Chapter 2: Cognitive Neuroscience

Chapter Outline

Neurons: The Building Blocks of the Nervous System
- The Microstructure of the Brain: Neurons
- The Signals that Travel in Neurons
- Method: Recording from Neurons

Localization of Function
- Localization for Perception
- Method: Brain Imaging
- Localization for Language
- Method: Event-Related Potential

Distributed Processing in the Brain

Representation in the Brain
- Representing a Tree: Feature Detectors
- The Neural Code for Faces
- The Neural Code for Memory

Something to Consider: "Mind Reading" by Measuring Brain Activity

CogLabs: Receptive Fields; Brain Asymmetry

Web Links

Literature, Cognition, & the Brain
Research at the intersection of literary studies, cognitive theory, and neuroscience. The webpage includes abstracts, reviews, accounts of work forthcoming or in progress, links to related websites, and a regularly updated annotated bibliography.
http://www2.bc.edu/~richarad/lcb/home.html

Philosophy of Science and Physiological Psychology
A worldview of physiological psychology that contains many valuable citations of articles and books.
http://www.circadian.org/PPP/ppp.html

Animations: How Drugs Work
An excellent set of demonstrations showing how drugs work in the body and in the brain. An animation shows how brain cells communicate, with demonstrations depicting the effects of alcohol, cocaine, and opiates in the brain.
http://www.pbs.org/wnet/closetohome/science/html/animations.html

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Brain and Behavior
Links to interactive exhibits about various brain phenomena and to other sites containing information about the brain.
http://serendip.brynmawr.edu/bb/

Probe the Brain
A website that lets you probe the brain to discover what area controls which part of the body. You could use it to ask students to explore the notion of localization of function versus distributed processing.
http://www.pbs.org/wgbh/aso/tryit/brain/#

Event-Related Potentials and Lie Detection
An abstract from a paper by Farwell and Donchin that investigates the usefulness of ERP techniques in lie detection (as an alternative to the technique of polygraphs). Students may find this application of ERPs compelling and intriguing. The full paper citation is also provided below.

http://www3.interscience.wiley.com/journal/119348239/abstract?CRETRY=1&SRETRY=0

Farwell, L.A. & Donchin, E. (1991). The truth will out: Interrogative polygraphy ("lie detection") and with event-related brain potentials. *Psychophysiology, 28*(5), 531-547.

Association for Psychological Science, Biological
A website on the Association for Psychological Science's webpage that contains an extensive list of links related to physiological psychology.
http://psych.hanover.edu/APS/teaching.html#biological

Discussion Questions

1. Students can be intimidated by the intricacy of the nervous system and sometimes insist that psychologists need not be biologists, too. Guide a discussion to convince them that any useful model/theory about cognition must be neurally plausible. Ask them to generate reasons why an understanding of the brain is an important component toward appreciating human cognition.
To drive these points home, you might supplement the text's ideas with additional descriptions of neuropsychological patient data (as students often find such cases of unique behaviors and dissociations fascinating). Ask them to draw conclusions about cognition from your supplemental examples (patient data, other types of physiological studies, etc.) to show that understanding neuroscience is an essential component to cognitive psychology.

2. Discuss the organization of the brain. Provide pictorial representations of the brain and have students locate and recognize a variety of structures, including the cerebral cortex and the lobes of the brain. Have students identify the cognitive processes associated with each area. Ask students to generate sample stimuli that might activate each of the areas. If possible, graphically link the stimuli to the associated area to provide visual memory cues for the students to assist in their learning.

3. Guide students in a discussion of how localization of function might create a disadvantage if the brain were solely organized around that principle. How might cognition be more fragile if important specific functions were located solely in one area? How does distributed processing create greater opportunities for protecting cognitive function and allowing for restoration of cognitive function in the event of a loss related to brain damage?

Demonstrations

1. Demonstrate the nature of the images obtained with the PET procedure and the subtraction technique. Explain the PET procedure. Provide a visual example of a PET scan. Explicate baseline activity (control task) and stimulation activity (target task). Explain that the brain activity associated with the target task is calculated by subtracting the baseline activity from the stimulation activity. Ask students to generate ideas for what may be the advantages and drawbacks of this brain-imaging tool.

2. If you have the ability to project the Internet to the class on a large screen, consider using the website listed below to demonstrate how researchers might measure one's ability to recognize faces. There are two tests that measure ability to recognize faces, and one is much longer than the other, so you might screen both to determine which will work best as a demonstration for your class. Once you have had a student perform the task, you might ask students how this sort of assessment differs from the brain-imaging techniques discussed in the text that might be used to assess the physiological reasons underlying prosopagnosia.

http://www.testmybrain.org/

3. Illustrate how learning and practice can impact the speed of neural transmission using a simple "squeeze chain" demonstration that will get students out of their seats. Have the students create a human chain by standing in a line around the perimeter of the room with their hands on the shoulders of the person in front of them. Have them close their eyes and then squeeze the shoulder of the person in front of them. At the same time, start a stop watch. Each student should squeeze the shoulder of the person in front of them when they feel the squeeze. Time how long it takes the squeeze chain to make it to the last person. Post the time where all students can see it and ask them to repeat this task a few more times (at least two). Most groups will show an increase in the speed of the chain with practice. This illustrates to them how neural activity, which is discussed on a very abstract level in the text, benefits from practice effects

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