Some methods for localizing brain function

• Lesions
  – E.g., severed corpus callosum
  – Inference: the damaged tissue supported the impaired function
  – Are these experiments?
    • No; there’s no manipulation

Some methods for localizing brain function

• Transcranial magnetic stimulation (TMS)
  – Creates temporary (!) lesions
  – Allows experimental designs

Some methods for localizing brain function

• Functional magnetic resonance imaging (fMRI)
  – Measures blood flow, which increases to tissue where neurons are firing faster
  – Inferences about function depend on subtractive method

Subtractive method

Looking at a stimulus Looking at blank screen Difference
Evidence that looking at the stimulus activates posterior cortical areas
Good internal validity requires careful design of control conditions
Neurons
Sensation

The neuron

Structure: Dendrites Soma Axon
Function: Inputs Computation Output

Polarization: Imbalance of electrical charges across cell membrane

Computation: Am I depolarized?
If so, then "fire": Propagate depolarization down axon
This propagation is an action potential ("spike")

Action potential

Each spike travels at constant speed
The firing rate (# spikes/second) determines signal strength
Traffic analogy: strong signal = same speed, lots of cars

Synapses

Synapse: Small gap between axon terminal and dendrite
Bridged by neurotransmitters released when a spike arrives
Some neurotransmitters add +’s, some add -’s

Excitatory synapses add +’s to the soma
Inhibitory synapses add -’s to the soma

Signal strength
Sensation

- Sensation begins with transduction:
  - Cells convert a stimulus to neural signals
  - Vision: Photoreceptor cells (rods, cones)
- Ends with perception of objects
  - Somewhere in the cortex
  - Many stages in between

The fovea is a region of high acuity

Receptive field of a ganglion cell

- Which ganglion cell(s) are firing at baseline?
  - B and D
- Which ganglion cell(s) are firing above baseline?
  - A
- Which ganglion cell(s) are firing below baseline?
  - C
• Ganglion cells project topographically to primary visual cortex
• The visual cortex detects rows of cells firing above or below baseline
  – So detects edges in the world
  – Edges help define objects

The Hermann grid

The ganglion cell at the intersection sends a weaker signal than its neighbors
The brain interprets the weaker signal as less light hitting the "+" region

Why do the spots go away when you foveate them?
Foveal ganglion cells have smaller receptive fields