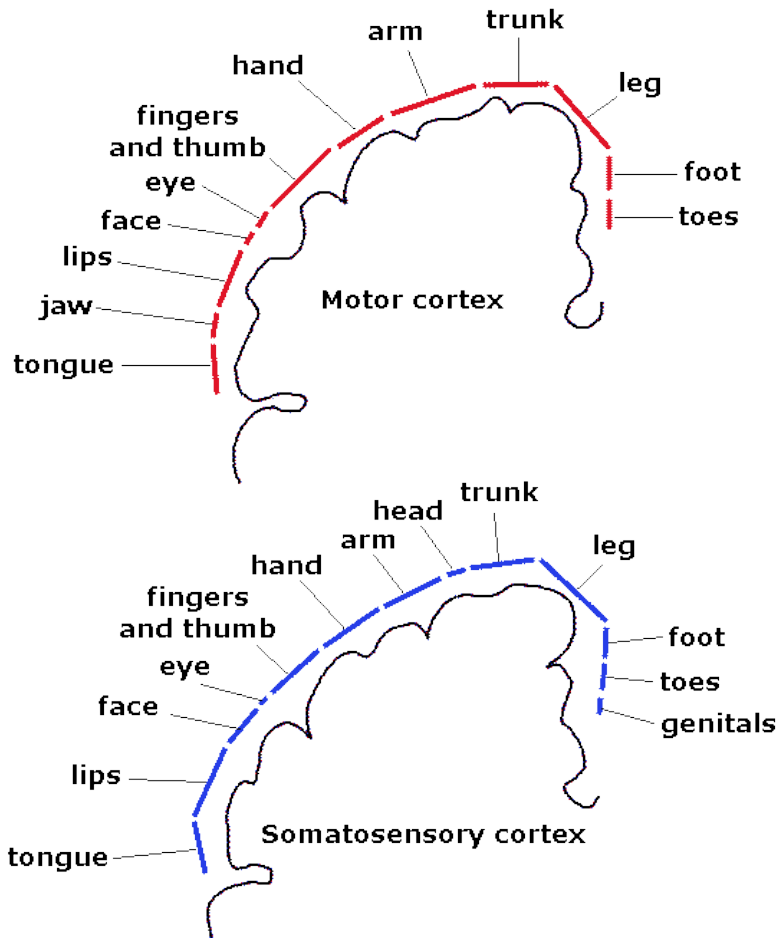
The cerebral cortex, or neocortex, is the outer layer of the cerebrum.

This is the 'gray matter': This seems to be where the 'cognitive', computational, action is .

Underneath the cortex is 'white matter' which seems to serve more supporting functions, e.g. connections



# Motor and Somatosensory Cortex



Here we find very specialized areas (modules) of the brain: specific areas responsible for specific functions

Question:

Is the rest of the brain (mind) like that? E.g. are there specific areas of the brain responsible for all knowledge regarding grandmother?

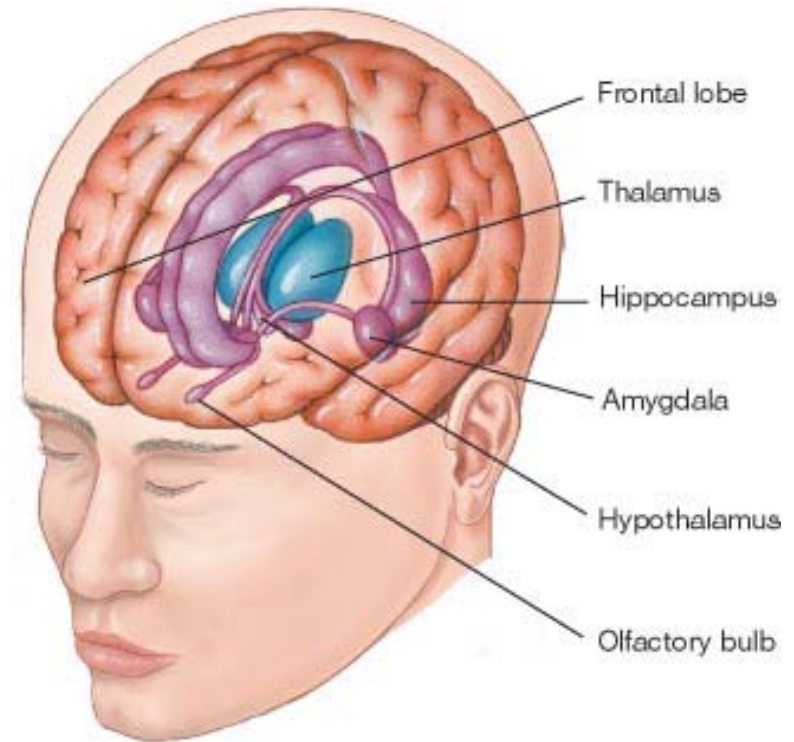


This figure represents how much of the cortex is devoted to the different parts of the body

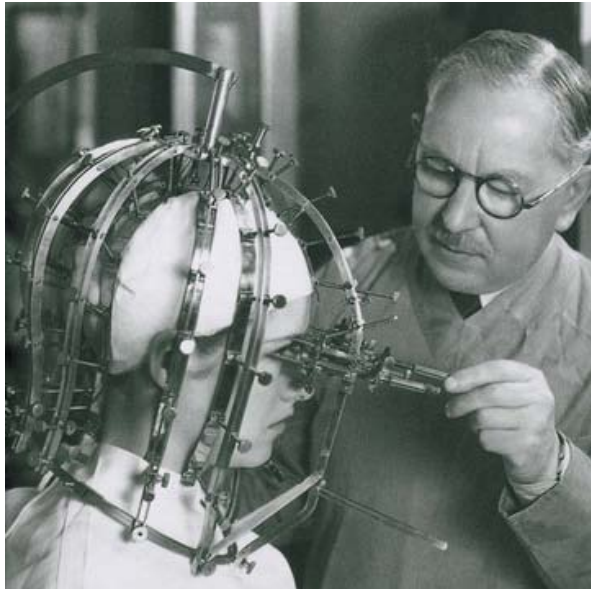
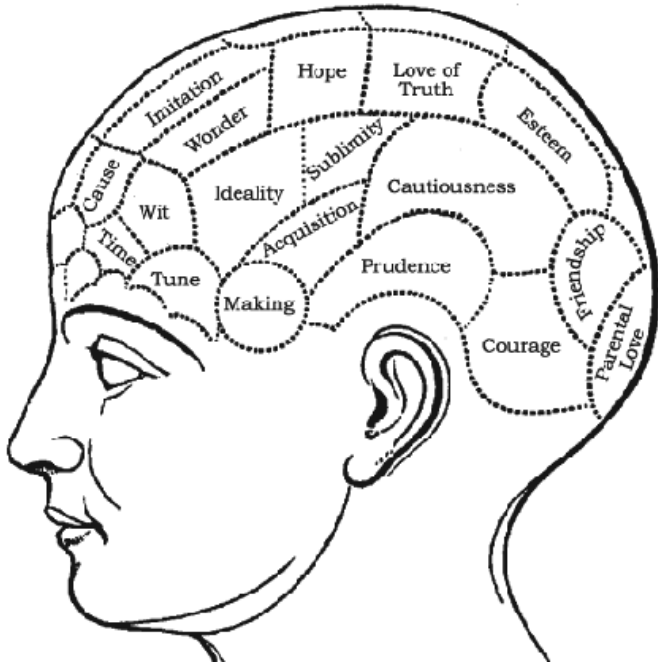


# Limbic System

- Thalamus: 'relay station' of sensory input to cortex (exception: smell)
- Hippocampus: formation of memory
- Amygdala: Emotional salience of stimuli
- Hypothalamus: basic drives (4 F's), breathing, heartrate, and more



# Phrenology



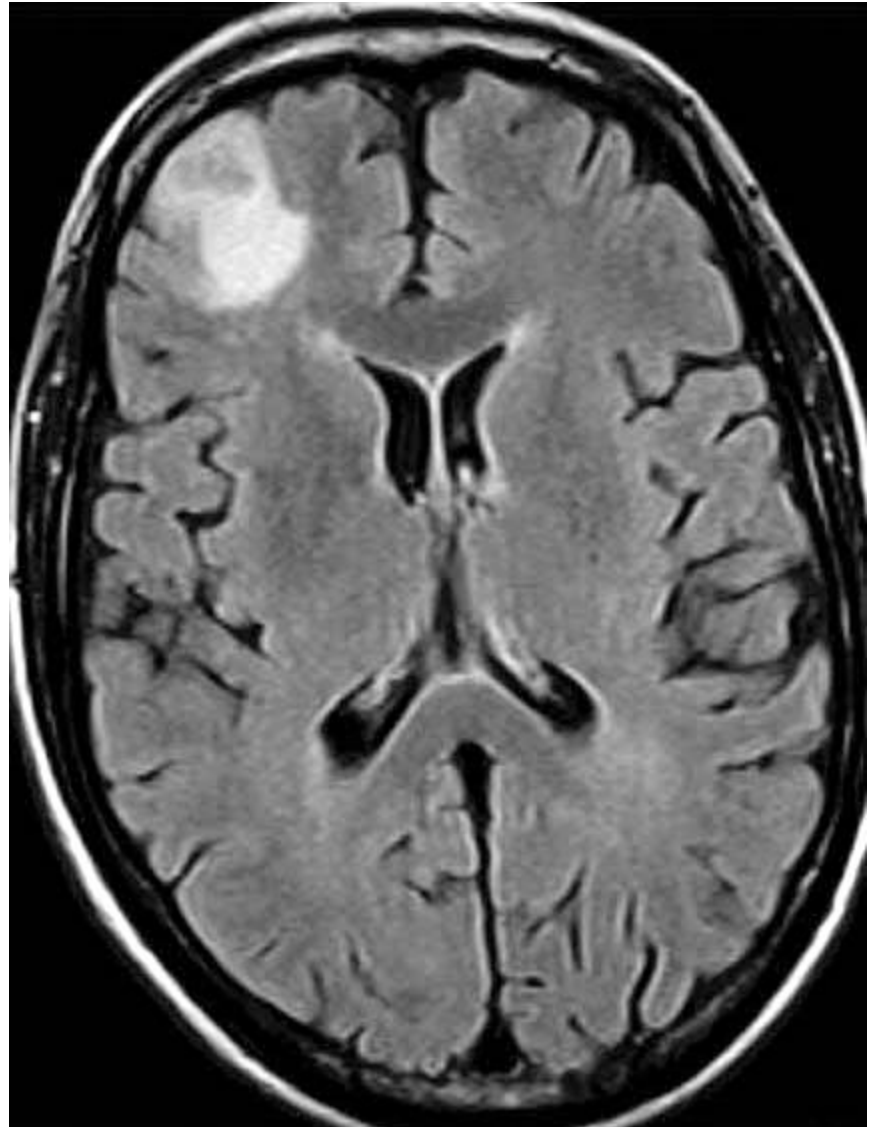
- 19<sup>th</sup> century 'brain science'
- Assumed localization of cognitive function (personality traits, really)
- Bumps or dents on head were thought to reveal more or less neurons devoted to that 'cognitive function'

# Modern Brain Nonsense: The 10% of Your Brain Myth

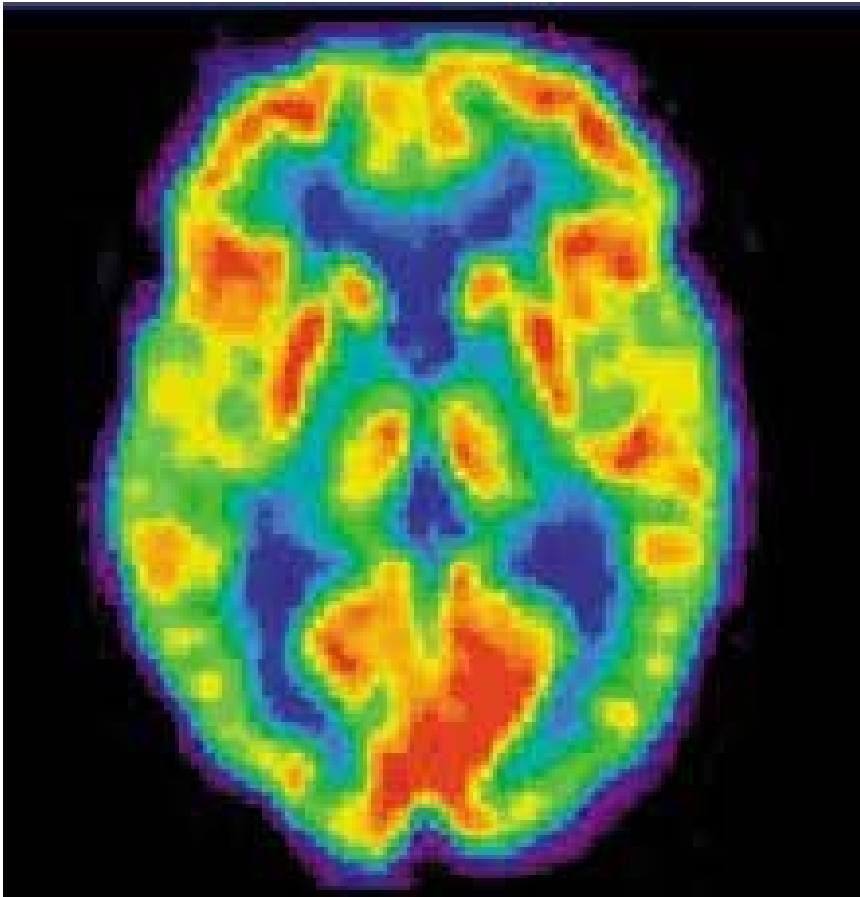
- “Most people only use 10% of their brain!”
  - The suggestion being that if you could somehow ‘unlock’ the ‘extra power’ of your brain, you could be so much smarter!
  - Which is why you should buy this book for \$79.99 or take this 7 week course for only \$499!!
- Total myth!
  - First off all: this makes no sense evolutionarily
  - Indeed, when doing brain imaging, we find activity all over the brain at all times
- Where does the myth come from?
  - Probably from exactly those brain images

# CAT Scans

- CAT or CT (Computed Axial Tomography)
  - x-ray
  - Provides rough structural/anatomical information
  - Mostly to find suspected brain damage



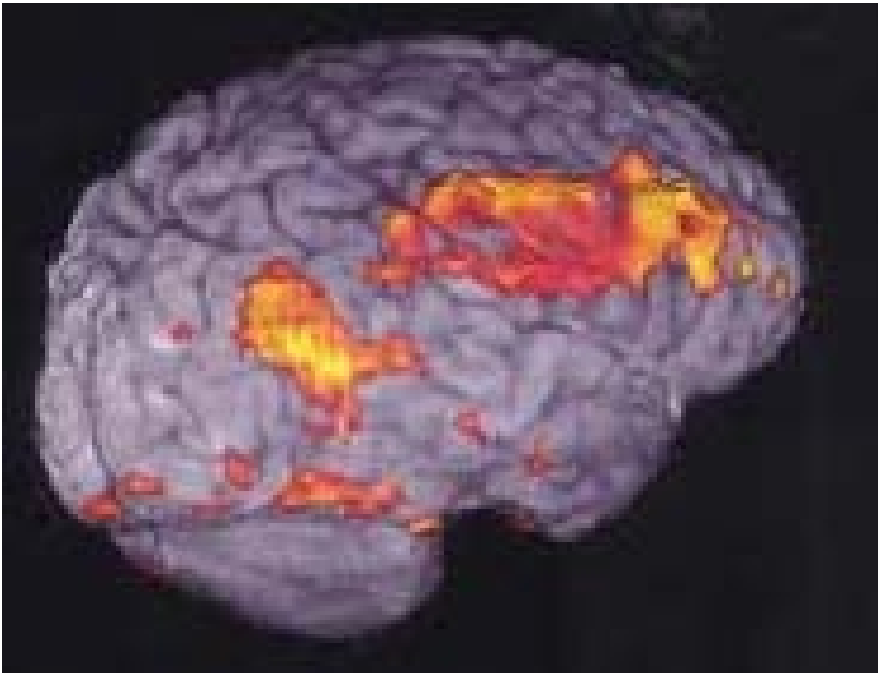
# PET Scans



- PET (Positron Emission Tomography)
  - Radioactive chemicals inserted in bloodstream
  - So, PET scans provide 'metabolic' information: roughly, reveal functional activity of brain

# MRI and fMRI Scans

- MRI (Magnetic Resonance Imaging)
  - Place subject in powerful magnetic field and measure differences in frequency
  - Good spatial resolution; low temporal resolution
  - f (functional) MRI: higher temporal resolution, lower spatial



← It is exactly these kinds of pictures that perpetuate the 10% myth: it looks as if only a small part of the brain is active, but what they're showing is merely areas whose 'activity' (or whatever it really is that the MRI is measuring) is above some defined threshold.

# EEG

- EEG (Electroencephalography)
  - Measure electric fields by placing electrodes on scalp
  - Good temporal resolution, terrible spatial resolution
  - Mostly used to detect ERP's (Event Related Potentials) that scientists try to interpret as cognitive events.

