Brief introduction to the methodology of Neuroeconomics

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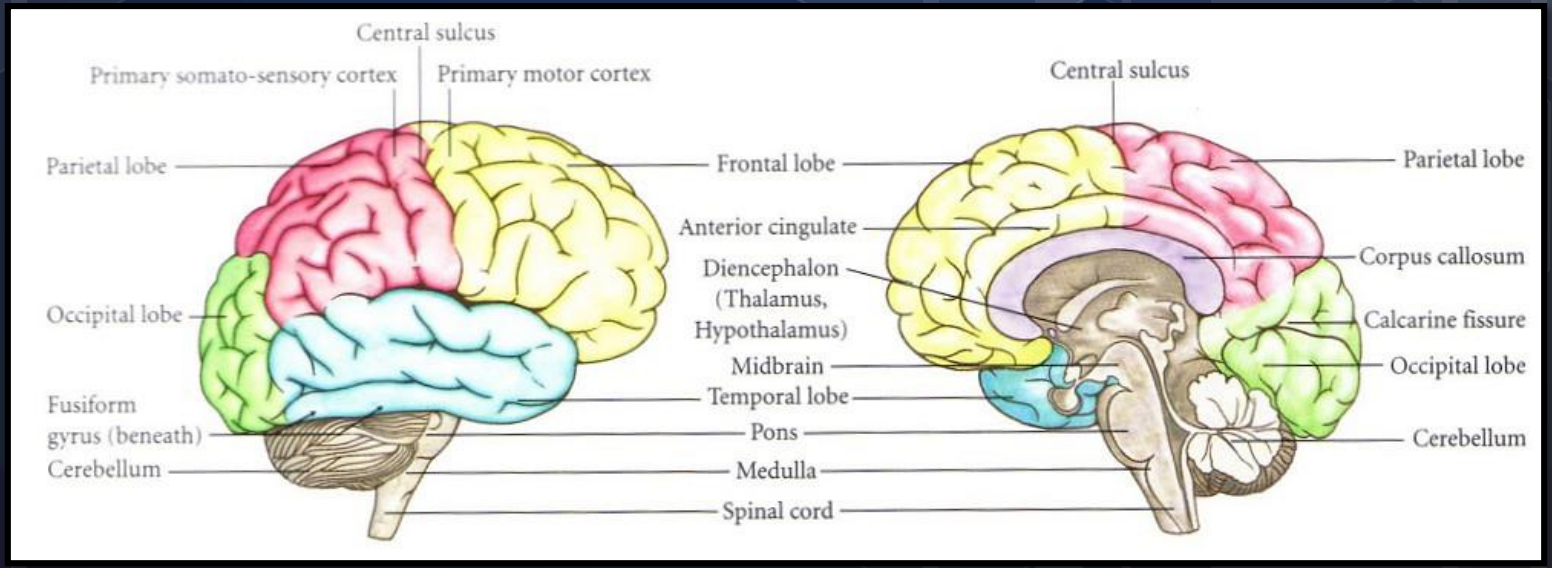
Neuroeconomics

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)

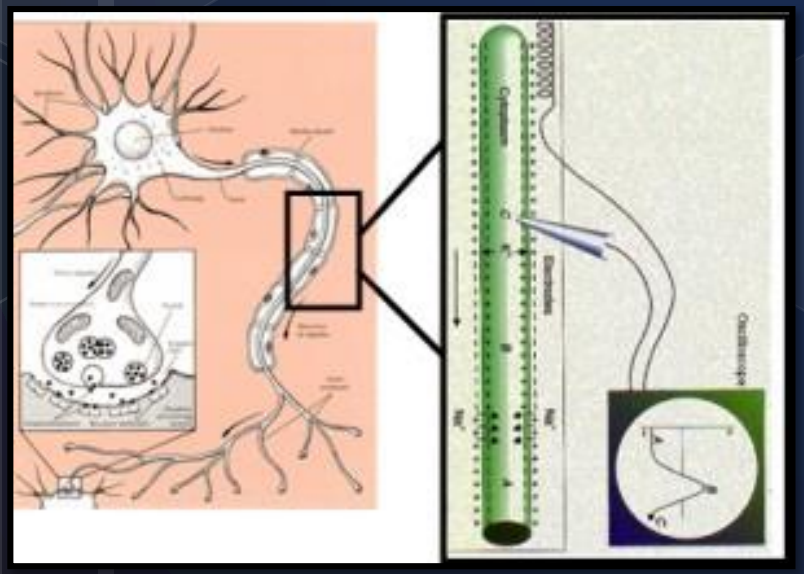
Indirect

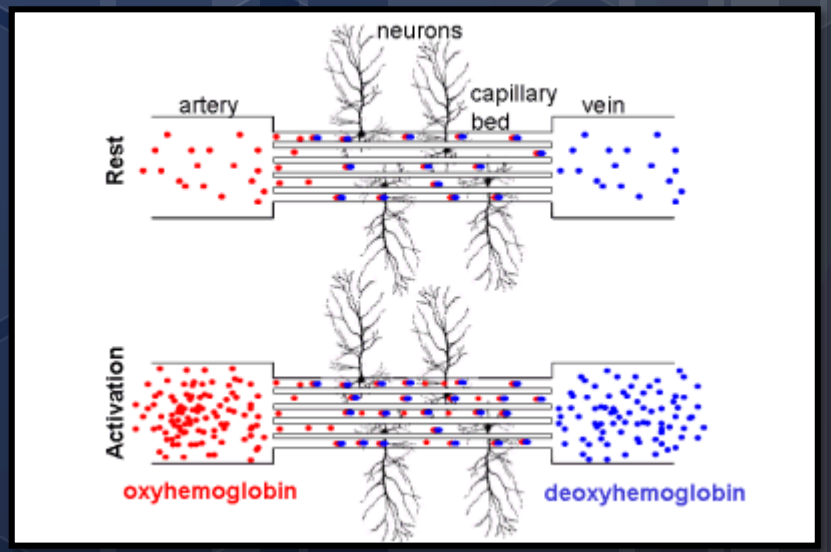
Temporary disruption

- Transcranial Magnetic Stimulation (TMS)

Increased local blood flow

- Positron Emission Tomography (PET)
- Functional Magnetic Resonance Imaging (fMRI)

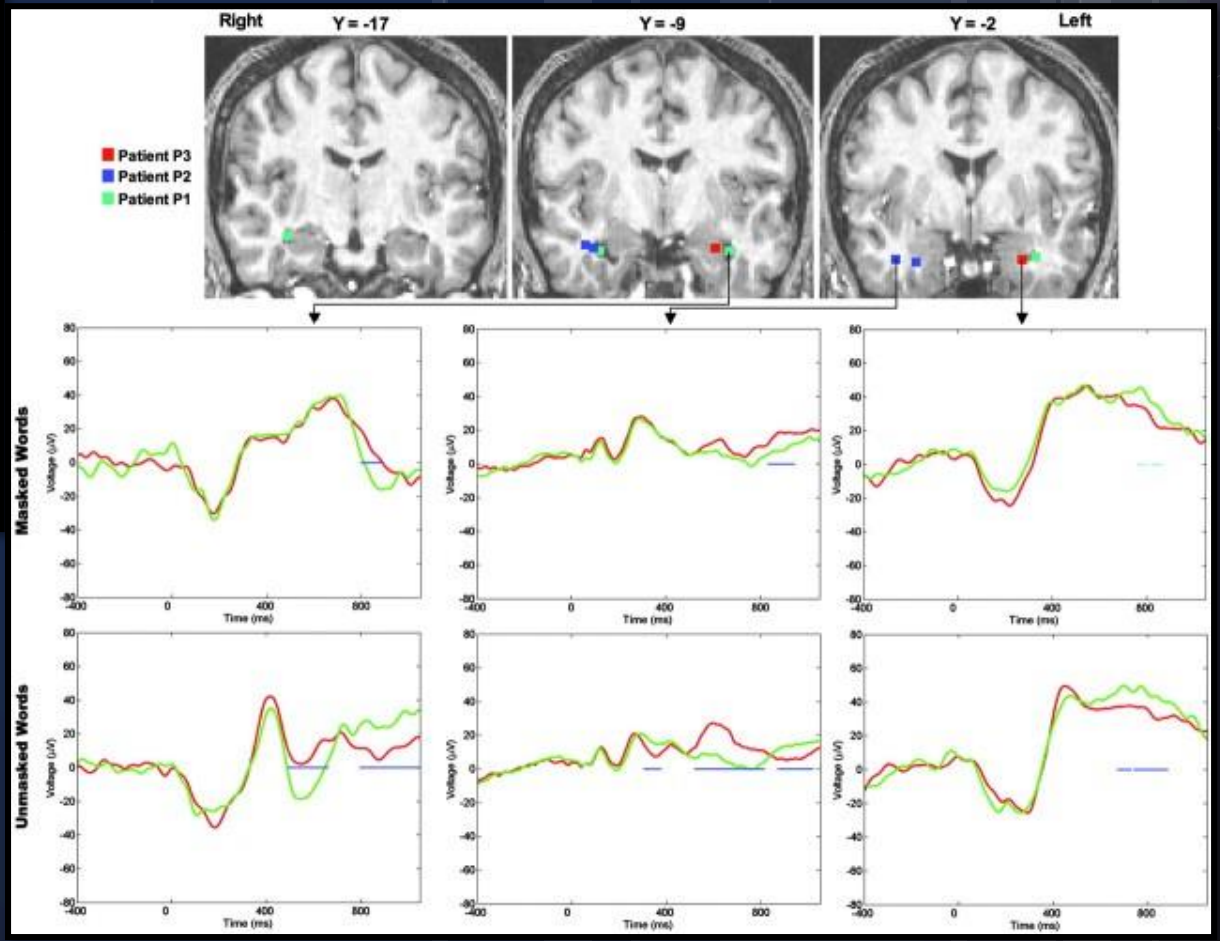




Electrophysiology

Direct measurement of neural activity

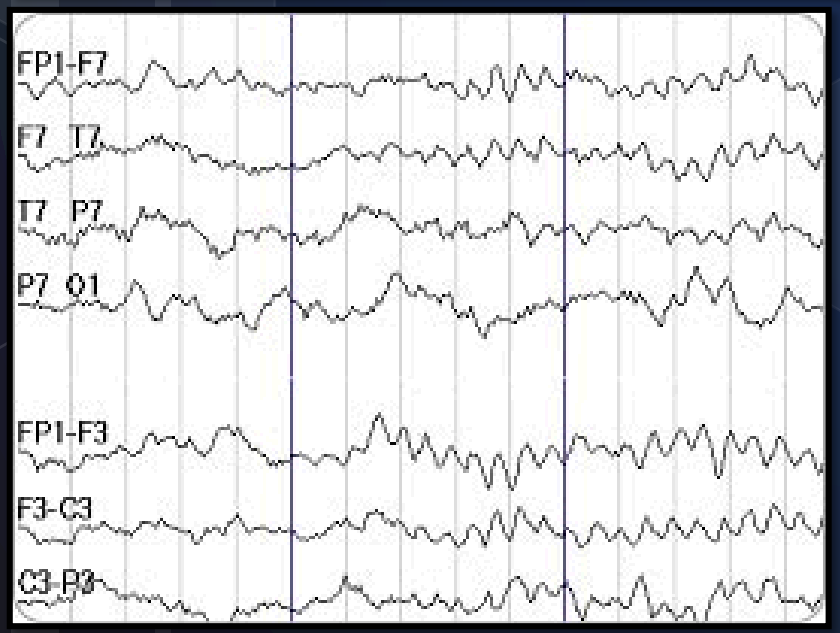
- Grid electrodes over cortex
- Depth electrode
- Electrodes implanted for monitoring of epileptic seizures



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

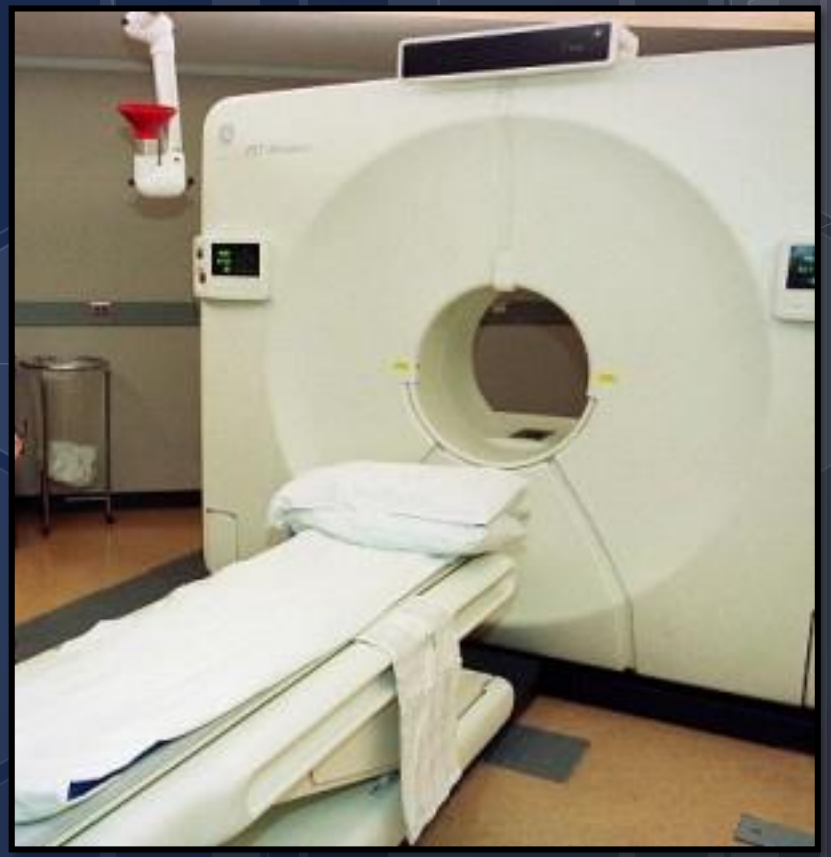
Positron-Emission Tomography (PET)

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



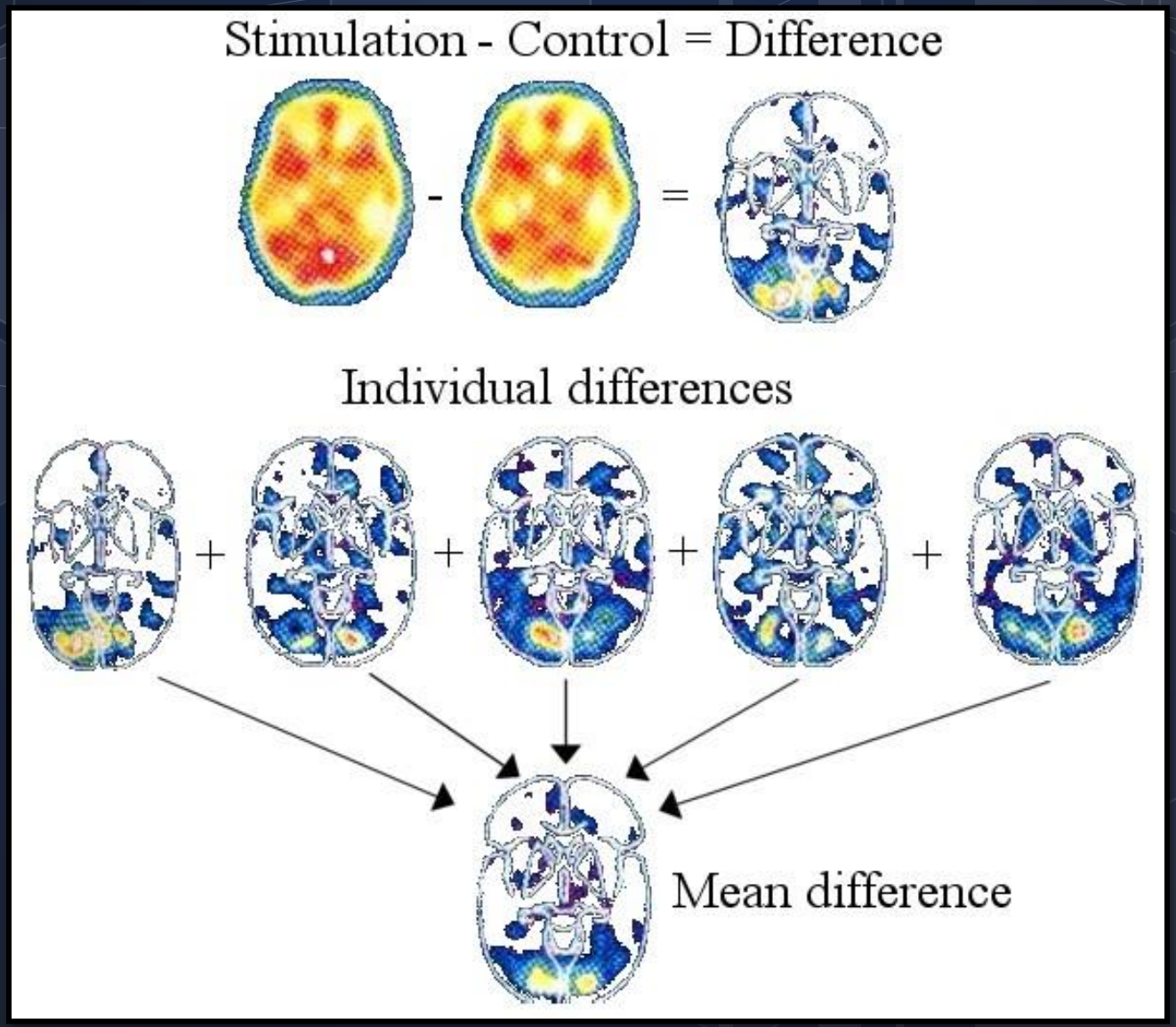
Functional Magnetic Resonance Imaging (fMRI)

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 resolution (still slow)
- PET can trace more than just blood (e.g., glucose or dopamine)

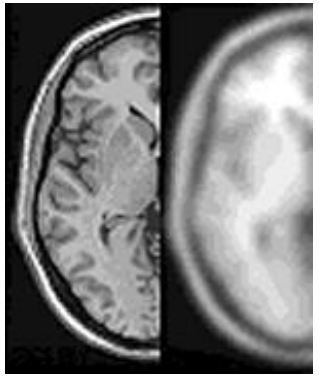
Data analysis



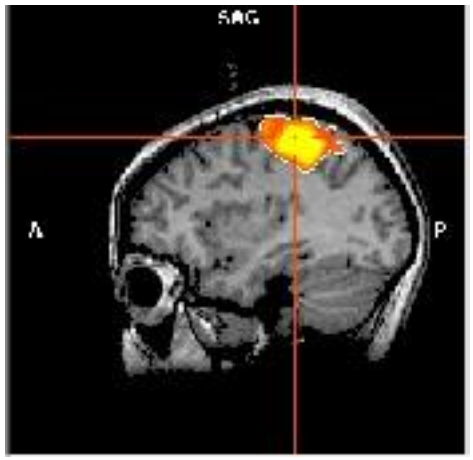
More than pretty pictures?

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



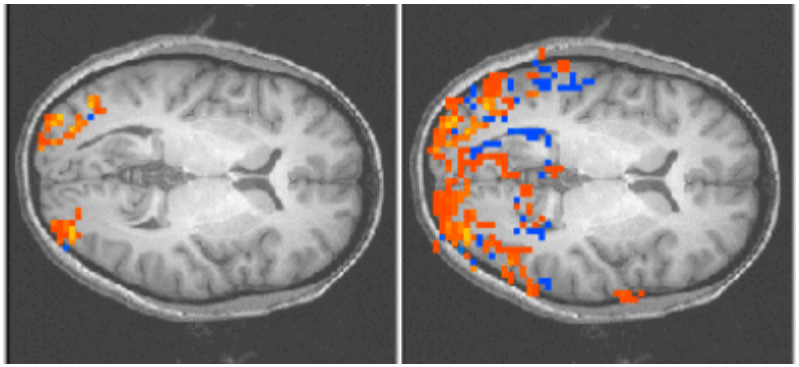
- Activation areas are usually big
  - Use of Talairach coordinates of peak activation (postcentral gyrus) but also: motor cortex, frontal eye fields, intraparietal sulcus



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