# Chapter Two

# Brain and Behavior

*Chapter Theme: Brain activity is the source of human consciousness, intelligence, and behavior*

**Discussion Topics**

One-Minute Motivator 2.1: Firing of the Neuron
One-Minute Motivator 2.2: Studying Memory
One-Minute Motivator 2.3: Oxytocin and Mothering
One-Minute Motivator 2.4: Studying Facial Recognition
One-Minute Motivator 2.5: Brain and the Mind
One-Minute Motivator 2.6: Surface Areas of the Cortex
One-Minute Motivator 2.7: Child without a Brain
One-Minute Motivator 2.8: Have No Fear
One-Minute Motivator 2.9: Hormones and Foods
One-Minute Motivator 2.10: Brain Specialization
One-Minute Motivator 2.11: Right Brain vs. Left Brain
Broadening Our Cultural Horizons 2.1: Use of Cerebral Hemispheres
Broadening Our Cultural Horizons 2.2: Cultural Attitudes toward Transplants
Value Clarification 2.1: Extreme Criminality Should Be Punished With Psychosurgery
Value Clarification 2.2: Personality is a Product of Free Will
Value Clarification 2.3: Parents Must Maximally Develop Their Children
Value Clarification 2.4: Medication for Brain Problems is Still Just Medication
Value Clarification 2.5: People with Depression Should Just Toughen Up
Value Clarification 2.6: People with Genetic Abnormalities Should Not Have Children
Value Clarification 2.7: People with Mental Illnesses Should be Genetically Tested
Value Clarification 2.8: People should be Able To Get High If They Want
Value Clarification 2.9: Parents Should Have Complete Control over Their Children's Health
Value Clarification 2.10: People Should Have the Right to Choose Their Health Care
Value Clarification 2.11: Fetal Tissue Should be Used to Cure Human Diseases
Value Clarification 2.12: Stem Cell Research Should be Forbidden
Value Clarification 2.13: Being Ambidextrous is Good

**Classroom Activities**

Exercise 2.1: Cortical Localization and Interference
Exercise 2.2: Neurotransmitters
Exercise 2.3: Sympathetic Nervous System
Exercise 2.4: Activity of the Brain
Exercise 2.5: Left-Handers in a Right-Handed World
Exorcise 2.6: Application to Other Disciplines
Exorcise 2.7: Brain Dominance
Exercise 2.8: Cultural Attitudes towards Prolonging Life
Exercise 2.9 Sculpting the Brain

Exercise 2.10 Brain Map
Role-Playing Scenario 2.1: Exploring Facial Agnosia
Role-Playing Scenario 2.2: One Hemisphere at a Time
Role-Playing Scenario 2.3: Exploring Your Nondominant Side
Role-Playing Scenario 2.4: Half a Brain

**Video Suggestions**

The Brain: Teaching Modules
The Brain: Your Information Superhighway
Discovering Psychology Series: The Behaving Brain
Dopamine Seduction: The Limbic System
The Neuroscience of Everyday Life
The Endocrine System

**Multimedia Resources**

PowerLecture with JoinIn™ and ExamView® for *Introduction to Psychology: Gateways to Mind and Behavior*, 13th Edition
Websites
Digital Media Library 3.0
- 3D Brain
- 3D Brain: The Cerebral Cortex
- Action Potential
- Brain Organization, Structure, and Function
- Brain Re-Growth
- Evaluation of Patients with Brain Damage
- Hemisphere Control
- Hemispheric Specialization
- Interference—Synaptic Transmission
- Mirror Neurons
- Movement of Sodium and Potassium Ions in Action Potential
- Neural Networks
- Neural Transmission
- Neurotransmitter Release
- New Brain Scan
- Resting Potential
- Structure of the Neuron
- Synaptic Transmission
- The Brain
- Traumatic Brain Injury
- Wernicke-Geschwind Model

**Supplemental Lecture**

The Brain

**Handouts**

Handout 2.1 Activity of the Brain
Handout 2.2 Lateral Eye Movements
Handout 2.3A Cultural Attitudes toward Prolonging Life
Handout 2.3B Cultural Attitudes toward Prolonging Life

## Chapter Two Outline

**2.1 Neurons—Building a "Biocomputer"**

**Gateway Question 2.1: How do neurons operate and communicate?**

Learning Objective 2.1.1 – Explain the function of neurons and glial cells within the nervous system; and list and describe the four parts of a neuron and the specific function of each part.

Learning Objective 2.1.2 – Describe an action potential, including why it is an all-or-nothing event, the function of the myelin layer within the process of saltatory conduction, why an action potential is considered an electrical event, and the definitions of the following terms: resting potential, threshold, ion channels, and negative after-potential.

Learning Objective 2.1.3 – Describe how nerve impulses are carried from one neuron to another through a chemical process, including an explanation of receptor sites and how different types of neurotransmitters can excite or inhibit the receiving cell.

Learning Objective 2.1.4 – Describe the function of the chemicals called neuropeptides in regulating the activities of other neurons as well as the pain-killing effects of the neuropeptide chemicals known as enkephalins and endorphins.

Learning Objective 2.1.5 – Describe how neural networks interlink collections of neurons and process information in our brains to produce all behavior.

Learning Objective 2.1.6 – Describe the process of neuroplasticity, including the use of therapy and training in self-directed neuroplasticity.

**2.2 The Nervous System—Wired for Action**

**Gateway Question 2.2: What are the major parts of the nervous system?**

Learning Objective 2.2.1 – Describe the make-up and functions of the central nervous system (CNS) and the peripheral nervous system (PNS).

Learning Objective 2.2.2 – Chart the subdivisions of the peripheral nervous system (PNS), describe the functions of the somatic nervous system (SNS) and the autonomic nervous system (ANS), identify the automatic bodily processes controlled by the sympathetic and parasympathetic branches of the ANS, and explain how the combined activity of both branches determines if the body is more or less relaxed or aroused.

Learning Objective 2.2.3 – Explain how a reflex arc arises within the spinal cord, including the functions of the sensory neurons, connector neurons, and motor neurons within this process.

Learning Objective 2.2.4 Explain the function of neurilemma in the regeneration of neurons and nerves within the PNS, list ways to prevent injury to the CNS, and discuss the techniques that scientists are working on ways to repair damaged neural tissue.

**2.3 Research Methods—Charting the Brain's Inner Realms**

**Gateway Question 2.3: How are different parts of the brain identified and what do they do?**

Learning Objective 2.3.1 – Define biopsychology.

Learning Objective 2.3.2 – Describe the brain research strategy referred to as localization of function.

Learning Objective 2.3.3 – Describe how brain structure is investigated through the techniques of dissection, CT scans, and MRI scans.

Learning Objective 2.3.4 – Describe the techniques that are used to map brain functions, including clinical case studies and the observations of neurological soft signs, electrical stimulation, ablation, deep lesioning, electrical recording, and microelectrode recording, as well as less intrusive EEG recording, PET scans, and fMRI scans; and discuss how these techniques have been used to detect and understand brain disorders, brain efficiency, and even behaviors, such as lying.

**2.4 The Cerebral Cortex—My, What a Wrinkled Brain You Have!**

**Gateway Question 2.4: How do the left and right hemispheres differ and what are the different functions of the lobes of the cerebral cortex?**

Learning Objective 2.4.1 – Describe the main differences between the brains of lower and higher animals and include a description of the cerebral cortex, the two hemispheres, gray matter, corticalization, the corpus callosum, and the curious problem called spatial neglect.

Learning Objective 2.4.2 – Explain how and why the brain is "split" and the resulting behavioral effects experienced by individuals who have undergone this type of brain surgery.

Learning Objective 2.4.3 – Describe the functions of the left cerebral hemisphere.

Learning Objective 2.4.4 – Describe the functions of the right cerebral hemisphere.

Learning Objective 2.4.5 – Discuss the location and functions of the frontal lobes of the brain, including the primary motor area and its mirror neurons and the many association areas, which combine and process information, and explain how damage to one association area, Broca's area, results in motor aphasia and how the prefrontal cortex is related to abstract thought and one's sense of self.

Learning Objective 2.4.6 – Describe the location and functions of the parietal lobes and its primary sensory area.

Learning Objective 2.4.7 – Describe the location and functions of the temporal lobes and its primary auditory area, and explain how damage to one association area, Wernicke's area, results in fluent aphasia.

Learning Objective 2.4.8 – Describe the location and functions of the occipital lobes and its primary visual area; and explain the effects of damage to these lobes.

Learning Objective 2.4.9 – Discuss the structural differences in the brains of men and women and the differences in how their brains are specialized to deal with intellectual and language capabilities.

**2.5 The Subcortex—At the Core of the (Brain) Matter**

**Gateway Question 2.5: What are the major parts of the subcortex?**

Learning Objective 2.5.1 – Identify the parts of the brain that make up the forebrain, midbrain, and hindbrain and the general functions of these subdivisions, and explain what regions of the brain would be considered "subcortex."

Learning Objective 2.5.2 – Identify the location and functions of the medulla and pons, and describe the effects that damage to these areas can cause, including the recent research on the locked-in syndrome that results from damage to the brainstem.

Learning Objective 2.5.3 – Provide a description of the cerebellum, including its appearance, location in the brain, its functions, and the symptoms that would result from damage to this area.

Learning Objective 2.5.4 – Describe the location and functions of the reticular formation (RF), and explain how a part of the RF called the reticular activating system (RAS) keeps the brain active and alert.

Learning Objective 2.5.5 – Describe the appearance, location, and functions of the thalamus and the effects of damage to this brain area.

Learning Objective 2.5.6 – Describe the appearance, location, and functions of the hypothalamus and the effects of damage to this brain area.

Learning Objective 2.5.7 – Discuss the emergence of the limbic system as part of the forebrain and the overall functions of this system; identify the specific structures that comprise the limbic system and their functions, including the amygdala and hippocampus; and explain the significance of "pleasure" and "aversive" areas within the limbic system.

**2.6 The Endocrine System—My Hormones Made Me Do It**

**Gateway Question 2.6: Does the glandular system affect behavior?**

Learning Objective 2.6.1 – Explain the purpose of the endocrine system and how the action of the hormones affects behavior, moods, and personality.

Learning Objective 2.6.2 – Describe the location of the pituitary, pineal, thyroid, and adrenal glands, the hormones produced by each gland, and the effects of these hormones on the body and behavior when produced in normal or abnormal amounts; explain the function of the pituitary gland as the "master gland" and how this gland is, in turn, influenced by the hypothalamus; and discuss the problems with anabolic steroid use.

**2.7 Psychology in Action: Handedness—Are You Sinister or Dexterous?**

**Gateway Question 2.7: In what ways do left- and right-handed individuals differ?**

Learning Objective 2.7.1 – Discuss the characterization of handedness throughout history, explain how handedness, sideness, and brain dominance can be determined, and list the proportion of individuals who are right-handed, left-handed, or inconsistent regarding motor skills and production of speech.

Learning Objective 2.7.2 – Explain when clear hand preferences become apparent, and discuss the genetic and environmental factors that influence handedness.

Learning Objective 2.7.3 – Explain how handedness is not a simple either/or trait with most people being strongly right-handed, a minority being strongly left-handed, and a few having moderate or mixed hand preferences or are ambidextrous.

Learning Objective 2.7.4 – Discuss the advantages and disadvantages of being right- or left-handed, or ambidextrous, including the effects of being less strongly lateralized.

## Discussion Topics

*One-Minute Motivator 2.1:* ***Firing of the Neuron***

To conceptualize the firing of the neuron, students often need analogies to concrete objects. Possible analogies include: a radio, a telephone, a fax machine, a stereo system, the process of sending mail, etc. The analogy must be developed carefully: It must clarify, not mystify or confuse. A cap pistol can be used to demonstrate the all-or-none quality of the action potential. Since the text refers to a "domino" effect of sorts, set up a domino chain on a table.

*One-Minute Motivator 2.2:* ***Studying Memory***

Have students pretend that they suspect that a certain part of the brain is related to memory. How could you use clinical studies, ablation, deep lesioning, ESB, PET scans, or fMRI to study the way brain structure is related to the function of memory?

*One-Minute Motivator 2.3:* ***Oxytocin and Mothering***

Oxytocin is often called the bonding hormone. It is released during orgasm and also helps promote let-down when mothers breastfeed infants. Yet oxytocin has another side to it—it can be released during times of high social stress. An interesting hypothesis is that the dual nature of oxytocin helps us turn highly stressful events (mothering a newborn baby) into opportunities for bonding. Ask students for ways to test this hypothesis. Have them evaluate a study design that would compare breastfeeding mothers to non-breastfeeding mothers' self-reported levels of stress and attachment to baby as well as oxytocin levels. What pattern of results would support the hypothesis? See DeAngelis (2008) for more information on this topic.

*One-Minute Motivator 2.4*: ***Studying Facial Recognition***

You want to know which areas of the brain's surface are most active when a person sees a face. What technology will you use?

*One-Minute Motivator 2.5:* ***Brain and the Mind***

Students are usually very interested in addressing the subject of the relationship between the brain and the mind**.** You might begin a discussion of this topic by pointing out that many philosophical speculations regarding this issue have lost their relevance in light of new and innovative techniques (e.g., PET scans) for studying the human brain. The subject is, nevertheless, still very complex, and a lively class discussion can be generated by describing the following hypothetical experiment:

You are looking at a PET scan of your brain while the radiologist taking the scan is sitting with you. You are discussing the activity depicted on the screen. Assume that the PET scanner is slightly advanced over what is presently available and depicts glucose utilization immediately. (State-of-the-art scans require a 30- to 45-minute lead-time.) As you are staring at the PET scan, the radiologist points out that the most active areas seen on the screen are in the left hemisphere, particularly the language area and the visual areas toward the back of the brain. At this moment you hear some music, and almost immediately the activity pattern of the scan changes. Now there is activity in the right hemisphere as well, and you call the radiologist's attention to that change. "That's somewhere in the region of the music appreciation center," she responds. Then a few

minutes later she asks, “Do you have any comments on the PET scan?” “What do you mean?” you reply, and, at this point, you notice another change. The auditory areas, as well as the frontal lobes, light up. You look toward the radiologist and see that she is smiling, and you finally realize that the PET scan is depicting your own brain activity! It is showing a shift as you change from one thinking activity to another.

Now ask the students to consider the following questions: Is this an example of their minds studying their brains, or can they adequately explain it as the brain studying itself?

*One-Minute Motivator 2.6:* ***Surface Areas of the Cortex***

To illustrate the enhanced surface areas of the cortex**,** wad up a piece of foil or aluminum-backed cloth to create a convoluted brain surface. If you don’t have these materials, crumpling a sheet of paper into a small ball will suffice.

*One-Minute Motivator 2.7:* ***Child without a Brain***

A national news service reported the case of a child born without a brain, a condition known as anencephaly**.** Anencephaly occurs in approximately 1 out of 1,000 live births, but most children live only hours or a few days at most. In the most recent instance, the defect was not discovered until the child was several months old. According to the doctors interviewed at the time, such cases occur about once a year. The baby, who appeared outwardly normal and healthy, began to cry excessively, and tests were performed to determine the cause. These tests revealed that the child had no brain. Doctors speculated that a cyst formed during prenatal development at the stem where the brain should have been and prevented further growth. The child survived because that portion of the brainstem that controls vital functions had already developed before the cyst formed. After students have read Chapter 3, they should be able to predict the kinds of abilities one might expect from such a child. You could ask them to describe the likelihood of this child having a personality, motivation, awareness, intelligence, etc.

*One-Minute Motivator 2.8:* ***Have No Fear***

S. M. is a woman who sustained damage to her amygdala. Consequently, she lives without fear. While this may sound like a great existence, ask students to think through the implications of it. Engage students in a discussion of the adaptive value of fear and why the amygdala may be part of the “old” brain because of this. For more information, read Feinstein et al. (2010).

*One-Minute Motivator 2.9:* ***Hormones and Foods***

There are many articles in the media discussing the interrelationship between different foods and our hormones. For example, people are encouraged to take chromium to raise insulin, eat chocolate when our estrogen levels drop, or eat iodized salt to help our thyroid. Ask students to share some of the media “blitzes” they’ve heard or read about.

*One-Minute Motivator 2.10:* ***Brain Specialization***

Are there advantages and/or disadvantages to having our brains as specialized and lateralized as they are? Consider aspects such as plasticity, brain damage, cognitive efficiency, etc.

*One-Minute Motivator: Exercise 2.11:* ***Right Brain vs. Left Brain***

Right Brain/Left Brain: After students have learned that the two cerebral hemispheres differ in abilities, have them figure out in what ways are they similar and compare it to the differences.

*Broadening Our Cultural Horizons 2.1:* ***Use of Cerebral Hemispheres***

Ask students to give their opinions as to ways that different cultures might make greater or lesser use of the various strengths of the right and left cerebral hemispheres.

*Broadening Our Cultural Horizons 2.2:* ***Cultural Attitudes toward Transplants***

Different religions have diverse attitudes concerning the rights of humans to intervene medically to save a life and also concerning the disposition of a person's body after death. Compare and contrast the following views:

a. Blood transfusions should not take place.
b. The body should not be violated after death.
c. Parts of the dead should be immediately used for transplants.
d. A person's body should be cremated at death.

*Value Clarification 2.1:* ***Extreme Criminality Should be Punished With Psychosurgery***

Brain surgery should be required for individuals convicted of serial murders and similarly horrible crimes.

*Value Clarification 2.2:* ***Personality is a Product of Free Will***

Personality is mostly a free choice, not a biological state.

*Value Clarification 2.3:* ***Parents Must Maximally Develop Their Children***

Parents should do everything possible to make sure that their child develops maximum intellectual abilities.

*Value Clarification 2.4:* ***Medication for Brain Problems is Still Just Medication***

Taking psychiatric medication for problems in the brain is no different than taking medication for any other organ that isn't functioning properly.

*Value Clarification 2.5:* ***People with Depression Should Just Toughen Up***

People who are suffering from depression because of a serotonin deficit should be able to work through their problems without anti-depressants.

*Value Clarification 2.6:* ***People with Genetic Abnormalities Should Not Have Children***

People who carry the gene for genetically related brain disorders, such as Parkinson's, should be discouraged from reproducing.

*Value Clarification 2.7:* ***People with Mental Illnesses Should be Genetically Tested***

If I had I some form of mental illness (e.g., Parkinson's disease, schizophrenia, etc.), I would go for genetic testing.

*Value Clarification 2.8:* ***People Should be Able to Get High If They Want***

If people want to take brain-altering drugs (including party drugs and steroids) then so be it; it's nobody else's business what they do with their bodies.

*Value Clarification 2.9:* ***Parents Should Have Complete Control Over Their Children's Health***

A parent has the right to decide whether medical treatment is given to his/her child, even if the child's life may be endangered by the decision.

*Value Clarification 2.10:* ***People Should Have The Right to Choose Their Health Care***

A person should be able to write a "living will" and prevent hospitals from using extreme measures to keep his or her body alive, or even to end their life early if they so desire.

*Value Clarification 2.11:* ***Fetal Tissue Should be Used to Cure Human Diseases***

Transplantation of brain tissue to cure human diseases and to reverse paralysis should be done even if fetal brains remain the only source of tissue.

*Value Clarification 2.12:* ***Stem Cell Research Should be Forbidden***

The moral issues surrounding stem cell research are too great, even where there is medical advancement.

*Value Clarification 2.13:* ***Being Ambidextrous is Good***

A person could be a better athlete if he/she were ambidextrous.

## Classroom Activities

*Exercise 2.1:* ***Cortical Localization and Interference***

This demonstration is a sure-fire illustration of cortical localization and interference. Begin by asking the entire class to simultaneously move the right hand and right foot in a clockwise direction for a few seconds. This should be quite easy for everyone. Next, ask that the right hand and left foot be moved in a clockwise direction. This is also easy. Next, have students make circular movements in opposite directions with the right hand and the left foot. This is more difficult, but most students will master it. Finally, have students attempt to move the right hand and right foot in opposite directions. This is extremely difficult for most people. After making these observations, students should be challenged to explain them. If they need a hint, ask them to think in terms of probable activity in the motor areas of the cortex.

*Exercise 2.2:* ***Neurotransmitters***

The power of neurotransmitters can be demonstrated using a squirt gun filled with laundry bleach. Squirt a colorful fabric; then squirt a glass or porcelain plate. The point to be made is that neurotransmitters must adhere to appropriate receptor sites before an action potential can be triggered.

*Exercise 2.3:* ***Sympathetic Nervous System***

Without warning, suggest that it would be helpful to know more about the interests of students. Explain, "In five minutes I will pick a student from the class and ask her/him to stand up and give a brief speech." After one student talks briefly, discuss the actions of the sympathetic nervous system in their own bodies during the past few minutes. Then guide students through a few minutes of deep breathing and relaxation to demonstrate the parasympathetic system. The transition from one to the other may be identified by asking students to indicate when they have sufficient saliva to actually swallow a cracker.

*Exercise 2.4:* ***Activity of the Brain***

In **Handout 2.1,** students will answer questions regarding the action of parts of the brain.

*Exercise 2.5:* ***Left-Handers in a Right-Handed World***

Ask left-handers to meet outside of class and make a list of all the inconveniences of living in a right-handed world**.** Ask them to share any horror stories from their childhoods, such as having their left hands tied to their backs, etc.

*Exercise 2.6:* ***Application to Other Disciplines***

Have students apply the information on the brain to education by asking them to develop a way to teach a child who is very verbal (left hemisphere strength) how to read vs. a child who is very visual-spatial (right hemisphere). They may need to do extra reading on the topic. The objective is to have them apply information from other sources and/or from this class to a real-world problem.

*Exercise 2.7:* ***Brain Dominance***

An in-class activity that will demonstrate the functioning of the left and right hemispheres of the brain and which may show dominance of one hemisphere over the other involves observing lateral eye movement. A study by Schwartz, Davidson, and Maer (1975) serves as a model for this exercise. They were able to show that spontaneous lateral eye movement reflects activity in one or other of the hemispheres of the brain. Eye movement to the left seemed to indicate involvement of the right hemisphere, and movement to the right appeared to involve the left side. It has been observed that some people shift their eyes to the left more often than to the right. These are called left-movers. Others typically shift to the right and are called right-movers.

A conclusion drawn by researchers in this area is that left-movers have right hemisphere dominance and tend to be more artistic, creative, and intuitive thinkers. Right movers have left hemisphere dominance and tend to be more logical, analytical, verbal, and numerical. These conclusions are considered to be general tendencies and therefore should be viewed with a skeptical eye. More study and research is needed to support these conclusions.

Data Sheets (**Handout 2.2**)

1. Select five students to be the subjects of the demonstration. Ask them to leave the room while preparations are made.

2. Explain to the rest of the class that you will ask the subjects a list of questions. The students are to observe and record the eye movements of each subject when the questions are asked. Caution them that the eye movements may be slight and will be to the left or right. They will have to observe with care (and they will not have the benefit of slow motion or instant replays).
3. Provide each student with a copy of the record sheet, which contains the questions and a space to record the subjects' responses.
4. Admit the subjects, one at a time, and have each one stand in front of the class in full view of the students.
5. You should ask each question and give the subject time to respond. The students will record their observation for each question. You should accept whatever answer is given and move on.
6. After all subjects have been questioned, tally the number of observed left and right eye movements for each question and each subject.
7. An analysis of the results should attempt to see:
    a. which items tended to elicit a left eye shift, indicating right hemisphere activity and which elicited a shift to the right, pointing to a left hemisphere involvement.
    b. if any subject had a tendency to shift more in one direction than the other, indicating a left or right hemisphere dominance.
8. The record sheet provided has a series of questions which follow a pattern. All odd-numbered items should elicit left hemisphere activity (eye shift to the right), and even-numbered items should elicit right hemisphere activity (eye shift to the left).
9. Discuss the results with the whole class, including the subjects who were observed. The class should try to see the left and right hemisphere patterns. Then they should ask the subjects about their preferences for left or right hemisphere activities to see if the eye movements do relate to hemisphere dominance.
10. Finally, ask the students to critique the exercise as a scientific endeavor. Was it scientific? Are the results valid? Reliable? Useful?

*Exercise 2.8:* ***Cultural Attitudes towards Prolonging Life***

Prepare two forms outlining hypothetical situations. Put the students into small groups and give each group one of the forms to discuss and research how people of different cultural and/or religious backgrounds would respond to these situations.

FORM #1: A 25-year-old woman is dying of cancer. She has asked that "no extreme procedures be used to prolong life." She is now comatose and can be kept alive only with machines. How would you decide whether her will should be respected? (**Handout 2.3A**)

FORM #2: A 25-year-old man is dying of cancer. He has asked that "no extreme procedures be used to prolong life." He is now comatose and can be kept alive only with machines. How would you decide whether his will should be respected? (**Handout 2.3B**)

*Exercise 2.9:* ***Sculpting the Brain***

This activity was described at the 2008 National Institute on the Teaching of Psychology Conference by Ellen Pastorino in her presentation entitled, *Active Learning Strategies: Getting Students Engaged!* It involves having students learn the various regions of the brain by having students actually sculpt their own mini-brain.

For this activity, you will need to bring enough Play-doh or modeling clay to class for each of your students. I would suggest the Play-doh as it is softer and easier to work with. Have students spend time creating their own replica of the brain. You may want them to create their brain so that the hemispheres cut away to reveal the corpus callosum and limbic system. Once they are done you can walk around and grade each brain, having your students identify for you the various parts of their brain.

*Exercise 2.10:* ***Brain Map***

Have your students work in small groups to map out the brain. You can go online and find blank maps of the brain. Copy these for you students. Ask them to identify the various structures and state the functions of each. I usually make my students map the flow of information from various parts of the body into the appropriate structures of the brain.

*Role-Playing Scenario 2.1:* ***Exploring Facial Agnosia***

What would it be like to have facial agnosia? What problems would you experience? What reaction do you think you would encounter from others? How would you feel? Enact this role as you attempt to interact with members of the class.

*Role-Playing Scenario 2.2****: One Hemisphere at a Time***

Try to behave as if you possessed only the abilities of the left hemisphere. Then try to limit your behavior to that based on the specialized functions of the right hemisphere. (Other students can question the person enacting these roles. They should also note when behavior inappropriate to each role occurs.)

*Role-Playing Scenario 2.3:* ***Exploring Your Nondominant Side***

Try getting through an entire day while using your nondominant hand. What kind of problems do you run into? What is the most frustrating problem? How would you feel if someone (say, a teacher) told you that you must use this hand from now on?

*Role-Playing Scenario 2.4:* ***Half a Brain***

What's it like to be missing a hemisphere? In rare cases, people have had one entire hemisphere removed because of an extreme medical condition. Since the right side of the brain controls the left side of the body, and vice versa, have students take turns trying to do simple tasks as if they were missing a hemisphere. The other group members should point out areas where the depiction is incorrect. For example, a person would not be able to talk properly, smile, pick things up, etc. Most students will underestimate how all-encompassing it would be to lose control of half their body!

## Key Terms

**Ablation** Surgical removal of tissue.
**Action potential** Nerve impulse.
**Adrenal glands** Endocrine glands that arouse the body, regulate salt balance, adjust the body to stress, and affect sexual functioning.
**Amygdala** A part of the limbic system associated with fear responses.

**Aphasia** A speech disturbance resulting from brain damage.
**Association areas (association cortex)** All areas of the cerebral cortex that are not primarily sensory or motor in function.
**Autonomic nervous system (ANS)** The system of nerves carrying information to and from the internal organs and glands.
**Axon** Fiber that carries information away from the cell body of a neuron.
**Axon terminals** Bulb-shaped structures at the ends of axons that form synapses with the dendrites and somas of other neurons.
**Brainstem** The lowest portions of the brain, including the cerebellum, medulla, pons, and reticular formation.
**Broca's area** A language area related to grammar and pronunciation.
**Central nervous system (CNS)** The brain and spinal cord.
**Cerebellum** A brain structure that controls posture, muscle tone, and coordination.
**Cerebral cortex** The outer layer of the brain.
**Clinical case study** A detailed investigation of a single person, especially one suffering from some injury or disease.
**Computed tomographic scan (CT scan)** A computer-enhanced X-ray image of the brain or body.
**Corticalization** An increase in the relative size of the cerebral cortex.
**Cranial nerves** Major nerves that leave the brain without passing through the spinal cord.
**Deep lesioning** Removal of tissue within the brain by use of an electrode.
**Dendrites** Neuron fibers that receive incoming messages.
**Dominant hemisphere** A term usually applied to the side of a person's brain that produces language.
**Electrical stimulation of the brain (ESB)** Direct electrical stimulation and activation of brain tissue.
**Electrode** Any device (such as a wire, needle, or metal plate) used to electrically stimulate or destroy nerve tissue or to record its activity.
**Electroencephalograph (EEG)** A device that detects, amplifies, and records electrical activity in the brain.
**Endocrine system** Glands whose secretions pass directly into the bloodstream or lymph system.
**Epinephrine** An adrenal hormone that tends to arouse the body; epinephrine is associated with fear. (Also known as adrenaline.)
**Facial agnosia** An inability to perceive familiar faces.
**Frontal lobes** Areas of the cortex associated with movement, the sense of self, and higher mental functions.
**Functional MRI (fMRI)** MRI technique that records brain activity.
**Growth hormone** A hormone, secreted by the pituitary gland, that promotes body growth.
**Handedness** A preference for the right or left hand in most activities.
**Hippocampus** A part of the limbic system associated with storing memories.
**Hormone** A glandular secretion that affects bodily functions or behavior.

**Hypothalamus** A small area of the brain that regulates emotional behaviors and motives.

**Ion channels** Tiny openings through the axon membrane.

**Lateralization** Differences between the two sides of the body, especially differences in the abilities of the brain hemispheres.

**Limbic system** A system in the forebrain that is closely linked with emotional response.

**Lobes of the cerebral cortex** Areas on the left and right cortex bordered by major fissures or defined by their functions.

**Localization of function** The research strategy of linking specific structures in the brain with specific psychological or behavioral functions.

**Magnetic resonance imaging (MRI)** An imaging technique that results in a three-dimensional image of the brain or body, based on its response to a magnetic field.

**Medulla** The structure that connects the brain with the spinal cord and controls vital life functions.

**Melatonin** Hormone released by the pineal gland in response to daily cycles of light and dark.

**Mirror neuron** A neuron that becomes active when a motor action is carried out *and* when another organism is observed carrying out the same action.

**Myelin** A fatty layer coating some axons.

**Negative after-potential** A drop in electrical charge below the resting potential.

**Nerve** A bundle of neuron axons.

**Neural networks** Interlinked collections of neurons that process information in the brain.

**Neurilemma** A layer of cells that encases many axons.

**Neurogenesis** The production of new brain cells.

**Neurological soft signs** Subtle behavioral signs of brain dysfunction, including clumsiness, an awkward gait, poor hand-eye coordination, and other perceptual and motor problems.

**Neuron** An individual nerve cell.

**Neuropeptides** Brain chemicals, such as enkephalins and endorphins, that regulate the activity of neurons.

**Neuroplasticity** The capacity of the brain to change in response to experience.

**Neurotransmitter** Any chemical released by a neuron that alters activity in other neurons.

**Norepinephrine** Both a brain neurotransmitter and an adrenal hormone that tends to arouse the body; norepinephrine is associated with anger. (Also known as noradrenaline.)

**Occipital lobes** Portion of the cerebral cortex in which vision registers in the brain.

**Oxytocin** A hormone, released by the pituitary gland, that plays a broad role in regulating pregnancy, parenthood, sexual activity, social bonding, trust, and even reducing stress reaction.

**Parasympathetic branch** The branch of the ANS that quiets the body.

**Parietal lobes** Areas of the cortex in which bodily sensations register.

**Peripheral nervous system (PNS)** All parts of the nervous system outside the brain and spinal cord.
**Pineal gland** Gland in the brain that helps regulate body rhythms and sleep cycles.
**Pituitary gland** The "master gland" whose hormones influence other endocrine glands.
**Pons** An area on the brainstem that acts as a bridge between the medulla and other structures.
**Positron emission tomography (PET)** An imaging technique that results in a computer-generated image of brain activity, based on glucose consumption in the brain.
**Prefrontal area (prefrontal cortex)** The very front of the frontal lobes; involved in sense of self, reasoning, and planning.
**Primary auditory area** Part of the temporal lobe in which auditory information is first registered.
**Primary motor area (primary motor cortex)** A brain area associated with control of movement.
**Primary somatosensory area (primary somatosensory cortex)** A receiving area for body sensations.
**Primary visual area** The part of the occipital lobe that first receives input from the eyes.
**Receptor sites** Areas on the surface of neurons and other cells that are sensitive to neurotransmitters or hormones.
**Reflex arc** The simplest behavior, in which a stimulus provokes an automatic response.
**Resting potential** The electrical charge of a neuron at rest.
**Reticular activating system (RAS)** A part of the reticular formation that activates the cerebral cortex.
**Reticular formation (RF)** A network within the medulla and brainstem; associated with attention, alertness, and some reflexes.
**Saltatory conduction** The process by which nerve impulses conducted down the axons of neurons coated with myelin jump from gap to gap in the myelin layer.
**Sensory neuron** A neuron that carries information from the senses toward the CNS.
**Sidedness** A combination of preference for hand, foot, eye, and ear.
**Soma** The main body of a neuron or other cell.
**Somatic nervous system (SNS)** The system of nerves linking the spinal cord with the body and sense organs.
**Spinal nerves** Major nerves that carry sensory and motor messages in and out of the spinal cord.
**"Split-brain" operation** Cutting the corpus callosum.
**Subcortex** All brain structures below the cerebral cortex.
**Sympathetic branch** The branch of the ANS that arouses the body.
**Synapse** The microscopic space between two neurons, over which messages pass.
**Temporal lobes** Areas of the cortex that include the sites in which hearing registers in the brain.

**Thalamus** A brain structure that relays sensory information to the cerebral cortex.
**Threshold** The point at which a nerve impulse is triggered.
**Thyroid gland** Endocrine gland that helps regulate the rate of metabolism.
**Visual agnosia** An inability to identify seen objects.
**Wernicke's area** A temporal lobe brain area related to language comprehension.

## Video Suggestions

*The Brain: Teaching Modules* (Annenberg, clips ranging from 5 to 20 minutes in length)
This series of video modules provides a variety of topics related to neuroscience that will engage your students. Many of them include the relationship between the brain and diseases or conditions that will be of interest to students, such as Parkinson's, Alzheimer's, autism, and schizophrenia, just to name a few. Some modules also contain information on neurorehabilitation. These DVDs may be purchased from Annenberg (www.learner.org)

*Brain and Nervous System: Your Information Superhighway* (Films for the Humanities and Sciences, 2000, 25 min.)
This program explores the brain and nervous system, using the analogy of computers and the Internet.

*Discovering Psychology Series: The Behaving Brain* (Annenberg, 2001, 30 min.)
Hosted by Dr. Phillip Zimbardo. This video provides an excellent review of basic brain structure including: the functioning of the neurons, subcortical structures, and neurotransmitters.

*Dopamine Seduction: The Limbic System.* (Films for the Humanities and Sciences, 1998, 25 min.)
This program illustrates the function of the limbic system in a subject named Greg, following the activity of his brain as he staves off danger and hunger. Extraordinary 3-D computer animation such as the release of hormones into the bloodstream and brain cells transmitting nerve impulses. (available from Insight Media at www.insight-media.com)

*The Neuroscience of Everyday Life.* (Insight Media, 2010, 30 min.)
This video features neuroscientist Sam Wang of Princeton University linking various biological processes relevant to this chapter's content to everyday experiences.

*The Endocrine System.* (Insight Media, 1998, 23 min.)
This video shows how the endocrine system makes and releases hormones that interact with body tissues and organs. It also considers the ways in which the nervous and endocrine systems work together to regulate the body.

## Multimedia Resources

**PowerLecture with JoinIn™ and ExamView ®** for *Introduction to Psychology: Gateways to Mind and Behavior*, 13th Edition.

**Websites**
Companion Site
www.cengage.com/psychology/coon

APA Online

http://www.apa.org/

APS Online
http://www.psychologicalscience.org

Basic Neural Processes Tutorials
http://psych.hanover.edu/Krantz/neurotut.html

Quiz on the structure of the brain, tutorial on the physical factors involved in an action potential, and a glossary of terms relating to neural issues. By Dr. John H. Krantz, Hanover College.

Brain Images on the Web
http://www.med.harvard.edu/AANLIB/home.html

Images include normal brains, brains with cerebrovascular diseases (e.g., acute and subacute strokes, hyptertensive encephalopathy, cerebral hemorrhage), neoplastic disease (e.g., Glioma, sarcoma), degenerative disease (e.g., Alzheimer's, Huntington's, Pick's), and inflammatory or infectious disease (e.g., multiple sclerosis, AIDS dementia). The Whole Brain Atlas can also be ordered on CD-ROM.

Society for Neuroscience
http://www.sfn.org/

**Digital Media Library 3.0**

3D Brain (Simulation that allows you to dissect human brain, 5 minutes)
3D Brain: The Cerebral Cortex (Simulation allows you to manipulate and label areas of the brain, 2 minutes)
Action Potential (Animation portraying an action potential passing along a nerve, 1 minutes 26 seconds)
Brain Organization, Structure, and Function (Video focused on how psychologists are learning to map the brain, 5 minutes 52 seconds)
Brain Re-Growth (Video depicting individual who lived in minimally conscious state for 20 years—and then begins to recover, 3 minutes 58 seconds)
Evaluating Patients with Brain Damage (Video showing use of MRI and clinical studies to identify location of brain damage, 2 minutes 16 seconds)
Hemisphere Control (Simulation demonstrating hemisphere control's relationship to multitasking)
Hemispheric Specialization (Simulation exploring which hemisphere is better at visuo-spatial processing, 10 minutes)
Interference—Synaptic Transmission (Animation illustrating process of synaptic transmission, 1 minute 6 seconds)
Mirror Neurons (Video exploring the importance of mirror neurons for social relationships, 5 minutes 41 seconds)
Movement of Sodium and Potassium Ions in Action Potential (Animation of movement of Na+ and K+ ions through a membrane during action potential, 17 seconds)
Neural Networks (Video showing research that examines how and where information is stored in the brain, 4 minutes 57 seconds)

Neural Transmission (Learning module about the transmission of nerve impulses, 5 minutes 30 seconds)
Neurotransmitter Release (Animation of neurotransmission, 1 minute 36 seconds)
New Brain Scan (Video of updated MRI technology, 5 minutes 2 seconds)
Resting Potential (Animation of the difference in charge inside versus outside a neuron, 50 seconds)
Structure of the Neuron (Animation of neuron structure in three dimensions, 1 minute 53 seconds)
Synaptic Transmission (Learning module illustrating how neurons communicate with one another, 8 minutes, 30 seconds)
The Brain (series of very short video clips ranging in length from 15 to 33 seconds of a scientist identifying various parts of the brain)
Traumatic Brain Injury (Video of three stories involving recovery from TBI, 8 minutes 56 seconds)
Wernicke-Geschwind Model (Learning module on the processing of language, 6 minutes, 30 seconds)

## Supplemental Lecture

Students always have a difficult time learning the parts of the brain and their chief functions. Diagrams in most texts tend to appear complex and confusing because so many parts are identified and labeled. An instructor should take the time to simplify the structure, focusing on the major parts or areas of the brain. Once the students learn these, they can then add other structures and eventually see the whole thing, but first, they should see the stripped-down version, the basic model.

In this lecture the students will learn:
1. that the brain is specialized with each area having a different function;
2. that the brain is not really one organ but several "brains," all in the same location in the skull;
3. what each of the three parts or "brains" is called, where each is located, and what special tasks each performs;
4. that all of these separate parts are really interconnected and work together in a kind of network to direct behavior.

This lecture would work out best if a model of the brain were used. The model should be able to be disassembled and put together again. Otherwise a large diagram would be good; or, if that is not available, drawing on the chalkboard, showing one part at a time, can be effective.

### THE BRAIN

I. Introduction
   A. Discuss the composition of the brain:
      1. type of cells
      2. number of cells (estimated)
      3. location of the brain
      4. size of brain in relation to the rest of the body
      5. relative proportion of brain devoted to cortex (corticalization)

B. Identify the main parts of the brain:
   1. hindbrain (brainstem and cerebellum)
   2. midbrain
   3. forebrain (limbic system and cortex)

C. Discuss each of the parts of the hindbrain, giving location and major functions:
   1. Brainstem
      a. It is located at the top of the spinal cord.
      b. This is the most primitive part of the brain and is found in all living organisms. It is what keeps a human or animal alive. Damage to this area could cause death.
      c. It controls involuntary functions—these are the vital functions necessary for survival of the physical organism.
      d. Its functions include regulation of circulation, respiration, digestion, and reproduction.
      e. Parts of the brainstem include the:
         Medulla, which connects the brain with the spinal cord and controls vital life functions.
         Pons, which acts as a bridge between the medulla and other structures.
         Reticular formation (RF), a network within the medulla and brainstem that is associated with attention, alertness, and some reflexes.
         Reticular activating system (RAS) A part of the reticular formation that activates the cerebral cortex.
   2. Cerebellum
      a. It is located at the rear and base of the skull.
      b. It is ball-shaped and consists of a left and right lobe
      c. It controls the muscles and skeleton. It is responsible for motor coordination, balance, and fine motor movement.
      d. Humans and all higher orders of animals have a well-developed cerebellum.
      e. Damage to this area results in impairment or loss of motor functions.

D. Discuss each of the parts of the forebrain, giving location and major functions:
   1. Limbic system
      a. It is located underneath the cortex (i.e. it is *sub*cortical).
      b. Regulates emotions and motivated behavior, such as rage, fear, sexual response, and intense arousal
      c. Earliest layer of the forebrain to evolve
      d. Limbic system organizes survival responses—feeding, fleeing, fighting, or reproduction—in lower animals
      e. Link to emotion remains in humans

      f. Parts of the limbic system include the:
         Thalamus, which relays sensory information to the cerebral cortex.
         Hypothalamus, which regulates emotional behaviors and motives.
         Amygdala, which is associated with fear responses.
         Hippocampus, which is associated with storing memories.
   2. Cortex
      a. It is located at the top and front of the skull and takes up most of the space in it.
      b. It is walnut-shaped and has a left and a right section or hemisphere.

c. Each hemisphere is divided into 4 parts or lobes, each of which has special functions. One function of each lobe is coordination of sensations:
    1. occipital lobe – vision
    2. temporal lobe – hearing
    3. parietal lobe – skin senses
    4. frontal lobe – olfaction and emotional control
d. The function of cortex is to coordinate sensations, regulate emotions, and direct thinking, learning, problem-solving, and other complex activities.
e. This area is relatively large in humans and is smaller in other animals. Anthropologists have been tracing the evolution of humans from lower forms by finding skulls of various sizes leading up to the massive skull of the human. The size of the cerebrum is thought to correspond to the ability of the organism to solve problems and adapt to its environment.
f. Damage to this area could lead to a variety of problems from minor dysfunctions to major disabilities and/or death.

E. Having dissected the brain, now you might say that there is a constant flow of information to all parts so that our behavior is integrated. If time permits, you could discuss subcortical structures that do some of the interconnecting. Mention should be made of the corpus callosum, thalamus, hypothalamus, and the reticular formation.
F. As an activity students should be asked to identify all of the parts and structures discussed, either by using a model or an outline drawing such as those in this lecture. Simply reproduce the drawings without the labels and have students identify what they see.

## Suggestions for Further Reading

***Journal Articles:***

**Barrett, D., Greenwood, J. G., & McCullagh, J. F.** (2006). Kissing laterality and handedness. *Laterality: Asymmetries of Body, Brain & Cognition, 11*(6), 573-579.

**Cardoso, S. H.** (2000). Our ancient laughing brain. *Cerebrum, 2*(4), 15-30.

**DeAngelis, T.** (2008). The two faces of oxytocin. *The APA Monitor, 39*(2), 30. Retrieved November 20, 2011 from http://www.apa.org/monitor/feb08/oxytocin.aspx.

**Feinstein, J. S., Adolphs, R., Damasio, A., et al.** (2010). The human amygdala and the induction and experience of fear. *Current Biology, 21*(1), 34-38.

**Gazzaniga, M. S.** (2005). Forty-five years of split-brain research and still going strong. *Nature Reviews Neuroscience, 6*(8), 653–659.

**Immordino-Yang, M. H.** (2008). How we can learn from children with half a brain? *New Scientist, 2664*, 44–45.

**Langleben, D. D., Dattilio, F. M., & Gutheil, T. G.** (2006). True lies: Delusions and lie-detection technology. *Journal of Psychiatry & Law, 34*(3), 351-370.

**Norman, T. R.** (2009). Melatonin: Hormone of the night. *Acta Neuropsychiatrica, 21*(5), 263-265.

**Schwartz, G. E., Davidson, R. J., & Maer, F.** (1975). Right hemisphere lateralization for emotion in the human brain: interactions with cognition, *Science, 190,* 286-288.

**Witelson, S. F., Kigar, D. L., & Harvey, T.** (1999). The exceptional brain of Albert Einstein. *Lancet, 353,* 2149–2153.

***Textbooks:***

**Banich, M. T., & Compton, R. J.** (2011). *Cognitive neuroscience* (3rd ed.). Belmont, CA: Cengage Learning/Wadsworth.

**Breedlove, S. M., Watson, N. V., & Rosenzweig, M. R.** (2010). *Biological psychology: An introduction to behavioral and cognitive neuroscience* (6th ed.). Sunderland, MA: Sinauer Associates.

**Kalat, J. W.** (2009). *Biological psychology* (10th ed.). Belmont, CA: Cengage Learning/Wadsworth.

***Popular Press Articles and Books:***

**Adamson, K.** (2004). *Kate's journey: Triumph over adversity*. Redondo Beach, CA: Nosmada Press.

**Colvin, M. K., & Gazzaniga, M. S.** (2007). *Split-brain cases*. Malden, MA: Blackwell Publishing.

**Freberg, L.A.** (2010). *Discovering biological psychology* (2nd ed.). Belmont, CA: Cengage Learning/Wadsworth.

**Hirstein, W.** (2005). *Brain fiction: Self-deception and the riddle of confabulation*. Cambridge, MA: MIT Press.

**Rizzolatti, G., Fogassi, L., & Gallese V.** (2006). Mirrors in the mind. *Scientific American, 295*(5), 54-61.

**Sacks, O.** (2010). *The mind's eye*. New York: Knopf.

**Handout 2.1** **Name _____**

## Activity of the Brain

Answer the following short answer questions:

1. What part of the brain processes visual information?

2. What part of the brain processes what you hear?

3. What parts of the brain are involved when you hear something and look at it?

4. What parts of the brain will be "working" when you reach for something and pick it up?

5. What parts of the brain will be "working" when you hear someone ask you a question and you give the answer?

6. How could you informally evaluate someone's language skills?

**Handout 2.2** **Name _____**

## LATERAL EYE MOVEMENT
## RECORD SHEET

Record your observations on this sheet. Mark an L for left and an R for right. Remember that you are recording the subject's eye movements to HIS or HER right, not to yours. Do not do anything to distract the subject, or yourself, since the eye movement may be slight.

| | SUBJECT | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 1. How many weeks are there in a year? | | | | | |
| 2. On what coin is John F. Kennedy pictured? | | | | | |
| 3. What is the last line of the "The Star-Spangled Banner"? | | | | | |
| 4. Without looking at me, what is the color of my shirt (tie, skirt)? | | | | | |
| 5. Define the term "psychology." | | | | | |
| 6. In England, on which side is the steering wheel of a car? | | | | | |
| 7. Why do people pay taxes? | | | | | |
| 8. Who is pictured on the front of a five-dollar bill? | | | | | |
| 9. What do the letters in "NASA" stand for? | | | | | |
| 10. About how far is it to the moon? | | | | | |

**Handout 2.3 A** **Name _____**

## Cultural Attitudes toward Prolonging Life

A 25-year-old woman is dying of cancer. She has asked that "no extreme procedures be used to prolong life." She is now comatose and can be kept alive only with machines. How would you decide whether her will should be respected?

**Handout 2.3 B** **Name _____**

## Cultural Attitudes toward Prolonging Life

A 25-year-old man is dying of cancer. He has asked that "no extreme procedures be used to prolong life." He is now comatose and can be kept alive only with machines. How would you decide whether his will should be respected?