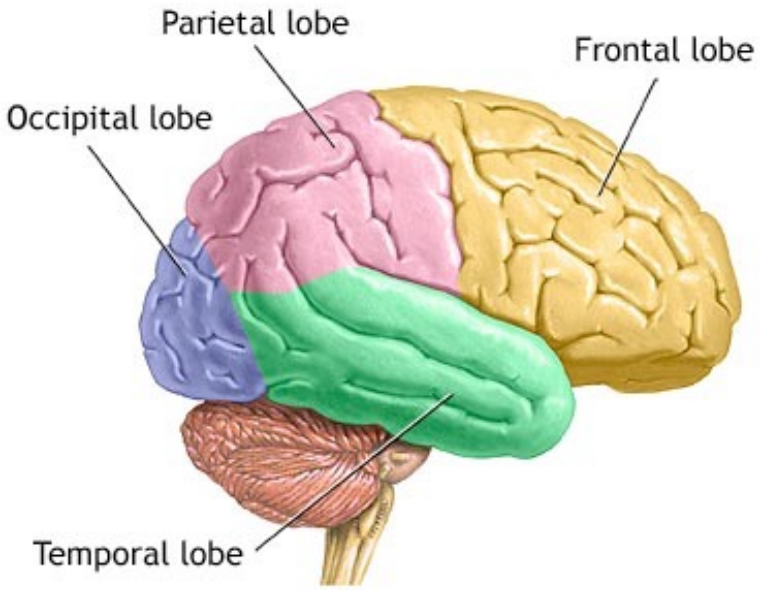
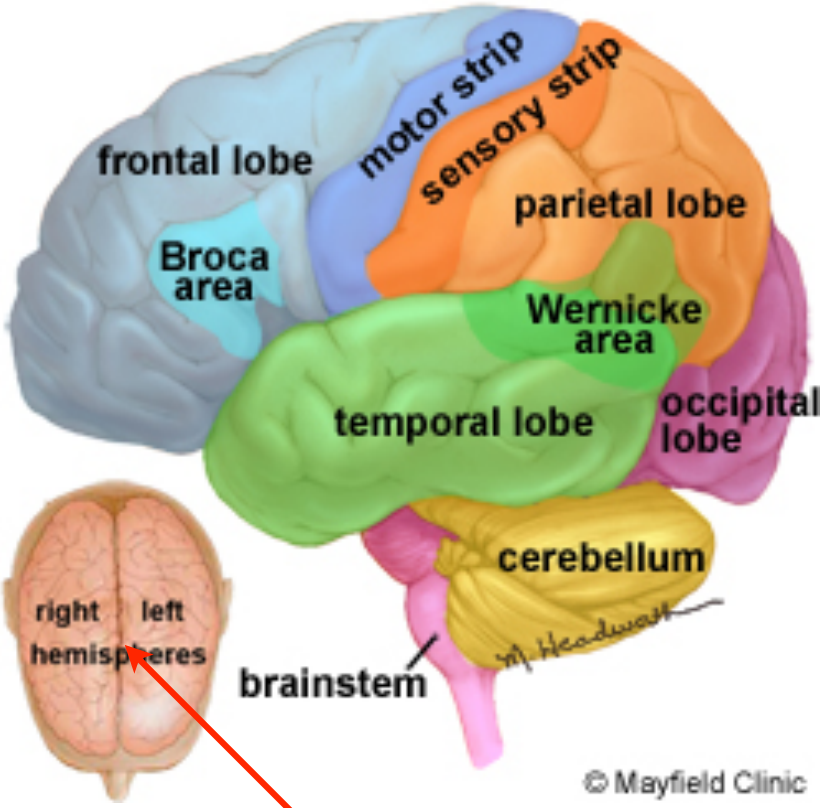
The brain = 10^{11} neurons





Cortex = "rind"

Corpus callosum
connects hemispheres

Occipital lobe -- vision
Temporal lobe -- audition etc
Parietal lobe -- attention etc -
Frontal lobe - executive function, decision making

- Localization of function

  Different parts of the brain do different things

  First famous example: Broca's area (about 1860)

    Broca's patients with left hemisphere damage in a particular place lost the power of speech

    First clear evidence that "higher thought" was localized in the cortex

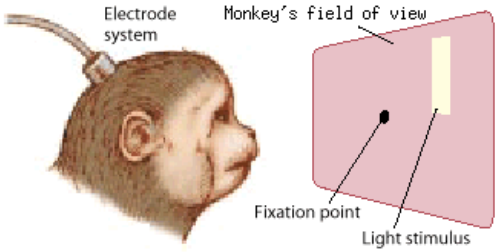
Neuroscientific methods

- Individual cellular recording

  - Electronic probes of individual neurons

  - Very sensitive, but also very invasive

  - Historically mostly in animals… now in humans too

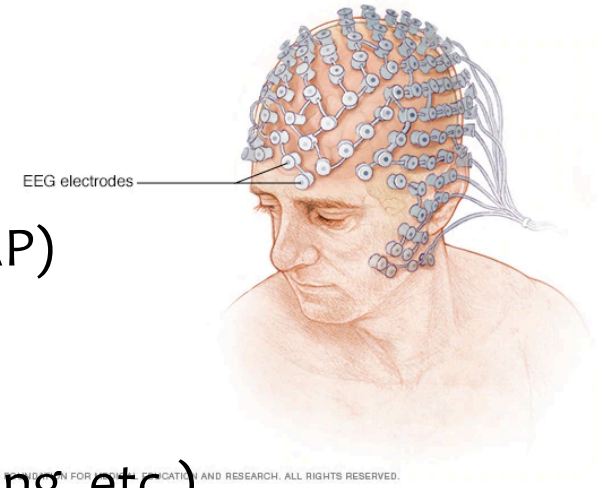


- Electroencephalography (EEG)

  - An array of electrical probes on the scalp

  - Characteristic results: Event-related potentials (ERP)

  - High temporal precision but low spatial precision



- Lesion studies (strokes, surgeries, bullets, CO poisoning, etc.)

  - Study what cognitive deficits are associated with what injuries

- Neuroimaging (PET, fMRI, etc.)

Neuroimaging

- Neuroimaging is a set of modern methods for visualizing brain function non-invasively
- PET -- positron emission tomography
- fMRI - function magnetic resonance imaging
- PET and fMRI both read: BOLD signal = Blood Oxygen Level Dependent, which shows where the blood is going

Method of subtraction

BOLD in experimental task
- BOLD in control task
= BOLD due only to critical aspect of task

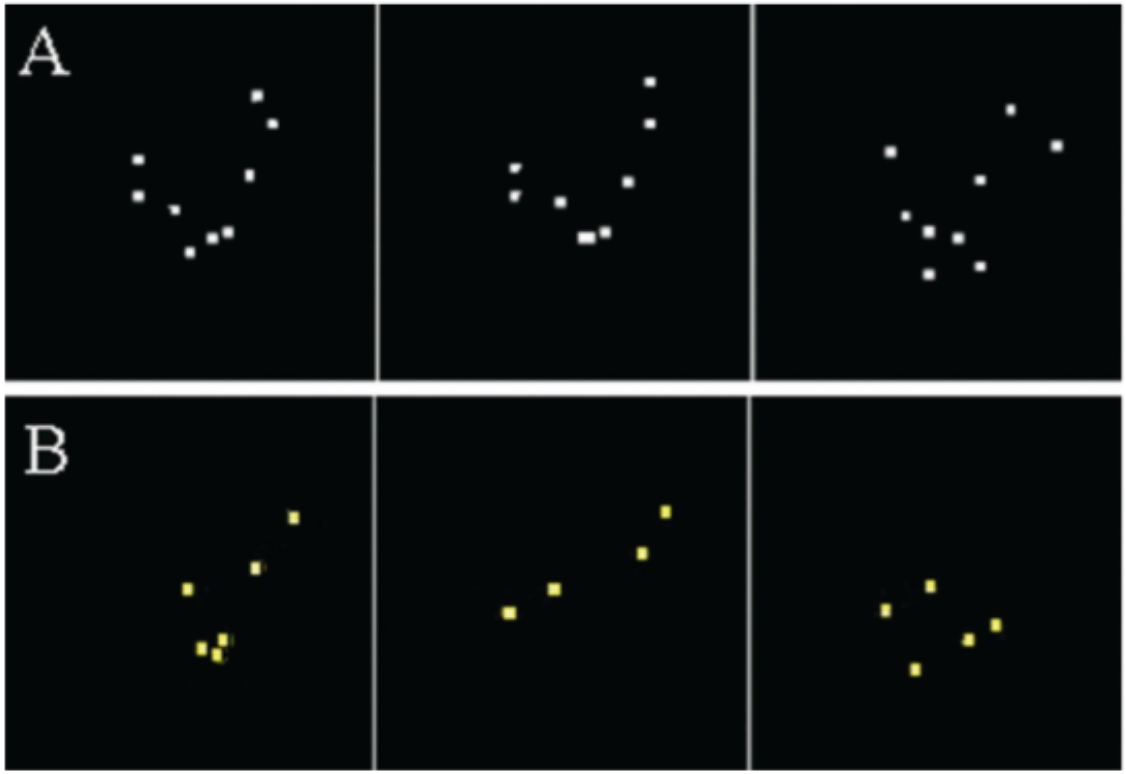
"What lights up" is really
"what lights up MORE in the experimental task than the control task"

Experimental task vs control task

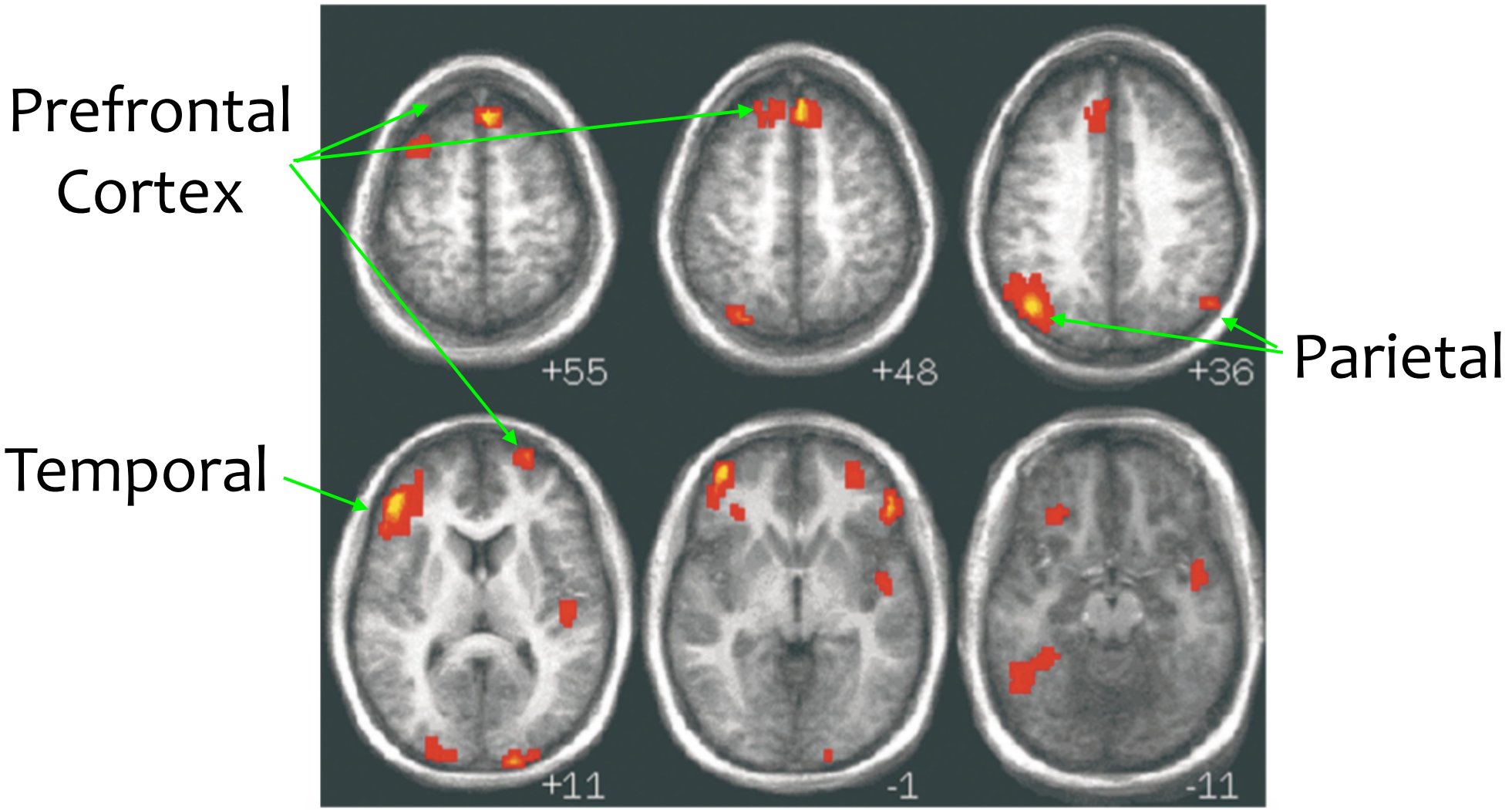
Example: Reber, Wong & Buxton (1992)

Categorization

Counting



fMRI subtraction images



Neuroanatomy of categorization

- Visual cortex
- Motor response areas
- Parietal lobe - decision areas
- Reward areas - Dopaminergic System / midbrain
- Exemplars — hippocampus and medial temporal lobe
- Categorization “proper” - prefrontal cortex

Two systems of categorization?

- Much modern research on concept learning concerns the dichotomy between two basic learning strategies:

  1. Abstraction of regularities (e.g. prototype models…)

  2. Storage of instances (e.g. exemplar models…)

- Instead of viewing these as competitors, many researchers now view these as complementary
- This is the hybrid or dual-systems framework
- There is some evidence that learners start with prototypes and employ exemplar strategies later

- Bird facts:
  - Robins fly
  - Eagles fly
  - Sparrows fly
  - Seagulls fly
  - Finches fly
  - Crows fly
  - Ravens fly
  - Ostriches can't fly
  - Penguins can't fly
  - …

Conclusion: Birds fly, except ostriches and penguins

- Mammal facts:
  - Cows can't fly
  - Horses can't fly
  - Cats can't fly
  - Antelopes can't fly
  - Wolves can't fly
  - Whales can't fly
  - Kangaroos can't fly
  - Bats can fly
  - …

Conclusion: Mammals can't fly, except bats

Strategy: Abstract to find regularities, then memorize the exceptions

Regularity extraction

Exemplar storage

Two distinct psychological mechanisms

COVIS model (COmpetition between Verbal and Implicit Systems)

- Ashby et al. divide categorization into Rule-based (RB) and Information-Integration (II) components
- RB involve learning rules on discrete, verbalizable dimensions

  - explicit (conscious)

- II involves computing similarity along combinations of dimensions

  - implicit (unconscious)

- They argue these are two completely distinct systems that involve different brain areas:

  RB: prefrontal cortex, anterior cingulate, head of the caudate nucleus, and the hippocampus

  II: striatum, etc.

- Maybe: RB system is evolutionarily newer (primates only?) and the II system is older?