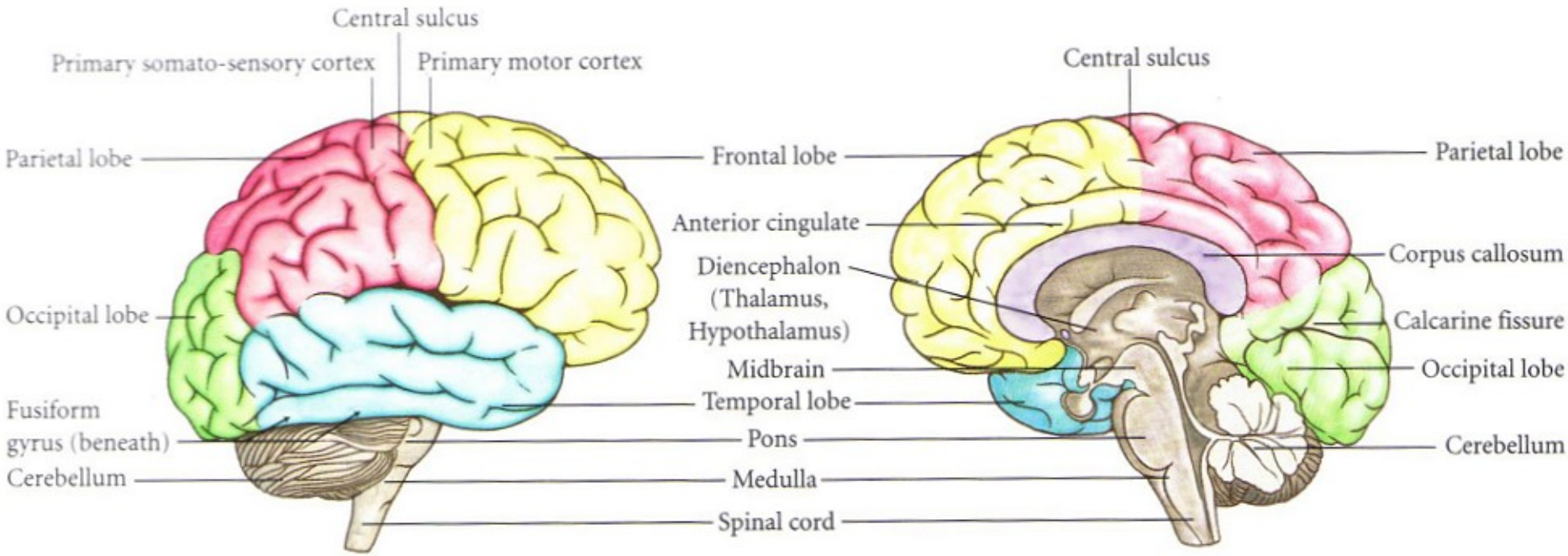
Neuroeconomics

- **Increasing interest in neuroeconomics**
  - Neuroeconomics is the use of data on brain processes to suggest new underpinnings for economic theories. Camerer
  - Crash course on brain activity measurement.



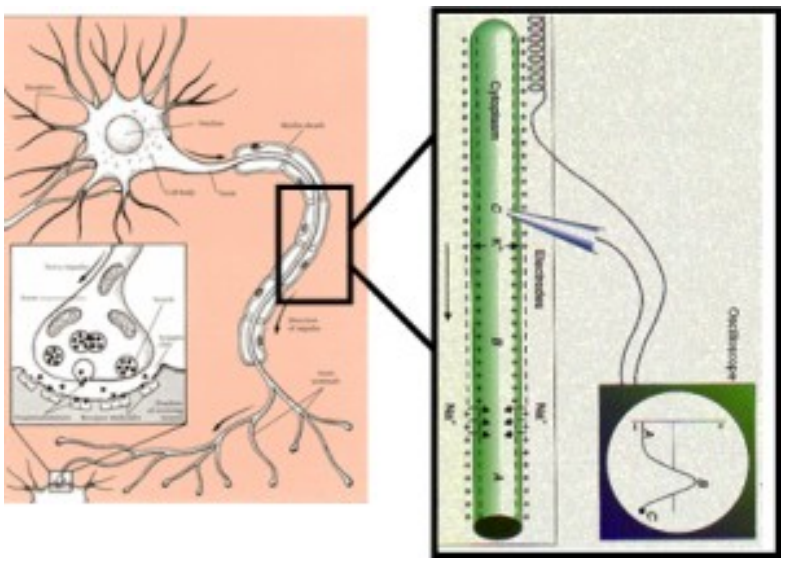
Measuring brain function

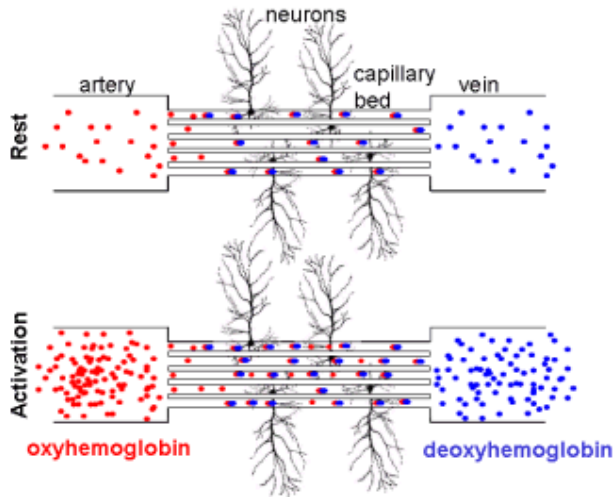
Direct

- **Electrical activity**
  - Electrophysiology
  - Electro-encephalography (EEG)
  - Magneto-encephalography (MEG)

Indirect

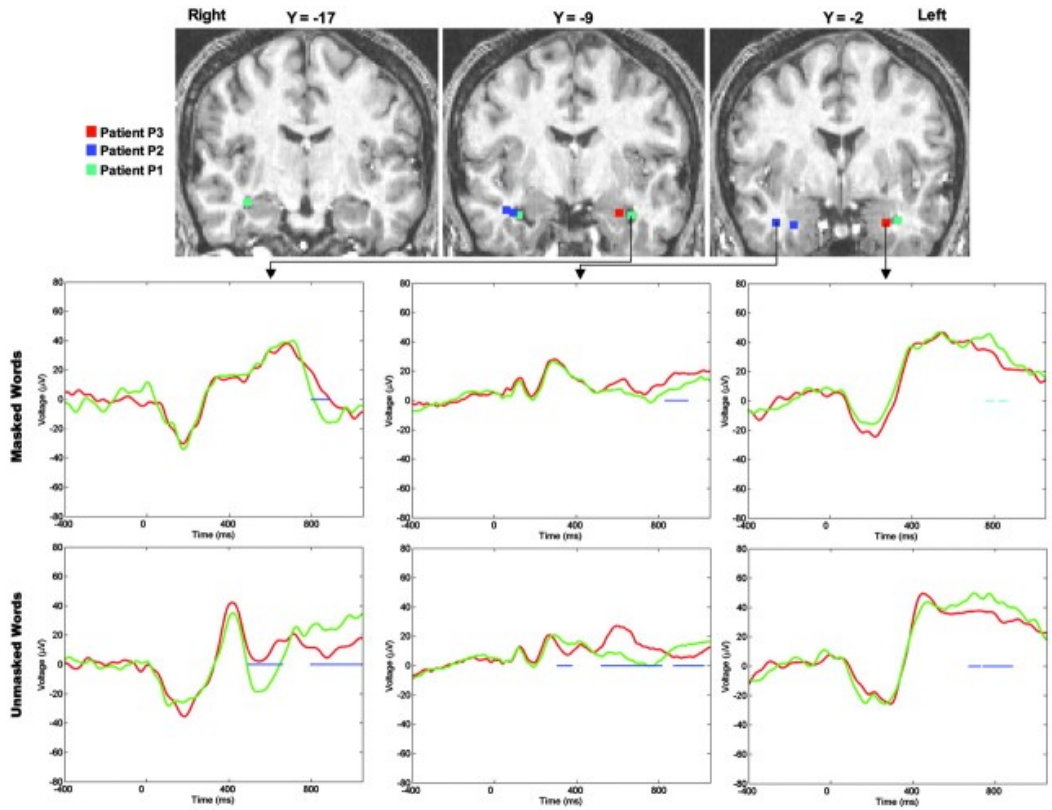
- **Temporary disruption**
  - Transcranial Magnetic Stimulation (TMS)
- **Increased local blood flow**
  - Positron Emission Tomography (PET)
  - Functional Magnetic Resonance Imaging (fMRI)





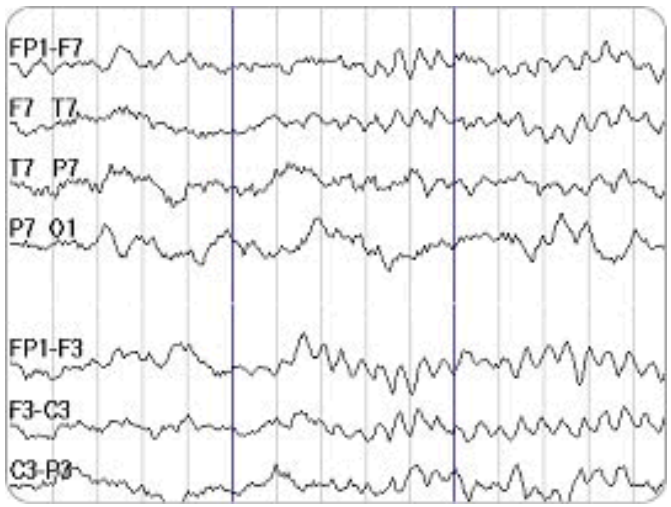
Electrophysiology

- **Direct measurement of neural activity**
  - Grid electrodes over cortex
  - Depth electrode
  - Electrodes implanted for monitoring of epileptic seizures



Electro-encephalography (EEG)

- **Measures neuronal activity generated by pyramidal cells**
  - Sensitive to conductivity of the skull and cranial tissue
  - Difficulty pinpointing specific brain areas
  - Measures electrical activity only in cells perpendicular to the skull



Magneto-encephalography (MEG)

- **Measures magnetic field of pyramidal neurons**
  - Sensitive to electromagnetic noise
  - Difficulty pinpointing specific brain areas
  - Measures electrical activity only in superficial neurons parallel to the skull

- **Compared to EEG**
  - Less sensitive to head shape
  - Superior temporal resolution
  - Not cap to wear
  - Samples from less neurons

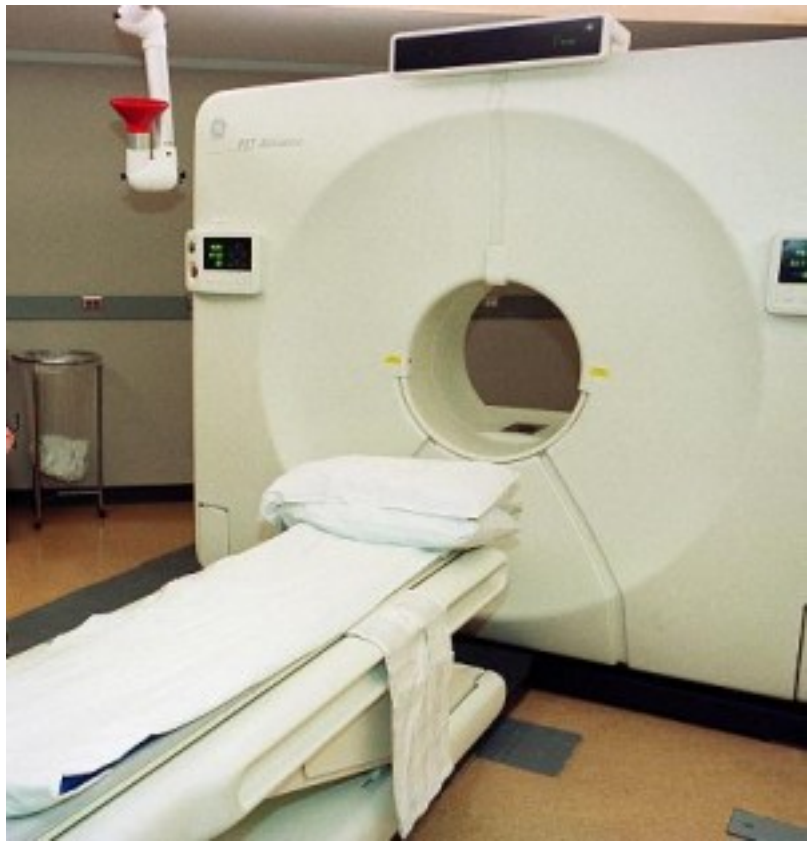
Transcranial Magnetic Stimulation (TMS)

- **Delivers a temporary current in a small area of the brain. The current interferes with processing in the brain.**
  - High temporal and good spatial precision
  - Can be used to infer causality
  - Affects only the surface of the brain

Positron-Emission Tomography (PET)

- **Measures decay of a radioactively-labeled chemical tracer**
  - O-15 Water (blood)
  - F-18 N-methylspiperone (dopamine)
  - C-11 carfentanil (opiate receptors)

- **Problems**
  - Invasive (injection)
  - Limited number of scans
  - Slow

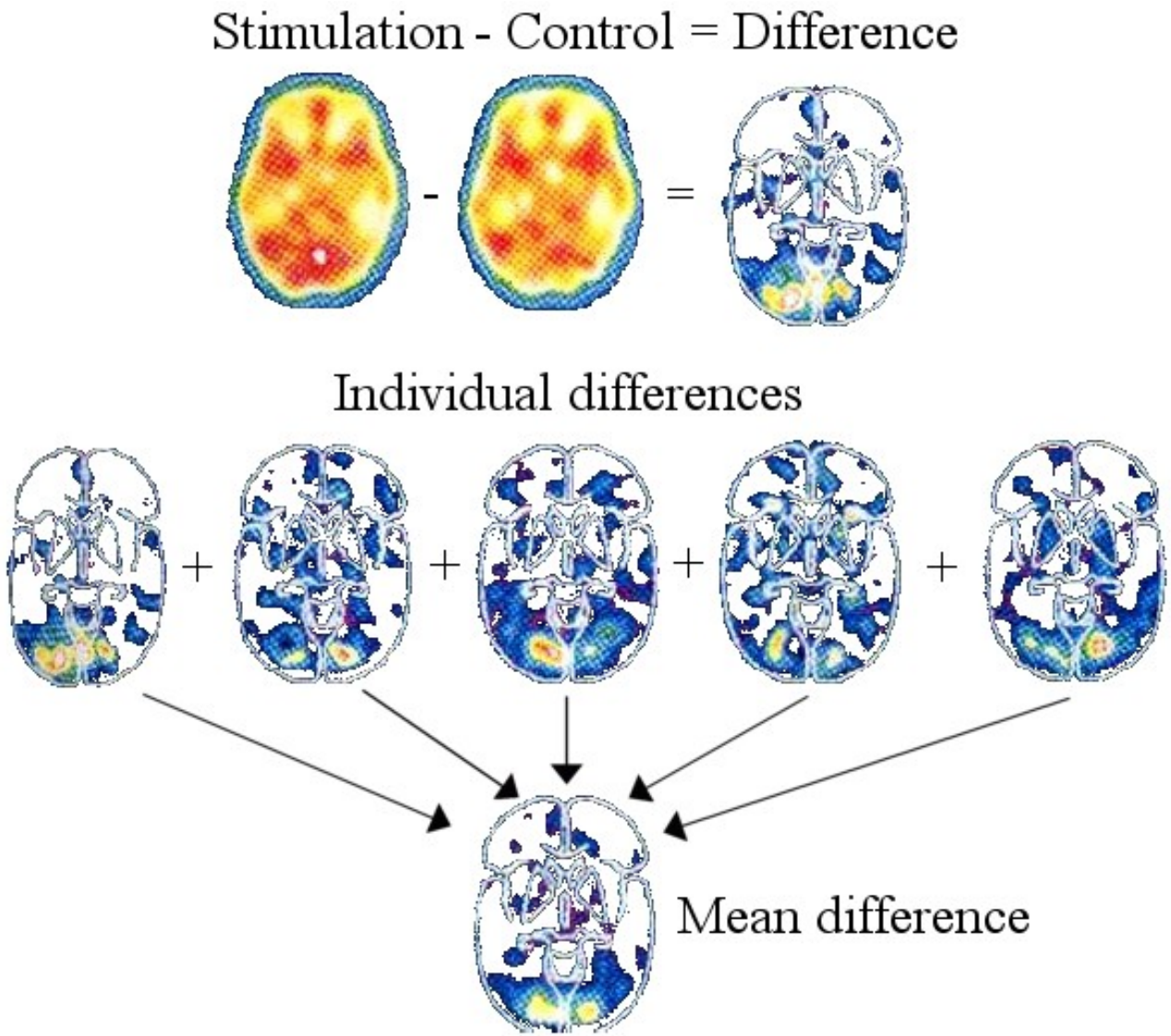


Functional Magnetic Resonance Imaging (fMRI)

- **Measures amount of oxygen in the blood (blood flow)**

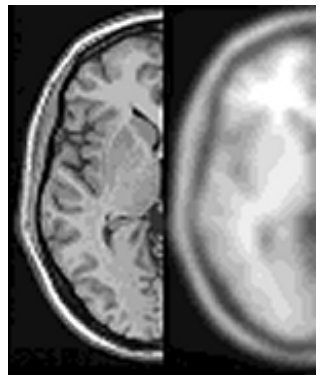
- **fMRI compared to PET**
  - No exposure to radiation
    - fMRI can be repeated
  - Better spatial and temporal resolutio (still slow)
  - PET can trace more than just blood (e.g., glucose or dopamine)

Data analysis

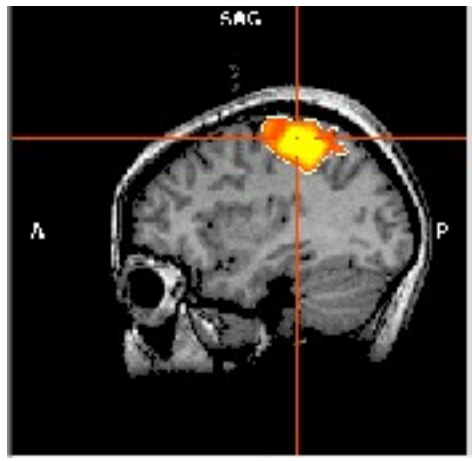


More than pretty pictures?

- **Common limitations of brain imaging**
  - Small number of subjects
  - Requires spatial smoothing (not all heads are equal)
    - Images are commonly smoothed to the MNI template
      - 305 brains: 78% males, mean age 23.4

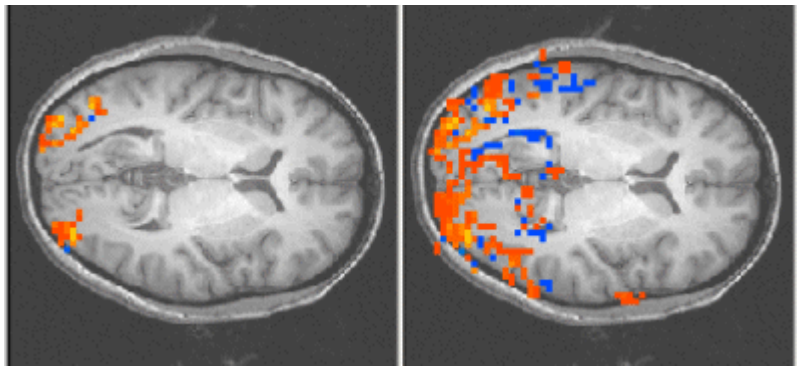


  - Activation areas are usually big
    - Use of Talairach coordinates of peak activation (postcentral gyrus) but also: motor cortex, frontal eye fields, intraparietal sulcus



More than pretty pictures?

- **Common limitations of brain imaging**
  - Deciding the ‘right’ significance level



  - Spatial resolution
    - Low activation of many neurons vs. high activation of a few neurons
  - Confounding factors such as attention (more activation) and experience (less activation)

Spatial and temporal resolution

- **fMRI and PET tell you where**
- **EEG and MEG tell you when**