Chapter 3
THE BIOLOGICAL AND EVOLUTIONARY BASES OF BEHAVIOR

▲ TABLE OF CONTENTS

To access the resource listed, click on the hot linked title or press **CTRL + click**
To return to the Table of Contents, click on **▲ Return to Table of Contents**
To return to a section of the Lecture Guide, click on **► Return to Lecture Guide**

► LECTURE GUIDE

▼ FULL CHAPTER RESOURCES

LECTURE GUIDE

INTRODUCTION/HEREDITY AND BEHAVIOR (Text p. 47)

Lecture Launchers/Discussion Topics:
- Leading Off the Chapter

Web Resources:
- General Resources for Biological Psychology

Outline

I. Introduction/Heredity and Behavior

Nature versus Nurture: Human behavior is causally determined by an extremely complex interaction between heredity and the environment.

A. Evolution and Natural Selection
   1. Charles Darwin and the voyage of the *HMS Beagle*
      a) Inspired the later published *The Origin of the Species* in 1859.
      b) *Natural selection* and the survival of the fittest: Only those organisms that can adapt to environmental changes and demands are most likely to survive.
   2. Contemporary research on natural selection.
      a) Peter and Rosemary Grant show that natural selection can be observed and present dramatic effects today.
      b) *Natural selection* examples are given for geographic isolation and chemical recognition in fruit flies.
   3. *Genotypes* refer to a specific genetic structure of an individual.
   4. *Phenotypes* are observable characteristics or behaviors of an individual.
   5. Genotype and environment interact to yield a particular phenotype. A detailed example of natural selection involving the size of beaks in finches and its relation to genotype and phenotype is explained.
   6. *Human Evolution*. Human evolution is known primarily for this combination of critical adaptations:
      a) *Bipedalism* is the ability to walk upright (walking on two feet).
      b) *Encephalization* refers to an increase in brain size that resulted in increased cognitive skills (such as problem solving) was selected for.
      c) *Language* is the basis of cultural evolution, which is the tendency of cultures to respond adaptively, through learning, to environmental change. This works much more quickly than genetic evolution.

B. Variation in the Human Genotype
   1. The study of the mechanisms of inheritance is known as *heredity*.
   2. *Mendel's* theory that pairs of inherited factors from each parent influenced the properties of offspring laid the foundations of modern genetics. Modern genetics is far beyond the focus of Mendel, but his work led to investigation into the basic structures of the genetic code.
   3. *Genetics* is the inheritance of physical and psychological traits from ancestors.
   4. *Human behavior genetics* is a research field that unites genetics and psychology.
   5. *Sociobiology* applies evolutionary theory to explain social behavior of humans and other species.
   6. *Evolutionary psychology* extends the approach of sociobiologists to apply the principles of evolution to include other aspects of human behavior, including cognitions.

C. Basic Genetics
   1. *Genes* are the organized components of DNA that contain the instructions for the production of proteins ultimately resulting in expression of a phenotype.
   2. Genes are found on rod-like structures known as *chromosomes*. Humans contain 46 chromosomes, 23 from the mother and 23 from the father.
   3. Sex chromosomes contain DNA for the coding of males and females. The X and Y chromosomes determine sex. One X comes from the mother, and either an X or a Y comes from the father. XX is female, XY is male.

4. Some versions of the genes are *dominant;* others are *recessive.* This influences phenotype.
5. Often phenotypes are influenced by multiple genes. These are called *polygenetic*.
6. Efforts are underway to identify all 20,500 human genes of the human *genome*.

D. *Heritability* is a measure of genetic influence. Adoption and twin studies are common methods to get heritability estimates.
E. The interaction of genes and environments is increasingly seen as playing a critical role in behavior.

▲ Return to Chapter 3: Table of Contents

THE NERVOUS SYSTEM IN ACTION (Text p. 54)

Lecture Launchers/Discussion Topics:
- Neurotransmitters: Chemical Communicators of the Nervous System
- Synaptic Transmission and Neurotransmitters

Classroom Activities, Demonstrations, and Exercises:
- Using Reaction Time to Show the Speed of Neurons
- The Dollar Bill Drop
- Using Dominoes to Understand the Action Potential
- Demonstrating Neural Conduction: The Class as a Neural Network
- Human Neuronal Chain

Web Resources:
- Neurons/Neural Processes
- The Nervous System

Outline

I. The Nervous System in Action

A. Rene Descartes, in the seventeenth century, argued that humans are animal machines and that human action is a mechanical response to the environment. He revolutionized the study of human behavior by suggesting that human physiology could be studied empirically. Neuroscience is the study of the links between the brain and behavior.
B. A *neuron* is a cell specialized to receive, process, and transmit information to other cells. There are at least 200 different types of neurons, which are typically comprised of dendrites, soma, axon, and terminal buttons.
   1. *Dendrites* are branched fibers that extend outward from the body of the neuron and that receive messages from other neurons.
   2. The *soma*, or cell body, integrates information received by the dendrites and passes it along to the axon.
   3. The *axon* is a single extended fiber that conducts information to terminal buttons.
   4. *Terminal buttons* are bulblike structures that secrete neurotransmitters, which influence other neurons.
C. There are three major classes of neurons: sensory, motor, and interneuron.
   1. *Sensory neurons* carry messages from sense receptors toward the CNS.
   2. *Motor neurons* carry messages from the CNS to the muscles and glands.
   3. *Interneurons* carry messages between different neurons.
   4. *Glia cells*, derived from the Greek word for "glue," outnumber neurons in the brain by about five or ten to one and perform three primary functions: housekeeping, insulation, and protection of the brain.
      a) *Development*: glia cells help guide newborn neurons to appropriate locations in the brain.
      b) *Housekeeping*: glia cells clean up after neurons die and absorb excess neurotransmitters.
      c) *Insulation*: glia cells form a *myelin sheath* around the axon of some types of neurons, greatly increasing the conduction speed of the axon.
      d) *Protection*: glia cells form a blood-brain barrier that prevents toxins from reaching the brain.
D. Action potentials: Neurons send messages in an all-or-none fashion through action potentials traveling down the axon, and they receive messages in the form of graded potentials through the dendrites.
   1. *Excitatory input* increases the likelihood that a neuron will fire.
   2. *Inhibitory input* decreases the likelihood that a neuron will fire.

E. The Biochemical Basis of Action Potentials
   1. An *action potential* begins when excitatory inputs are strong enough to overcome inhibitory inputs and involves depolarization of the neuron by sodium ions rushing into the cell.
   2. *Resting potential* is the slightly negative voltage of a neuron in a resting state.
   3. *Ion channels* in neuron membranes respond to changes in excitatory and inhibitory input. Excitatory input causes the ion channels to allow sodium ions into the neuron, allowing the neuron to fire. Inhibitory input causes the ion channels to keep the neuron negatively charged, preventing the neuron from firing.
   4. The action potential then travels down the axon as adjacent areas of the axon successively depolarize.
   5. When the fluid inside the neuron becomes positive, the sodium ion channels close and potassium ion channels open, allowing potassium ions to exit the cell, restoring negative charge of the neuron.

F. Properties of Action Potentials
   1. Action potentials obey the "*all-or-none law*." The size of the action potential is not influenced by the intensity of stimulation beyond the threshold level.
   2. The speed of transmission varies greatly: the AP travel between 10 cm up to 200 meters a second. The myelin sheath and the Nodes of Ranier increase transmission speed.
   3. After firing, neurons enter a *refractory period*, a period during which they cannot fire or will only fire with more intense stimulation than normal.

G. Synaptic transmission: relay of information across the synaptic cleft.
   1. A *synapse* is a small physical gap between neurons. It is between the terminal button of one cell and the dendrite or soma of another.
   2. Once an action potential reaches an axon terminal button, *synaptic vesicles* release neurotransmitters (chemical substances that stimulate other neurons) into the synaptic gap. The neurotransmitters then traverse across the *synaptic cleft* and attach to receptor molecules embedded in the postsynaptic neuron membrane.
   3. Neurotransmitters bind to receptor molecules when they are not blocked by other substances and the neurotransmitter's shape matches the receptor shape like a key and a key hole.
   4. This information is either expiatory or inhibitory. Synapses integrate information from 1,000 to 10,000 other neurons.

H. Neurotransmitters and their Function
   1. *Acetylcholine,* a neurotransmitter found in both the central and peripheral nervous systems, is implicated in memory loss associated with Alzheimer's disease and in some types of respiratory failure.
   2. *Gamma-amino butyric acid (GABA)* is thought to be related to anxiety, as depressants bind to receptor molecules sensitive to GABA and cause sedation.
   3. *Glutamate*, the brain's most common expiatory neurotransmitter, is critical for emotion, learning, and memory. Disruptions in levels of glutamate are associated with addictions and schizophrenia.
   4. *Catecholamines* such as dopamine and norepinephrine play prominent roles in mood disturbances and schizophrenia.
      a) Decreased levels of *norepinephrine* have been related to depression.
      b) Increased levels of *dopamine* have been related to schizophrenia.
   5. *Serotonin* is involved in autonomic processes, arousal, and depression.
   6. *Endorphins* are neuromodulators that modify the activities of postsynaptic neurons and may play an important role in emotional behaviors and pain responses.

▲ Return to Chapter 3: Table of Contents

BIOLOGY AND BEHAVIOR (Text p. 60)

Lecture Launchers/Discussion Topics:
- The Perception of Phantom Pain
- The Brain
- The Cranial Nerves
- Berger's Wave
- Freak Accidents and Brain Injuries
- Neural Effects of a Concussion
- The Phineas Gage Story
- Workplace Problems: Left-Handedness
- Understanding Hemispheric Function
- Brain's Bilingual Broca
- The Results of a Hemispherectomy
- Too Much or Too Little: Hormone Imbalances
- Would You Like Fries With That Peptide?

Classroom Activities, Demonstrations, and Exercises:
- Mapping the Brain
- Review of Brain Imaging Techniques
- Trip to the Hospital
- The Importance of a Wrinkled Cortex
- Probing the Cerebral Cortex
- Lateralization Activities
- Localization of Function Exercise
- Looking Left, Looking Right
- The Brain Diagram
- Psychology in Literature: *The Man Who Mistook His Wife For a Hat*
- Twenty Questions

APS Reader:
- The Occipital Cortex in the Blind: Lessons about Plasticity and Vision
- Beyond Fear: Emotional Memory Mechanisms in the Human Brain

Forty Studies That Changed Psychology:
- One Brain or Two?
- More Experience = Bigger Brain

Web Resources:
- The Brain
- Phineas Gage

Outline

I. Biology and Behavior

A. Eavesdropping on the brain
1. Brain lesions to understand brain structure—function relationships
   a) Phineas Gage
   b) Creating lesions can be helpful (e.g., treating neurological disorders like epilepsy) and helps to more accurately identify brain areas and associated functions. Cannot be done experimentally on humans for obvious ethical reasons.
   c) Paul Broca, through autopsies of speech impaired individuals, discovered *Broca's area*, the region of the brain that translates thoughts into speech.
2. Alternatives to physical lesions for human research and assessment:
   a) *rTMS* creates temporary "lesions" with pulses of magnetic stimulation.
   b) Walter Hess found that sleep, sexual arousal, anxiety, and terror could be turned on and off by electrically stimulating specific areas of the brain.
   c) *Electroencephalogram (EEG*) records large, integrated patterns of brain electrical activity.

d) *CT* or *CAT (computerized axial tomography) scan* takes a series of X-rays to create a 3-D picture of the brain.
e) Lesions are localized brain injuries researchers produce.
f) *Positron-emission tomography (PET)* scans construct a dynamic portrait of the brain by detecting how radioactive (but safe) substances are processed in the brain during different cognitive and behavioral activities.
g) *Magnetic resonance imaging (MRI)* uses pulses of energy to cause atoms to align with a magnetic field. Special radio receivers then monitor the rate at which atoms decay from alignment once the energy pulse is complete. Computers analyze this information to create dynamic models of brain activity.
h) An fMRI combines benefits of both PET scans and MRI to identify both structure and function.

B. The nervous system comprises two major divisions:
1. The *central nervous system (CNS*) contains all neurons in the brain and spinal cord.
   a) Integrates and coordinates all bodily functions, processes all incoming neural messages, and sends commands to different parts of the body.
   b) Relies on PNS for information from sensory receptors.
2. The *peripheral nervous system (PNS)* is all neurons forming the nerve fibers that connect the CNS to the body. It provides the CNS with sensory information and relays commands from the brain to the body's organs and muscles. It is composed of two subdivisions:
   a) The *somatic nervous system* (SNS) regulates the actions of skeletal muscles.
   b) The *autonomic nervous system* (ANS) sustains basic life processes and is further divided into two subdivisions: The *sympathetic* division governs response to emergencies and the *parasympathetic* division governs routine operation of internal bodily functions.

C. Brain structures and their functions
1. The brain is the most important component of the CNS and is composed of three layers: the brain stem, the limbic system, and the cerebrum.
2. The *brain stem*, the *thalamus*, and the *cerebellum*.
   a) The *medulla*, located at the top of the spinal cord, controls breathing, blood pressure, and the heart.
   b) The *pons*, located directly above the medulla, provides inputs to other structures of the brain stem and to the cerebellum.
   c) The *reticular formation*, located between the medulla and pons, arouses the cerebral cortex to new stimulation and keeps the brain alert even during sleep.
   d) The *thalamus*, located above the pons, receives input from the reticular formation and channels incoming sensory information to the appropriate area of the cerebral cortex.
   e) The *cerebellum*, attached to the brain stem at the base of the skull, coordinates body movements and plays a role in some types of learning.
3. The *limbic system* mediates motivated behaviors, emotional states, and memory processes and is composed of three structures:
   a) The *hippocampus* plays an important role in the acquisition of explicit memories (ones you are aware of retrieving).
   b) The *amygdala* plays a role in emotional control and the formation of emotional memories, especially those related to threat and danger.
   c) The *hypothalamus* plays a role in maintaining *homeostasis* in body weight, temperature, and the endocrine system.
4. The *cerebrum* regulates higher emotional and cognitive functions and is composed of the following:
   a) The *cerebral cortex* is the thin outer layer of the cerebrum.
   b) The cerebrum is divided into symmetrical halves called *cerebral hemispheres.*
   c) The two hemispheres are connected by a thick mass of nerve fibers called the *corpus callosum,* which relays messages between hemispheres.
   d) Grooves in the cerebrum, called the *central sulcus* and the *lateral fissure,* help divide each cerebral hemisphere into four lobes.
   e) The *frontal lobe,* located at the front of the cerebrum, is involved in motor control and cognitive activities (e.g., planning and goal setting).

f) The *parietal lobe* is located at the top of the cerebrum and is responsible for the sensations of touch, pain, and temperature.
g) The o*ccipital lobe* is located at the back of the cerebrum and is responsible for visual processing.
h) The *temporal lobe* is located at the side of the cerebrum and is responsible for auditory processing. It also is the location of *Wernicke's area* which is involved in speech production.
i) The hemispheres and lobes of the brain do not function independently, rather they work as an integrated unit similar to an orchestra.
j) The *motor cortex,* located in front of the central sulcus, controls movement of the body's voluntary muscles.
k) The *somatosensory cortex*, located behind the central sulcus in the parietal lobes, processes information about temperature, touch, body position, and pain.
l) The *auditory cortex*, in the temporal lobes, processes auditory information.
m) The *visual cortex*, in the occipital lobes, processes visual information.
n) The *association cortex* includes all unlabeled parts of the cortex. It interprets and integrates information from many parts of the brain.

D. *Hemispheric lateralization* describes how separate hemispheres are responsible for some specific functions.
1. Roger Sperry and Michael Gazzaniga devised situations that could allow visual information to be presented separately to each hemisphere.
2. Information from the right visual field goes to the left hemisphere, and information from the left visual field goes to the right hemisphere.
3. Speech may be the most highly lateralized of all brain functions. For most people, speech is a left hemisphere function.
4. The left hemisphere tends to be more analytical, processing information bit by bit.
5. The right hemisphere tends to be more holistic, processing information in global patterns.

E. The *endocrine system* is a highly complex communication system comprised of a network of glands and supplements the work of the nervous system.
1. *Hormones* are chemicals secreted by the glands of the endocrine system. They influence sexual development, physical growth, moods, arousal level, immune functioning, and metabolism rate.
2. The *hypothalamus* serves as an intermediary between the endocrine system and the nervous system. Messages from the brain cause the hypothalamus to release hormones to the pituitary gland.
3. The *pituitary gland*, the "master gland," secretes about ten types of hormones which influence the functioning of all other endocrine system glands, as well as growth.
   a) In males, the pituitary gland activates secretion of *testosterone*, which leads to sperm production.
   b) In females, the pituitary gland activates secretion of *estrogen*, which is essential to the release of eggs from the ovaries.

F. *Plasticity* and *Neurogenesis:* Our Changing Brain. Plasticity is the brain's ability to adapt and change.
1. Examples of environmental experience changing the brain:
   a) Mark Rosenzweig's research shows rats raised in good environments have denser cortexes than those raised in improvised environments.
   b) *Sensory cortex* is changed by things like practicing a musical instrument.
2. Researchers are interested in response to injury.
   a) *Stem cell* may be used to replace damaged neurons.
   b) *Neurogenesis* is the natural occurrence of stem cells replacing damaged neurons.

▲ Return to Chapter 3: Table of Contents

CHAPTER SUMMARY

Classroom Activities, Demonstrations, and Exercises:
- Crossword Puzzle
- Fill in the Blank

▲ Return to Chapter 3: Table of Contents

KEY TERMS

Action Potential
All-or-None Law
Amygdala
Association Cortex
Auditory Cortex
Autonomic Nervous System (ANS)
Axon
Brain Stem
Broca's Area
Central Nervous System (CNS)
Cerebellum
Cerebral Cortex
Cerebral Hemisphere
Cerebrum
Computerized Axial Tomography (CT or CAT)
Corpus Callosum
Dendrites
DNA (deoxyribonucleic acid)
Electroencephalogram (EEG)
Endocrine System
Estrogen
Evolutionary Psychology
Excitatory Input
Frontal Lobe
Functional MRI (fMRI)
Gene
Genetics
Genome
Genotype
Glia
Heredity
Heritability
Hippocampus
Homeostasis
Hormone
Human Behavior Genetic
Hypothalamus
Inhibitory Input
Interneuron
Ion Channel
Lesions
Limbic System
Magnetic Resonance Imaging (MRI)
Medulla
Motor Cortex
Motor Neuron
Myelin Sheath
Natural Selection
Neurogenesis
Neuromodulator
Neuron
Neuroscience
Neurotransmitter
Occipital Lobe
Parasympathetic Division
Parietal Lobe
Peripheral Nervous System (PNS)
Phenotype
Pituitary Gland
Plasticity
Polygenetic Trait
Pons
Positron Emission Tomography (PET) Scan
Refractory Period
Repetitive Transcranial Magnetic Stimulation (rTMS)
Resting Potential
Reticular Formation
Sensory Neuron
Sex Chromosome
Sociobiology
Soma
Somatic Nervous System
Somatosensory Cortex
Sympathetic Division
Synapse
Synaptic Transmission
Temporal Lobe
Terminal Button
Testosterone
Thalamus
Visual Cortex
Wernicke's Area

▲ Return to Chapter 3: Table of Contents

CHANGES FROM *PSYCHOLOGY AND LIFE, NINETEENTH EDITION* TO *PSYCHOLOGY AND LIFE, TWENTIETH EDITION*

Chapter 3: The Biological and Evolutionary Bases of Behavior

- New Critical Thinking in Your Life: How Does Culture Become "Embrained"?
- New section on the interaction of genes and environments
- New discussion of mirror neurons
- Expanded discussion of H. M.
- New Research Studies:
  - "Attention and memory in aged rats: Impact of lifelong environmental enrichment" (Harati et al., 2011)
  - "Children's genotypes interact with maternal responsive care in predicting children's competence: Diathesis-stress or differential susceptibility?" (Kochanska et al., 2011)
  - "A genetic analysis of coffee consumption in a sample of Dutch twins" (Vink et al., 2009)

▲ Return to Chapter 3: Table of Contents

LECTURE LAUNCHERS AND DISCUSSION TOPICS

▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Leading Off the Chapter

Your students may find the presence of a chapter on "biology" puzzling in a psychology textbook. An effective lead off for the chapter is to point out our tendency to take for granted the integrity and normal functioning of the nervous system. Only when there is damage through stroke, disease, or brain trauma do we realize its importance. If there is an example from your personal life that is apropos here, such as a family member with a neurological disease, consider sharing it with your students. Students may add their own stories as well to highlight the importance of studying "biology" in a psychology class.

► Return to Lecture Guide: Introduction/Heredity and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Neurotransmitters: Chemical Communicators of the Nervous System

In 1921, a scientist in Austria put two living, beating hearts in a fluid bath that kept them beating. He stimulated the vagus nerve of one of the hearts. This is a bundle of neurons that serves the parasympathetic nervous system and causes a reduction in the heart's rate of beating. A substance was released by the nerve of the first heart and was transported through the fluid to the second heart. The second heart reduced its rate of beating. The substance released from the vagus nerve of the first heart was later identified as *acetylcholine*, one of the first neurotransmitters to be identified. Although many other neurotransmitters have now been identified, we continue to think of acetylcholine as one of the most important neurotransmitters. Curare is a poison that was discovered by South American Indians. They put it on tips of the darts they shoot from their blowguns. Curare blocks acetylcholine receptors; paralysis of internal organs results. The victim is unable to breathe, and dies. A substance in the venom of black widow spiders stimulates release of acetylcholine at the synapses. Botulism toxin, found in improperly canned foods, blocks release of acetylcholine at the synapses and has a deadly effect. It takes less that one millionth of a gram of this toxin to kill a person. A deficit of acetylcholine is associated with Alzheimer's disease, which afflicts a high percentage of older adults.

Many neurotransmitters have been identified in the years since 1921, and there is increasing evidence of their importance in human behavior. Psychoactive drugs affect consciousness because of their effects on synaptic transmission. For example, cocaine and the amphetamines prolong the action of certain neurotransmitters and opiates imitate the action of natural neuromodulators called the endorphins. It appears that the neurotransmitters dopamine, norepinephrine, and serotonin are associated with some of the most severe forms of mental illness.

There are probably only a few ounces of these substances in the body, but they may have a profound effect on mood, memory, perception, and behavior. Could intelligence be primarily a matter of having plenty of the right neurotransmitter at the right synapses?

► Return to Lecture Guide: The Nervous System in Action
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Synaptic Transmission and Neurotransmitters

Point out to students that neurons do not touch each other. Instead, two neurons are connected through a small space called a *synapse*, into which flow substances called *neurotransmitters* that either enhance or impede impulses moving from one neuron to the next. During the first half of the 1900s, there was controversy over whether synaptic transmission was primarily chemical or electric. By the 1950s, it was apparent that the communication between the neurons was chemical. During this period, some synapses showed what was termed *gap junction* or electrical transmission between neurons at the synapse. Recent research has shown that electrical synaptic transmission may be more frequent than neuroscientists once believed (Bennett, 2000). Even though the transmission of information between neurons at the synapses is primarily chemical, some electrical synapses are known to exist in the retina, the olfactory bulb, and the cerebral cortex (Bennett, 2000).

Use “The Wave,” an activity at sports arenas, as an analogy for the action potential. Like “The Wave,” the action potential travels the length of the neuron; the neuron doesn’t experience the action potential all at once. To extend the analogy, mention that right after people stand up in “The Wave,” they are somewhat tired and must recover (i.e., refractory period) to be prepared for the next go-round (i.e., action potential).

► Return to Lecture Guide: The Nervous System in Action
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: The Perception of Phantom Pain

The idea of pain sensation means different things to different people. Many students are aware of phantom pain sensations and are actually very curious as to what it is. Medical professionals have recorded many cases of what has come to be called “phantom limbs.” Phantom limb phenomenon occurs when a person who has had an amputation of some body part, such as an arm or leg, reports “feeling” sensations from the now-missing limb. Phantom limb refers to the subjective sensory awareness of an amputated body part, and may include numbness, itchiness, temperature, posture, volume, or movement. For example, one man whose left arm was amputated just above the elbow during a horrific car accident claimed that he could still feel the arm as a kind of ghostly presence. He could feel himself wiggling non-existent fingers and “grabbing” objects that would have been in his reach had his arm still been there (Ramachandran & Blakeslee, 1998). Phantom sensations may take years to fade, and usually do so from the end of the limb up to the body—in other words, one’s phantom arm seems to get shorter and shorter until it can no longer be felt. In addition to legs and arms there have been cases of phantom breasts, bladders, rectums, vision, hearing, and internal organs.

Phantom limb pain refers to the specific case of painful sensations that appear to reside in the amputated body part. Patients have variously reported pins-and-needles sensations, burning sensations, shooting pains that seem to travel up and down the limb, or cramps, as thought the severed limb was in an uncomfortable and unnatural position. Many amputees often experience several types of pain; others report that the sensations are unlike other pain they’ve experienced. Unfortunately, some estimates suggest that over 70 percent of amputees still experience intense pain, even 25 years after amputation. Most treatments for phantom limb pain (there are over 50 types of therapy) help only about 7 percent of sufferers.

What causes these phantom sensations? A recent study has shed light on the causes of phantom limb sensations. Researchers at Humboldt University in Berlin suggest that the most severe type of this pain occurs in amputees whose brains undergo extensive sensory reorganization. Magnetic responses were measured in the brains of 13 arm amputees in response to light pressure on their intact thumbs, pinkies, lower lips, and chins. These responses were then mapped onto the somatosensory cortex controlling that side of the body. Because of the brain’s contralateral control over the body, the researchers were able to estimate the location of the somatosensory sites for the missing limb. They found that those amputees who reported the most phantom limb pain also showed the greatest cortical reorganization. Somatosensory areas for the face encroached into regions previously reserved for the amputated fingers.

Renowned neuroscientist Dr. V. S. Ramachandran has investigated many cases of phantom limb sensations in his career. He believes that examination of people who experience these phenomena, using the non-invasive techniques of magnetoencephalograms and functional MRIs, can teach us much about the relationship between sensory experience and consciousness. Researchers have long known that touching certain points on the stump of the amputation (and in some cases on the person's face) can produce phantom sensations in a missing arm or fingers (Ramachandran & Hirstein, 1998). Older explanations of phantom limb sensations have called it an illusion brought on by the irritation of the nerve endings in the stump due to scar tissue. But using anesthesia on the stump does not remove the phantom limb sensations or the pain experienced by some patients in the missing limb, so that explanation is not adequate. Ramachandran and colleagues suggest instead that phantom limb sensations may occur because areas of the face and body near the stump "take over" the nerve functions that were once in the control of the living limb, creating the false impression that the limb is still there, feeling and moving. This "remapping" of the limb functions, together with the sensations from the neurons ending at the stump and the person's mental "body image" work together to produce phantom limb sensations.

Although these findings do not by themselves solve the riddle of phantom limb pain, they do offer avenues for future research. For example, damage to the nervous system may cause a strengthening of connections between somatosensory cells and the formation of new ones. Phantom limb pain may result due to an imbalance of pain messages from other parts of the brain. As another possibility, pain may result from a remapping of somatosensory areas that infringes on pain centers close by.

Boas, R. A., Schug, S. A., & Acland, R. H. (1993). Perineal pain after rectal amputation: A 5-year follow-up. *Pain*, 52, 67–70.
Bower, B. (1995). Brain changes linked to phantom-limb pain. *Science News*, 147, 357.
Brena, S. F., & Sammons, E. E. (1979). Phantom urinary bladder pain—Case report. *Pain*, 7, 197–201.
Bressler, B., Cohen, S. I., & Magnussen, F. (1955). Bilateral breast phantom and breast phantom pain. *Journal of Nervous and Mental Disease*, 122, 315–320.
Dorpat, T. L. (1971). Phantom sensations of internal organs. *Comprehensive Psychiatry*, 12, 27–35.
Katz, J. (1993). The reality of phantom limbs. *Motivation and Emotion*, 17, 147–179.
Ramachandran, V. S., & Blakeslee, S. (1998). *Phantoms in the Brain*. William Morrow, N.Y.
Ramachandran, V. S. and W. Hirstein (1998). The perception of phantom limbs: The D. O. Hebb lecture. *Brain, 121*, 1603–1630.
Shreeve, J. (1993, June). Touching the phantom. *Discover*, pp. 35–42.

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: The Brain

To set the mood for your discussion of the brain, try the following: (1) talk about the relatively small size of the brain; (2) discuss its role in humankind's most amazing accomplishments; (3) discuss its role in humankind's most destructive actions; and (4) note that, to our knowledge, the brain is probably the only thing in the universe that can ponder its own existence (by asking your students to think about it, the statement is supported).

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: The Cranial Nerves

The textbook discusses various divisions of the nervous system. You may want to add a description of the cranial nerves to your outline of the nervous system. Although the function of the cranial nerves is not different from that of the sensory and motor nerves in the spinal cord, they do not enter and leave the brain through the spinal cord. There are twelve cranial nerves, numbered 1 to 12 and ordered from the front to the back of the brain, that primarily transmit sensory information and control motor movements of the face and head. The twelve cranial nerves are:

1. *Olfactory*. A sensory nerve that transmits odor information from the olfactory receptors to the brain.
2. *Optic*. A sensory nerve that transmits information from the retina to the brain.
3. *Oculomotor*. A motor nerve that controls eye movements, the iris (and therefore pupil size), lens accommodation, and tear production.
4. *Trochlear*. A motor nerve that is also involved in controlling eye movements.

5. *Trigeminal*. A sensory and motor nerve that conveys somatosensory information from receptors in the face and head and controls muscles involved in chewing.
6. *Abducens*. Another motor nerve involved in controlling eye movements.
7. *Facial*. Conveys sensory information and controls motor and parasympathetic functions associated with facial muscles, taste, and the salivary glands.
8. *Auditory-vestibular*. A sensory nerve with two branches, one of which transmits information from the auditory receptors in the cochlea and the other conveys information concerning balance from the vestibular receptors in the inner ear.
9. *Glossopharyngeal*. This nerve conveys sensory information and controls motor and parasympathetic functions associated with the taste receptors, throat muscles, and salivary glands.
10. *Vagus*. Primarily transmits sensory information and controls autonomic functions of the internal organs in the thoracic and abdominal cavities.
11. *Spinal accessory*. A motor nerve that controls head and neck muscles.
12. *Hypoglossal*. A motor nerve that controls tongue and neck muscles.

Carlson, N. R. (1994). *Physiology of behavior* (5th ed.). Boston: Allyn and Bacon.
Thompson, R. F. (1993). *The brain: A neuroscience primer* (2nd ed.). New York: W. H. Freeman.
Reprinted from Hill, W. G. (1995). Instructor's resource manual for *Psychology* by S. F. Davis and J. J. Palladino. Englewood Cliffs, NJ: Prentice Hall.

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Berger's Wave

Ask if anyone knows what is meant by the term, *Berger's wave*. Explain that the study of electrical activity in the brain was once limited to studies in which different kinds of measuring devices were attached to the exposed brains of animals. Studies involving humans were rare because researchers could only measure the electrical activity of the living human brain in individuals who had genetic defects of their skull bones that cause the skin of their scalps to be in direct contact with the surfaces of their brains.

All this changed when a German physicist named Hans Berger, after several years of painstaking research, discovered that it was possible to amplify and measure the electrical activity of the brain by attaching special electrodes to the scalp which, in turn, sent impulses to a machine that graphed them. In his research, Berger discovered several types of waves, one of which he called the "alpha" wave for no other reason than its having been the first one he discovered ("alpha" is the first letter of the Greek alphabet). He kept his research a secret until he published an article about it in 1929.

Obviously, Berger achieved one of the most important discoveries in the history of neuroscience. However, his life was not a happy one. Shortly after his article was published, the Nazis rose to power in Germany, which greatly distressed him. In addition, his work wasn't valued in Germany; he was far better known in the United States. As a result, Berger fell into a deep depression in 1941 and hanged himself.

The alpha wave is also sometimes called *Berger's wave* in honor of Berger's discovery.

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Freak Accidents and Brain Injuries

Students may be interested in the unusual cases of individuals who experience bizarre brain injuries due to freak accidents with nail guns. The most fascinating example involved Isidro Mejia, a construction worker in Southern California, who had six nails driven into his head when he fell from a roof onto his coworker who was using a nail gun. Incredibly, none of the nails caused serious damage to Mejia's brain. One nail lodged near his spinal cord, while another came very close to his brain stem. Immediate surgery and treatment with antibiotics prevented deadly infections that could have been caused by the nails. In a similar accident, a construction worker in Colorado ended up with a nail lodged in his head due to a nail gun mishap. Unlike Mejia, Patrick Lawler, didn't realize he had a nail in his head for six days. The nail was discovered when he visited a dentist due to a "toothache." It appears that Lawler fired a nail into the roof of his mouth. The nail barely missed his brain and the back of his eye.

Nail Gun /Victim Lives. *Current Science*, A Weekly Reader publication, Sept. 10, 2004, v90 (1), Page 14.
http://www.summitdaily.com/article/20050119/NEWS/50119002/0/FRONTPAGE

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Neural Effects of a Concussion

During the fall term, when college football is in season, it is especially appropriate to stress the discussion of the neuronal and behavioral effects of concussion. Chances are good that in any given class, you will have several students who will report having had a concussion in the past, usually as a result of participation in football or other sports activities, or as a result of an automobile accident. You can ask the students to discuss their experiences with the class, asking what kind of physiological and cognitive effects occurred. The most common effects include loss of vision ("blackout"), blurred vision, ringing in the ears, nausea/vomiting, and not being able to think clearly. However, the physiological and cognitive effects vary between individuals; some may not have experienced nausea at all, whereas others only experienced blurred vision. It is important to point out the variability between individuals, because it can be inferred that concussions vary greatly in terms of the severity of brain damage and the brain areas affected.

The brain sits in the cranium surrounded by cerebral fluid. When a severe blow to the head occurs, the brain may collide with the cranium, then "bounce back" and collide with the opposite side of the cranium. For example, if a football player falls and hits the back of his or her head, the brain may hit the back of the cranium, then the front. At this point, you might ask students what brain areas would be affected in this example ("occipital and frontal lobes" are a pretty decent answer). Therefore, both vision and some cognitive functioning may be affected. At the neuronal level, a concussive blow to the head results in a twisting or stretching of the axons, which in turn creates swelling. Eventually, the swelling may subside and the neuron may return to its normal functioning. However, if the swelling of the axon is severe enough, the axon may disintegrate. A more severe blow to the head may even sever axons, rendering those neurons permanently damaged. Either way, neuronal signaling is disrupted, either temporarily or permanently. Depending on the brain areas where the damaged axons are located, different physiological symptoms may occur.

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: The Phineas Gage Story

Recently, the journal *History of Psychiatry* reprinted the original presentation of the case study of Phineas P. Gage, noteworthy in psychology for surviving an accident in which an iron tamping rod was driven through his skull and brain. The case notes, by physician John M. Harlow, reveal aspects of the event that provide greater detail about Gage and his unfortunate accident.

Phineas Gage stood five feet six inches tall, weighed 150 pounds, and was 25 years old at the time of the incident. By all accounts this muscular foreman of the Rutland and Burlington Railroad excavating crew was well-liked and respected by his workers, due in part to "an iron will" that matched "his iron frame." He had scarcely known illness until his accident on September 13, 1848, in Cavendish, Vermont. Here is an account of the incident, in Harlow's own words:

> *He was engaged in charging a hold (sic) drilled in the rock, for the purpose of blasting, sitting at the time upon a shelf of rock above the hole. His men were engaged in the pit, a few feet behind him.... The powder and fuse had been adjusted in the hole, and he was in the act of 'tamping it in,' as it is called....While doing this, his attention was attracted by his men in the pit behind him. Averting his head and looking over his right shoulder, at the same instant dropping the iron upon the charge, it struck fire upon the rock, and the explosion followed, which projected the iron obliquely upwards...passing completely through his head, and high into the air, falling to the*

ground several rods behind him, where it was afterwards picked up by his men, smeared with blood and brain.

The tamping rod itself was three feet seven inches in length, with a diameter of 1¼ inches at its base and a weight of 13¼ pounds. The bar was round and smooth from continued use, and it tapered to a point 12 inches from the end; the point itself was approximately ¼ inch in diameter.

The accounts of Phineas' frontal lobe damage and personality change are well-known, and are corroborated by Harlow's presentation. Details of Phineas' subsequent life (he lived 12 years after the accident) are less known. Phineas apparently tried to regain his job as a railroad foreman, but his erratic behavior and altered personality made it impossible to do so. He took to traveling, visiting Boston and most major New England cities, and New York, where he did a brief stint at Barnum's sideshow. He eventually returned to work in a livery stable in New Hampshire, but in August, 1852, he turned his back on New England forever. Gage lived in Chile until June of 1860, then left to join his mother and sister in San Francisco. In February, 1861, he suffered a series of epileptic seizures, leading to a rather severe convulsion at 5 A.M. on February 20. The family physician unfortunately chose bloodletting as the course of treatment. At 10 P.M., May 21, 1861, Phineas eventually died, having suffered several more seizures. Although an autopsy was not performed, Phineas' relatives agreed to donate his skull and the iron rod (which Phineas carried with him almost daily after the accident) to the Museum of the Medical Department of Harvard University.

Miller (1993) also briefly notes that John Martyn Harlow himself had a rather pedestrian career, save for his association with the Gage case. Born in 1819, qualifying for medical practice in 1844, and dying in 1907, he practiced medicine in Vermont and later in Woburn, Massachusetts, where he engaged in civic affairs and apparently amassed a respectable fortune as an investor. Like Gage himself, Harlow was an unremarkable person brought into the annals of psychology by one remarkable event.

Harlow, J. M. (1848). Passage of an iron rod through the head. *Boston Medical and Surgical Journal, 39*, 389–393.
Harlow, J. M. (1868). Recovery from the passage of an iron bar through the head. Paper read before the Massachusetts Medical Society.
Miller, E. (1993). Recovery from the passage of an iron bar through the head. *History of Psychiatry, 4*, 271–281.

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Workplace Problems: Left-Handedness

Between Canada and the United States, there are approximately 33 million people who are left-handed. This presents a severe detriment to the workplace. It has been shown that left-handed individuals are more likely to have accidents at work than are right-handed individuals, in fact 25% more likely, and if they are working with tools and machinery, 51% more likely. Accommodations such as being able to rearrange the work area and having tools available that are either left- or right-hand adapted would make the workplace a safer place to be. Have students suggest ways that the workplace could be made safer or even what could be done in the classroom that would make it easier for students who are left handed to take notes or tests. What about the mouse on computers? The mouse is actually made for people who are right-handed. How adaptable must a left-handed person become in order not to be frustrated by using a right-handed mouse?

Gunsch, D. For Your Information: Left-handed workers struggle in a right-handed work world. *Personnel Journal, 93*, 23–24.

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Understanding Hemispheric Function

A variation on the rather dubious statement that "we only use one-tenth of our brain" is that "we only use one-half (hemisphere) of our brain." Research suggests that each cerebral hemisphere is specialized to perform certain tasks (e.g., left hemisphere/language; right hemisphere/visuospatial relationships), with the abilities of one hemisphere complementary to the other. From this came numerous distortions, oversimplifications, and unwarranted extensions, many of which are discussed in two interesting reviews of this trend toward "dichotomania" (Corballis, 1980; Levy, 1985). For example, the left hemisphere has been described variously as logical, intellectual, deductive, convergent, and "Western," while the right hemisphere has been described as intuitive or creative, sensuous, imaginative, divergent, and "Eastern." Even complex tasks are described as right- or left-hemispheric because of their language component. In every individual one hemisphere supposedly dominates, affecting that person's mode of thought, skills, and approach to life. One commonly cited, but questionable test for dominance is to note the direction of gaze when a person is asked a question (left gaze signaling right hemisphere activity; right gaze showing left hemisphere activity). Advertisements have claimed that artistic abilities can be improved if the right hemisphere is freed, and the public schools have been blamed for stifling creativity by emphasizing left-hemisphere skills and by neglecting to teach the children's right hemisphere.

Corballis and Levy explode these myths and trace their development. In reality, the two hemispheres are quite similar and can function remarkably well even if separated by split-brain surgery. Each hemisphere does have specialized abilities, but the two hemispheres work together in all complex tasks. For example, writing a story involves left-hemispheric input concerning syntax, but right-hemispheric input for developing an integrated structure and for using humor or metaphor. The left hemisphere is not the sole determinant of logic, nor is the right hemisphere essential for creativity. Disturbances of logic are more prevalent with right-hemisphere damage, and creativity is not necessarily affected. Although one hemisphere can be somewhat more active than the other, no individual is purely "right-brained" or "left-brained." Also, eye movement and hemispheric activity patterns poorly correlate with cognitive style or occupation. Finally, because of the coordinated, interactive manner of functioning of both hemispheres, educating or using only the right or left hemisphere is impossible (without split-brain surgery). (*Note*: Suggestions for a student activity on this topic are given in the following Classroom Activities section of this manual).

Corballis, M.C. (1980). Laterality and myth. *American Psychologist, 35*, 284–295.
Levy, J. (1985). Right brain, left brain: Fact or fiction? *Psychology Today, 19*, 38–45.

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Brain's Bilingual Broca

Se potete parlare Italiano, allore potete capire questa sentenza. Of course, if you only speak English, you probably only understand *this* sentence. If you speak both languages, then by this point in the paragraph you should be really bored.

Bilingual speakers who come to their bilingualism in different ways show different patterns of brain activity. Joy Hirsch of Memorial Sloan-Kettering Cancer Center in New York and her colleagues monitored the activity in Broca's area in the brains of bilingual speakers who acquired their second language starting in infancy, and compared it to the activity of bilingual speakers who adopted a second language in their teens. Participants were asked to silently recite brief descriptions of an event from the previous day, first in one language and then in the other. A functional magnetic resonance image (fMRI) was taken during this task. All of the 12 adult speakers were equally fluent in both languages, used both languages equally often, and represented speakers of English, French, and Turkish, among other tongues.

Hirsch and her colleagues found that among the infancy-trained speakers, the same region of Broca's area was active, regardless of the language they used. Among the teenage-trained speakers, however, a different region of Broca's area was activated when using the acquired language. Similar results were found in Wernicke's area in both groups. Although the full meaning of these results is a matter of some debate (do they reflect sensitivity in Broca's area to language exposure, or pronounced differences in adult versus childhood language learning?), they nonetheless reveal an intriguing link between la testa e le parole.

Bower, B. (1997, July 12). Brains show signs of two bilingual roads. *Science News, 152,* 23.

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: The Results of a Hemispherectomy

Matthew is eight years old now. Two years ago, surgeons removed half of his brain.

His first three years were completely normal. Just before he turned four, however, Matthew began to experience seizures, which did not respond to drug treatment. The seizures were severe (life threatening) and frequent (as often as every three minutes). The eventual diagnosis was Rasmussen's encephalitis, a rare and incurable condition of unknown origin.

The surgery, a hemispherectomy, was performed at Johns Hopkins Hospital in Baltimore. A few dozen such operations are performed each year in the U.S., usually as a treatment for Rasmussen's and for forms of epilepsy that destroy the cortex but do not cross the corpus callosum. After surgeons removed Matthew's left hemisphere, the empty space quickly filled with cerebrospinal fluid.

The surgery left a scar that runs along one ear and disappears under his hair; however, his face has no lopsidedness. The only other visible effects of the operation are a slight limp and limited use of his right arm and hand. Matthew has no right peripheral vision in either eye. He undergoes weekly speech and language therapy sessions. For example, a therapist displays cards that might say "fast things" and Matt must name as many fast things as he can in 20 seconds. He does not offer as many examples as other children his age. However, he is making progress in the use of language perhaps as a result of fostering and accelerating the growth of dendrites.

The case of Matthew indicates the brain's remarkable plasticity. It is interesting to note that Matt's personality never changed through the seizures and surgery.

Boyle, M. (1997, August 1). Surgery to remove half of brain reduces seizures. *Austin American-Statesman*, A18.
Swerdlow, J. L. (1995, June). Quiet miracles of the brain. *National Geographic, 87*, 2-41.
Adapted from Davis, S. F., & Palladino, J. J. (1996) *Interactions: A Newsletter to Accompany Psychology*, *1(Spr)*, 4.

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Too Much or Too Little: Hormone Imbalances

Students may find it interesting to hear more about the various problems caused by problems within the endocrine system. The following disorders/medical problems are associated with abnormal levels within the pituitary, thyroid and adrenal glands.

Pituitary Malfunctions

Hypopituitary Dwarfism

If the pituitary secretes too little of its growth hormone during childhood, the person will be very small, although normally proportioned.

Giantism

If the pituitary gland over-secretes the growth hormone while a child is still in the growth period, the long bones of the body in the legs and other areas grow very, very long—a height of 9 feet is not unheard of. The organs of the body also increase in size, and the person may have health problems associated with both the extreme height and the organ size.

Acromegaly

If the over-secretion of the growth hormone happens after the major growth period is ended, the person's long bones will not get longer, but the bones in the face, hands, and feet will increase in size, producing abnormally large hands, feet, and facial bone structure. The famous wrestler/actor, Andre the Giant (Andre Rousimoff), had this condition.

Thyroid Malfunctions

Hypothyroidism

In hypothyroidism, the thyroid does not secrete enough thyroxin, resulting in a slower than normal metabolism. The person with this condition will feel sluggish and lethargic, have little energy, and tends to be obese.

Hyperthyroidism

In hyperthyroidism, the thyroid secretes too much thyroxin, resulting in an overly active metabolism. This person will be thin, nervous, tense, and excitable. He or she will also be able to eat large quantities of food without gaining weight (and I hate them for that—oh, if only we came equipped with thyroid control knobs!).

Adrenal Gland Malfunctions

Among the disorders that can result from malfunctioning of the adrenal glands are **Addison's disease** (low levels of cortisol and steroid hormones) and **Cushing's syndrome** (high levels of cortisol and steroid hormones). In the former, fatigue, low blood pressure, weight loss, nausea, diarrhea, and muscle weakness are some of the symptoms, while for the latter, obesity, high blood pressure, a "moon" face, and poor healing of skin wounds is common.

If there is a problem with over-secretion of the sex hormones in the adrenals, **virilism** and **premature puberty** are possible problems. Virilism results in women with beards on their faces and men with exceptionally low, deep voices. Premature puberty, or full sexual development while still a child, is a result of too many sex hormones during childhood. There is a documented case of a 5-year old Peruvian girl who actually gave birth to a son (Strange, 1965). Puberty is considered premature if it occurs before the age of 8 in girls and 9 in boys. Treatment is possible using hormones to control the appearance of symptoms, but must begin early in the disorder.

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

Lecture/Discussion: Would You Like Fries With That Peptide?

Toast and juice for breakfast. Pasta salad for lunch. An orange, rather than a bagel, for an afternoon snack. These sound like reasonable dietary choices, involving some amount of deliberation and free will. However, our craving for certain foods at certain times of the day may be more a product of the brain than of the mind.

Sarah F. Leibowitz, Rockefeller University, has been studying food preferences for over a decade. What she has learned is that a stew of neurochemicals in the paraventricular nucleus, housed in the hypothalamus, plays a crucial role in helping to determine what we eat and when. Two in particular—Neuropeptide Y and galanin—help guide the brain's craving for carbohydrates and for fat.

Here's how they work. Neuropeptide Y (NPY) is responsible for turning on and off our desire for carbohydrates. Animal studies have shown a striking correlation between NPY and carbohydrate intake; the more NPY produced, the more carbohydrates eaten, both in terms of meal size and duration. Earlier in the sequence, the stress hormone cortisol seems responsible, along with other factors, for upping the production of Neuropeptide Y. This stress ⇨ cortisol ⇨ Neuropeptide Y ⇨ carbohydrate craving sequence may help explain overweight due to high carbohydrate intake. But weight, and craving, rely on fat intake as well. Leibowitz has found that the neuropeptide galanin plays a critical role in this case. Galanin is the on/off switch for fat craving, correlating positively with fat intake; the more galanin produced, the heavier an animal will become. Galanin also triggers other hormones to process the fat consumed into stored fat. Galanin itself is triggered by metabolic cues resulting from burning fat as energy, but also from another source: estrogen.

Neuropeptide Y triggers a craving for carbohydrates, galanin triggers a craving for fat, but the two march to different drummers throughout a day's cycle. Neuropeptide Y has its greatest effects in the morning (at the start of the feeding cycle), after food deprivation (such as dieting), and during periods of stress. Galanin, by contrast, tends to increase after lunch and peaks toward the end of our daily feeding cycle.

The implications of this research are many. For example, the findings suggest that America's obsession with dieting is a losing proposition (but not around the waistline). Skipping meals, gulping appetite suppressers, or experiencing the stress of dieting will trigger Neuropeptide Y to encourage carbohydrate consumption, which in turn can foster overeating. Paradoxically, then, by trying to fight nature we may stimulate it even more. As another example, the onset and maintenance of anorexia may be tied to the chemical cravings in the hypothalamus. Anorexia tends to develop during puberty, a time when estrogen is helping to trigger galanin's craving for fat consumption. Some women (due to societal demands, obsessive-compulsive tendencies, or other pressures) react to this fat trigger by trying to accomplish just the opposite; subsisting on very small, frequent, carbohydrate-rich meals. The problem is that the stress and starvation produced by this diet cause Neuropeptide Y to be released, confining dietary interest to carbohydrates, but also affecting the sex centers nearby in the hypothalamus. Specifically, Neuropeptide Y may act to shut down production of gonadal hormones.

Marano, H. E. (1993, January/February). Chemistry and craving. *Psychology Today*, pp. 30–36, 74.
http://www.rockefeller.edu/labheads/leibowitz/research.php

► Return to Lecture Guide: Biology and Behavior
▼ Return to List of Lecture Launchers and Discussion Topics for Chapter 3
▲ Return to Chapter 3: Table of Contents

CLASSROOM ACTIVITIES, DEMONSTRATIONS, AND EXERCISES

▲ Return to Chapter 3: Table of Contents

Activity: Using Reaction Time to Show the Speed of Neurons

I always begin this demonstration by asking students if they believe that there is a difference in reaction time if the impulse has to travel farther. Most frequently students answer in the affirmative. Here is a simple demonstration of the time required to process information along sensory neurons in the arm and can be done by asking students to form a line by holding hands. Ask a student to start and stop a stopwatch. Then begin by asking for volunteers. The number of students who volunteer is irrelevant. Instruct the students to close their eyes and to squeeze the hand of the person next to them when they feel the person on the opposite side squeeze their hand. The last person in line should signal the timekeeper that his or her hand has been squeezed by raising a free hand. Have the student stop the watch and record the elapsed time. Repeat the process until the reaction times appear to be stable. Take the final reaction time and divide by the number of students in the line to obtain the average reaction time.

Next, ask the students to squeeze the next person's shoulder instead of hand. The average reaction time should now decrease since the sensory information has a shorter distance to travel. The difference in average reaction time obtained from the two procedures represents—roughly—the average conduction time for sensory information between the hand and shoulder.

► Return to Lecture Guide: The Nervous System in Action
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: The Dollar Bill Drop

After engaging in the neural network exercise, try following it up with the "dollar bill drop" (Fisher, 1979), which not only delights students but also clearly illustrates the speed of neural transmission. Ask students to get into pairs and to come up with one crisp, flat, one-dollar bill (or something bigger, if they trust their fellow classmates!) between them. First, each member of the pair should take turns trying to catch the dollar bill with their nondominant (for most people, the left) hand as they drop it from their dominant (typically right) hand. To do this, they should hold the bill vertically so that the top, center of the bill is held by the thumb and middle finger of their dominant hand. Next, they should place the thumb and middle finger of their nondominant hand around the dead center of the bill, as close as they can get without touching it. When students drop the note from one hand, they should be able to easily catch it with the other before it falls to the ground.

Now that students are thoroughly unimpressed, ask them to replicate the drop, only this time one person should try to catch the bill (i.e., with the thumb and middle finger of the nondominant hand) while the other person drops it (i.e., from the top center of the bill). Student "droppers" are instructed to release the bill without warning, and "catchers" are warned not to grab before the bill is dropped. (Students should take turns playing dropper and catcher.) There will be stunned looks all around as dollar bills whiz to the ground. Ask students to explain why it is so much harder to catch it from someone other than themselves. Most will instantly understand that when catching from ourselves, the brain can simultaneously signal us to release and catch the bill, but when trying to catch it from someone else, the signal to catch the bill can't be sent until the eyes (which see the drop) signal the brain to do so, which is unfortunately a little too late.

Fisher, J. (1979). *Body Magic*. Briarcliff Manor, NY: Stein and Day.

► Return to Lecture Guide: The Nervous System in Action
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Using Dominoes to Understand the Action Potential

Walter Wagor suggests using real dominoes to demonstrate the so-called "domino effect" of the action potential as it travels along the axon. For this demonstration, you'll need a smooth table-top surface (at least 5 feet long) and one or two sets of dominoes. Set up the dominoes beforehand, on their ends and about an inch apart, so that you can push the first one over and cause the rest to fall in sequence. Proceed to knock down the first domino in the row and students should clearly see how the "action potential" is passed along the entire length of the axon. You can then point out the concept of refractory period by showing that, no matter how hard you push on the first domino, you will not be able to repeat the domino effect until you take the time to set the dominoes back up (i.e., the resetting time for the dominoes is analogous to the refractory period for neurons). You can then demonstrate the all-or-none characteristic of the axon by resetting the dominoes and by pushing so lightly on the first domino that it does not fall. Just as the force on the first domino has to be strong enough to knock it down before the rest of the dominoes will fall, the action potential must be there in order to perpetuate itself along the entire axon. Finally, you can demonstrate the advantage of the myelin sheath in axonal transmission. For this demonstration, you'll need to set up two rows of dominoes (approximately 3 or 4 feet long) next to each other. The second row of dominoes should have foot-long sticks (e.g., plastic rulers) placed end-to-end in sequence on top of the dominoes. By placing the all-domino row and the stick-domino row parallel to each other and pushing the first domino in each, you can demonstrate how much faster the action potential can travel if it can jump from node to node rather than having to be passed on sequentially, single domino by single domino. Ask your students to discuss how this effect relates to myelinization.

Wagor, W. F. (1990). Using dominoes to help explain the action potential. In V. P. Makosky, C. C. Sileo, L. G. Whittemore, C. P. Landry, & M. L. Skutley (Eds.), *Activities handbook for the teaching of psychology: Vol. 3* (pp. 72–73). Washington, DC: American Psychological Association.

► Return to Lecture Guide: The Nervous System in Action
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Demonstrating Neural Conduction: The Class as a Neural Network

In this engaging exercise (suggested by Paul Rozin and John Jonides), students in the class simulate a neural network and get a valuable lesson in the speed of neural transmission. Depending on your class size, arrange 15 to 40 students so that each person can place his or her right hand on the right shoulder of the person in front of them. Note that students in every other row will have to face backwards in order to form a snaking chain so that all students (playing the role of individual neurons) are connected to each other. Explain to students that their task as a neural network is to send a neural impulse from one end of the room to the other. The first student in the chain will squeeze the shoulder of the next person, who, upon receiving this "message," will deliver (i.e., "fire") a squeeze to the next person's shoulder and so on, until the last person receives the message. Before starting the neural impulse, ask students (as "neurons") to label their parts; they typically have no trouble stating that their arms are axons, their fingers are axon terminals, and their shoulders are dendrites.

To start the conduction, the instructor should start the timer on a stopwatch while simultaneously squeezing the shoulder of the first student. The instructor should then keep time as the neural impulse travels around the room, stopping the timer when the last student/neuron yells out "stop." This process should be repeated once or twice until the time required to send the message stabilizes (i.e., students will be much slower the first time around as they adjust to the task). Next, explain to students that you want them to again send a neural impulse, but this time you want them to use their ankles as dendrites. That is, each student will "fire" by squeezing the ankle of the person in front of them. While students are busy shifting themselves into position for this exercise, ask them if they expect transmission by ankle-squeezing to be faster or slower than transmission by shoulder-squeezing. Most students will immediately recognize that the ankle-squeezing will take longer because of the greater distance the message (from the ankle as opposed to the shoulder) has to travel to reach the brain. Repeat this transmission once or twice and verify that it indeed takes longer than the shoulder squeeze.

This exercise—a student favorite—is highly recommended because it is a great ice-breaker during the first few weeks of the semester and it also makes the somewhat dry subject of neural processing come alive.

Rozin, P., & Jonides, J. (1977). Mass reaction time measurement of the speed of the nerve impulse and the duration of mental processes in class. *Teaching of Psychology, 4*, 91–94.

► Return to Lecture Guide: The Nervous System in Action
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Human Neuronal Chain

Objective: To illustrate that the transmission of messages in the nervous system is not instantaneous.

Materials: 20 students standing, facing forward, in a line; a stopwatch

Procedure: Ask the last student to tap either shoulder of the next person and each subsequent person to continue the process through the entire line, always using the same shoulder and never crossing the body (i.e., left hand to right shoulder). Use the stopwatch to time how long it takes for the last person to receive the stimulus.

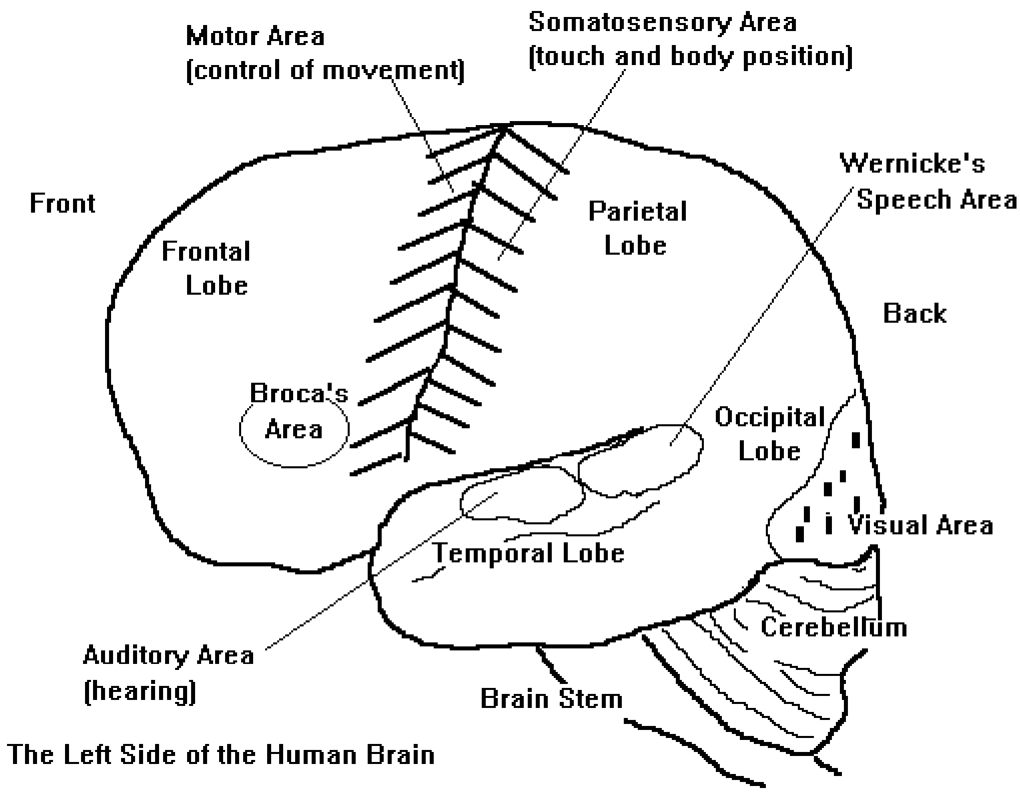
Harcum, E. R. (1988). Reaction time as a behavioral demonstration of neural mechanisms for a large introductory psychology class. *Teaching of Psychology, 15*, 208–209.

► Return to Lecture Guide: The Nervous System in Action
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Mapping the Brain

Many students, especially those with little background in the sciences, will find it a challenge to keep track of the location of all the parts of the brain outlined in the text. One simple way to reinforce their learning of brain structure is to have students locate the various parts on a photocopied diagram of the brain. The brain diagram and the student instructions for this exercise are included as **Handout Master 3.1**. The day before you present this activity, ask students to bring colored pencils or markers to class. On the day of the activity, divide students into small groups and distribute copies of the diagram of the brain and the accompanying questions in the student handouts. Within their groups they can help each other locate each part of the brain and then color code them using their pencils or markers. They can also indicate the function of each part on the diagram. This exercise is very useful for helping students to memorize brain anatomy, and the color-coded diagram serves as a helpful study guide.

For your convenience, a completed diagram and suggested answers to the questions are furnished on the next page.



1. This is a diagram of the left side of the brain.
   a) *Left side functions*: The left hemisphere controls touch and movement of the right side of the body, vision in the right half of the visual field, comprehension and production of speech, reading ability, mathematical reasoning, and a host of other abilities.
   b) *Right side functions*: The right hemisphere controls touch and movement of the left side of the body, vision in the left half of the visual field, visual-spatial ability, map-reading, art and music appreciation, analysis of nonverbal sounds, and a host of other abilities.
2. The front of the brain is on the left side of the diagram; the back of the brain is on the right.
3. The cerebrum is the sum of the frontal, parietal, temporal, and occipital lobes. The cerebellum is labeled on the diagram above.
   a) The cerebrum is responsible for higher forms of thinking, including a variety of specific abilities described under motor cortex, visual cortex, somatosensory cortex, and auditory cortex. The cerebral cortex also contains vast association areas, whose specific functions are poorly defined but may include reasoning and decision making, planning appropriate behavior sequences, and knowing when to stop. The limbic system, which appears to be strongly involved in regulating emotions, is also part of the cerebrum.
   b) The cerebellum aids in the sense of balance and motor coordination.
4. The frontal, parietal, temporal, and occipital lobes are labeled on the diagram above.
5. The motor cortex is labeled on the diagram above. The motor cortex in each hemisphere controls movements on the opposite side of the body.
6. The visual cortex is labeled on the diagram above. The visual cortex in each hemisphere receives information from the visual field on the opposite side.
7. The auditory cortex is labeled on the diagram above. The auditory cortex is responsible for processing sounds.
8. The somatosensory cortex is labeled on the diagram above. The somatosensory cortex on each side receives information about touch, joint position, pressure, pain, and temperature from the opposite side of the body.
9. Broca's and Wernicke's areas are labeled on the diagram above.
   a) Broca's area is often referred to as the motor speech area. It is responsible for our ability to carry out the movements necessary to produce speech.
   b) Wernicke's area is often referred to a sensory speech area. It is mainly involved in comprehension and planning of speech.

10. Neurons would be found all over the drawing. (The brain is made up of billions of neurons.) Each neuron is very tiny compared to the size of the brain, so no single neuron would be visible to the naked eye in a drawing at this scale. The cell bodies of the largest neurons in the brain are about 1/20 of a millimeter in diameter!
11. The brain stem is labeled on the diagram above. Different parts of the brain stem are involved in regulation of sleep and wakefulness, dreaming, breathing, heart rate, and attentional processes.

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Review of Brain-Imaging Techniques

Objectives: To review information on brain-imaging techniques.

Materials: None

Procedures: Ask students to tell which brain-imaging technique could answer each of the following questions:

1. How do the brains of children and adults differ with regard to energy consumption? (PET)
2. In what ways do brain waves change as a person falls asleep? (EEG)
3. In which part of the brain has a stroke patient experienced a disruption of blood flow? (CT, MRI)
4. What is the precise location of a suspected brain tumor? (CT, MRI)
5. How can brain structures be examined without exposing a patient to radiation? (MRI)
6. How can scientists view structures and their functions at the same time? (fMRI)
7. What techniques allow scientists to view changes in the magnetic characteristics of neurons as they fire? (SQUID, MEG)

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Trip to the Hospital

Objective: To demonstrate brain imaging techniques.

Materials: Local or regional hospital

Procedure: Arrange a trip to the local or regional hospital to see their CAT, PET, MRI, and fMRI facilities. Being able to see and hear about this equipment firsthand far exceeds what students can gain from the text. Such a trip can be undertaken only if you have a small class, recitation, or laboratory section. A voluntary sign-up list also can be used. You will have to make your plans well in advance and at the convenience of the hospital staff. If the size of your class precludes this field trip, you could invite a local physician or one of the technicians to discuss these procedures. It will be helpful if he or she can arrange to bring examples of the records or scans that are produced for evaluation of neurological disorders. You should plan to ask your guest speaker to compare modern procedures to earlier evaluations of neurological disorders.

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: The Importance of a Wrinkled Cortex

At the beginning of your lecture on the structure and function of the brain, ask students to explain why the cerebral cortex is wrinkled. There are always a few students who correctly answer that the wrinkled appearance of the cerebral cortex allows it to have a greater surface area while fitting in a relatively small space (i.e., the head). To demonstrate this point to your class, hold a plain, white sheet of paper in your hand and then crumple it into a small, wrinkled ball. Note that the paper retains the same surface area, yet is now much smaller and is able to fit into a much smaller space, such as your hand. You can then mention that the brain's actual surface area, if flattened out, would be roughly the size of a newspaper page (Myers, 1995). Laughs usually erupt when the class imagines what our heads would look like if we had to accommodate an unwrinkled, newspaper-sized cerebral cortex!

Myers, D. G. (1995). *Psychology* (4th ed.). New York: Worth.

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Probing the Cerebral Cortex

Use: Pearson Introductory Psychology Teaching Films

Synopsis: This clip contains commentary by Wilder Penfield, a pioneer in mapping the areas of the cerebral cortex. Penfield discusses the work that led to electrode-stimulation of the cortex. He also interviews a brain surgery patient about her experiences during surgery. Stimulation of various areas of her cortex produced memories of past events and the perception of music playing.

Form a Hypothesis

Q: What happens when Penfield stimulates a small area of the temporal lobe, called the auditory cortex?
A: The patient "hears" sounds.

Test Your Understanding

Q: What are the four lobes of the cerebral cortex?
A: The four lobes of cerebral cortex are occipital, parietal, temporal, and frontal.
Q: What are the functions of the somatosensory cortex, motor cortex, and association cortex areas?
A: Somatosensory cortex interprets sensations and coordinates the motor behavior of skeletal muscles. Association areas, located on all four cortical lobes, are involved in the integration of various brain functions, such as sensation, thought, memory, planning, etc.
Q: What two areas of the association cortex specialize in language?
A: Wernicke's area, located toward the back of the temporal lobe, is important in understanding the speech of others. Broca's area is essential to sequencing and producing language.

Thinking Critically

Q: What four types of research methods are commonly used in the study of behavioral neuroscience?
A: Microelectrode techniques are used to study the functions of individual neurons. Macroelectrode techniques, such as an EEG, record activities of brain areas. Structural imaging, such as computerized axial tomography or CAT scans, is useful for mapping brain structures. Functional imaging, in which specific brain activity can be recorded in response to tasks or stimulation, offers the potential to identify specific brain areas and functions.

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Lateralization Activities

Procedure:

There are several demonstrations that illustrate the lateralization of the brain. Several have been described by Filipi and Gravlin (1985). A variant by Morton Gernsbacher requires students to move their right hand and right foot simultaneously in a clockwise direction for a few seconds. Next ask that the right hand and left foot be moved in a clockwise direction. Then, have students make circular movements in opposite directions with right the hand and the left foot. Finally, have students attempt to move the right hand and right foot in opposite directions. This generally produces laughter as students discover that this procedure is most difficult to do even though they are sure—before they try it—that it would be no problem to perform. A simple alternative activity is to ask students to pat their head and to rub their stomach clockwise and then switch to a counterclockwise motion. The pat will show slight signs of rotation as well.

The brain is lateralized to some extent, and this makes some activities difficult to perform. Challenge your students to explain why activities of these types are difficult to execute. This will generally lead to interesting discussions and the assertion by some students that this type of behavior is no problem. Generally students who have been trained in martial arts, dance, and/or gymnastics have less difficulty completing these activities due to rigorous physical training.

Kemble, E. D. (1987). Cerebral lateralization. In V. P. Makosky, L. G. Whittemore, and A. M. Rogers (Eds.). *Activities handbook for the teaching of psychology* (Vol. 2) (pp. 33–36). Washington, D.C.: American Psychological Association.
Kemble, E. D., Filipi, T., & Gravlin, L. (1985). Some simple classroom experiments on cerebral lateralization. Teaching of Psychology, 12, 81–83.

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Localization of Function Exercise

This exercise has several functions. It is designed to get students to review the methods which are used to study the brain and where particular functions are localized. It is also intended to make students think critically about how we know what we know about functional localization. The examples included are based on real life examples of situations which have provided information about localization of functions in the brain. Some of the situations described may be difficult for students to conceptualize. Be prepared to assist students in conceptualizing each situation. Students can do this exercise individually or in small groups. Group work is probably preferable because students can learn by bouncing ideas off of each other. The student handout for this activity is included as **Handout Master 3.2**. Suggested answers are included below.

1. The lesion method is being used to study brain function. Students may be puzzled by this, thinking that the lesion method always involves *intentionally* damaging part of the brain to study its function. This is not the case; much of the information we have about functional localization comes from fairly old studies of veterans who received gunshot wounds to their brains.

   This part of the brain controls movement on the opposite side of the body. It is the *motor* area of the cerebral cortex.

   By looking at the drawing we can see that damage high up on the brain results in paralysis which is lower down on the body and vice versa. It is as if the body is "mapped" upside down and backwards on the motor cortex. (If you have a drawing of the "motor homunculus," it would be helpful to share this with the students after they have completed this exercise.)

2. The lesion method is being used to study brain function.

   Based on the information provided, the part of the brain labeled J is responsible for the ability to speak. The area marked J controls the ability to speak; it is on the left side of the brain. The equivalent area on the right side of the brain must be doing something else, since damage to this area does not produce any affect on speech.

3. The function of this part of the brain is being studied with the electrical stimulation method. Students may be surprised, and horrified, to find out that people are often awake during surgery on their brains. This is necessary because in real life the brain is not color coded, nor does it come with nice little labels saying what its different parts do. During surgery, surgeons have a general idea where they are, but one part looks pretty much the same as the next. When the surgeon is planning to remove a part of the brain, for example, an area where a tumor is located or an area where a patient's epileptic seizures tend to start, he/she does not want to remove a part which would result in a marked decrement in the patient's quality of life (for example, a speech area). Therefore, it is fairly routine to stimulate an awake patient's brain during surgery, to verify the function of the areas the surgeon is working near. During surgery, the scalp, bone, and membranes covering the brain must be anesthetized, so that the patient does not feel pain. The brain itself does not have pain receptors, so that working on the brain is not physically painful.

   This part of the brain appears to process visual information; in fact, it is the *visual* cortex. When this part of the brain is stimulated electrically, neurons are activated in much the same way that they would be by natural visual stimulation. Therefore, the patient reports seeing a visual stimulus that is not actually there.

   The information provided suggests that there is an upside-down and backwards map of the visual world on the visual cortex (note the similarity to the upside-down and backwards map of the body on the motor cortex in the first example). Note that the left side of the brain is being stimulated. Yet, when the patient fixates on the cross in the middle of the screen, all of the points of light that he reports are to the right of the fixation point. Therefore, the information from the right side of the visual field is relayed to the left side of the brain. Note also, that when points which are higher up on the cortex are stimulated, the patient reports seeing flashing lights in the lower part of the visual field; conversely, when points lower down on the visual cortex are stimulated, the patient reports flashing lights in the upper part of the visual field. Hence, the notion of an upside-down and backwards map of the visual world in the visual cortex.

4. The function of this part of the brain is being studied through the electrical stimulation method.

   This part of the brain is responsible for the sense of touch (among other things) on the opposite side of the body. The area being stimulated is the *somatosensory* cortex.

   By looking at the drawing we can see that stimulation high up on the brain results in a tingling sensation which is lower down on the body and vice versa. It is as if the body is "mapped" upside down and backwards on the somatosensory cortex. (If you have a drawing of the "sensory homunculus" it would be helpful to share this with the students after they have completed this exercise.) The notion of the world being mapped upside down and backwards on the brain should be starting to sound like a recurring theme by now!

5. The method being used is positron emission tomography (PET scanning).

   This area is responsible for processing information concerning sounds; it is the *auditory* cortex.

6. A needle electrode is being used to record the electrical activity of this part of the brain.

   The evidence suggests that this part of the brain may be responsible for triggering eating behavior; alternately, it may be responsible for the sensation of hunger.

7. The lesion method is being used to study brain function, but this time, in contrast to examples 1 and 2, the damage to the brain was created intentionally.

   The corpus callosum relays information from one side of the brain to the other when it is intact. In this example, because the corpus callosum is cut, information cannot be relayed from one side of the brain to the other. This explains the two specific deficits noted in this example.

The patient is unable to name an object placed in her left hand because the sensory information from that hand is relayed to the right side of her brain, which has little or no language or speech ability.

The patient is unable to pick out an object with her right hand that she has already felt with her left hand because that would require comparison of sensory information relayed to the two sides of the brain, which is no longer possible with the corpus callosum cut.

Students may wonder why it is important that the patient kept her eyes closed in these two examples. This was done because each eye, when open, sends information to both sides of the brain. If the patient had had her eyes open in these examples, information would have been sent to both sides of the brain, and the patient would not have had difficulty with these tasks.

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Looking Left, Looking Right

Objective: To demonstrate that lateral eye movements are associated with thinking.

Materials: Left and Right Hemisphere Questions (**Handout 3.1**)

Procedure: It has been theorized that when language-related tasks are being performed in the left hemisphere, the eyes look to the right; when nonlanguage, spatial abilities are being used in the right hemisphere, the eyes look to the left. This is a relatively easy class activity. After pairing up, one student asks the questions and records lateral eye movements, while the other attempts to answer the questions.

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Assignment: The Brain Diagram

Students often have trouble encoding the location and function of the different parts of the brain, both because (a) they glance too quickly over the colorful textbook illustrations and (b) their eyes tend to glaze over during class discussion of the brain's structure and function. As an easy remedy to this problem, try asking students to draw their own colorful rendition of the human brain, an active learning strategy that ensures that they encode and think about the parts of the brain rather than passively glossing over them in the text. Prior to the class period in which you will be discussing the brain, ask students to read Chapter 3 and to hand-draw a diagram of the brain (in a cross-section) on a clean white sheet of unlined paper. For each of the following sections of the brain, students should color and label the appropriate structure, and also list at least one or two of its major functions: (a) the cerebral cortex, including the four lobes, (b) the thalamus, (c) the hypothalamus, (d) the hippocampus, (e) the amygdala, (f) the cerebellum, (g) the pons, and (h) medulla. Added benefits of this assignment are that it is easy to grade, students enjoy doing it (and it is an easy and fun way for them to get points), and it can be used by students as a study aid for the exam.

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Psychology in Literature

The Man Who Mistook His Wife for a Hat

Oliver Sacks' national bestseller chronicles over 20 case histories of patients with a variety of neurological disorders. His compassionate retelling of bizarre and fascinating tales include patients plagued with memory loss, useless limbs, violent tics and jerky mannerisms, the inability to recognize people or objects, and unique artistic or mathematical talents despite severe mental deficits. A reading of this absorbing book will surely increase your students' understanding of the connection between the brain and the mind, and will also give them invaluable insights into the lives of disordered individuals. Ask your students to write a book report focusing on a few of the cases that most interest them, and to apply principles from the text and lecture to the stories. As a more elaborate project, you might consider assigning this book at the end of the semester, as many of the cases are ripe with psychological principles that may be encountered later in the course (e.g., perception, memory, mental retardation).

Sacks, O. (1985). *The man who mistook his wife for a hat*. New York: Harper Collins.
Staff (1995, May/June). PT interview: Oliver Sacks; the man who mistook his wife for a ... what? *Psychology Today*, 28–33.

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Twenty Questions

Objective: To review information about hormones.

Materials: None

Procedures: Play a round of the Twenty Questions game. Tell students that you are thinking of a certain hormone. The students are to determine which hormone by asking you questions to which you can respond only "yes" or "no."

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Crossword Puzzle

Frequently instructors want an activity that is interactive for their students as well as a reinforcer of the material just covered in the lecture. An activity such as a crossword puzzle can fulfill both criteria. Copy and distribute **Handout Master 3.3** to students as a homework or in-class review assignment.

Answers for the Crossword Puzzle:

Across

1. Neurotransmitter that causes the receiving cell to stop firing. **inhibitory**
3. The cell body of the neuron, responsible for maintaining the life of the cell. **soma**
4. Endocrine gland located near the base of the cerebrum which secretes melatonin. **pineal**
7. Glands that secrete chemicals called hormones directly into the bloodstream. **endocrine**
8. Long tube-like structure that carries the neural message to other cells. **axon**
10. Chemical found in the synaptic vesicles which, when released, has an effect on the next cell. **neurotransmitter**
13. Bundles of axons coated in myelin that travels together through the body. **nerves**
14. Branch-like structures that receive messages from other neurons. **dendrites**
15. Endocrine gland found in the neck that regulates metabolism. **thyroid**
17. Thick band of neurons that connects the right and left cerebral hemispheres. **corpus callosum**
19. Part of the nervous system consisting of the brain and spinal cord. **central**

Down

2. Part of the limbic system located in the center of the brain, it acts as a relay from the lower part of the brain to The proper areas of the cortex. **thalamus**
4. Endocrine gland that controls the levels of sugar in the blood. **pancreas**
5. Fatty substances produced by certain glial cells that coat the axons of neurons to insulate, protect, and speed up the neural impulse. **myelin**
6. The basic cell that makes up the nervous system and which receives and sends messages within that system. **neuron**
8. Chemical substances that mimic or enhance the effects of a neurotransmitter on the receptor sites of the next cell. **agonists**
9. Part of the lower brain that controls and coordinates involuntary, rapid, fine motor movement. **cerebellum**
11. Process by which neurotransmitters are taken back into the synaptic vesicles. **reuptake**
12. A group of several brain structures located under the cortex and involved in learning, emotion, memory, and motivation. **limbic**
16. Chemicals released into the bloodstream by endocrine glands. **hormones**
18. Brain structure located near the hippocampus, responsible for fear responses and memory of fear. **amygdala**

► Return to Lecture Guide: Chapter Summary
▼ Return to List of Classroom Activities, Demonstrations and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

Activity: Fill in the Blank

Copy and distribute **Handout Master 3.4** to students as a homework or in-class review assignment.

Answers for Fill in the Blank:

1. Nervous system
2. Neuron
3. Axon
4. Dendrites
5. Soma
6. Myelin
7. Nerves
8. Ions
9. Resting potential
10. All or none
11. Synaptic vesicles
12. Neurotransmitters
13. Excitatory
14. Agonists
15. Spinal cord
16. Sensory
17. Peripheral nervous
18. Somatic nervous
19. Autonomic nervous
20. Sympathetic division
21. Electroencephalograph
22. Cerebellum
23. Thalamus
24. Pons
25. Reticular formation
26. Hippocampus
27. Amygdala
28. Cortex

29. Corpus callosum
30. Occipital cortex
31. Parietal cortex
32. Temporal lobes
33. Frontal lobes
34. Endocrine
35. Adrenal glands

► Return to Lecture Guide: Chapter Summary
▼ Return to List of Classroom Activities, Demonstrations and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents

HANDOUT MASTERS

▲ Return to Chapter 3: Table of Contents

Handout Master 3.1

Mapping the Brain—Instructions

Label the diagram of the brain to show or answer the following questions.

1. Is this a drawing of the left side or the right side of the brain? What are the particular functions of that side of the brain as compared to the other hemisphere?

   Left side functions: Right side functions:

2. Where is the front of the brain? Where is the back?

3. Label the cerebrum and cerebellum and describe their functions.

   Cerebral functions: Cerebellar functions:

4. Label the four lobes of the cerebral cortex.

5. Label the motor cortex and describe its function.

6. Label the visual cortex and describe its function.

7. Label the auditory cortex and describe its function.

8. Label the somatosensory cortex and describe its function.

9. Label Broca's and Wernicke's areas and describe their functions.

10. Where would you expect to find neurons in this drawing and how big would they be if they were drawn?

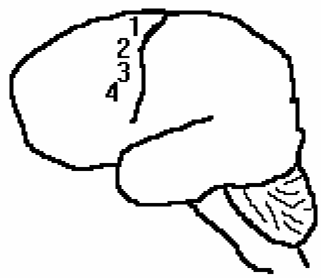
11. Label the brain stem. What is its function?

► Return to Lecture Guide: Biology and Behavior
▼ Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3
▲ Return to Chapter 3: Table of Contents
▼ Return to List of Handout Masters for Chapter 3

Handout Master 3.2

Localization of Function Exercise

Case 1. Dr. Holmes sees a series of patients with gunshot injuries to parts of their frontal lobes. The location of the damage to each person's brain is indicated in the drawing. Patient 1 has some paralysis of his right hip and thigh muscles. Patient 2 has paralyzed trunk muscles on his right side. Patient 3's right arm is paralyzed. Patient 4 shows paralysis of the muscles on the right side of her face.

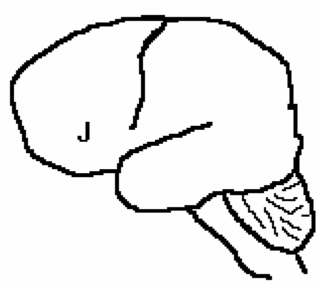


a. What method is being used to study brain function?

b. What does this part of the brain do?

c. What can you say about the representation of this function in the brain based on this information (what are the rules of organization)?

Case 2. Dr. Broca's patient (J) has suddenly lost his ability to speak, apparently due to a stroke. After J dies, Dr. Broca studies the brain and discovers an area of damage in the location marked with J in the drawing below. Later another patient (K) dies and Dr. Broca is amazed to discover that this patient has damage to the comparable area of the brain on the right side, with NO effect on speech.

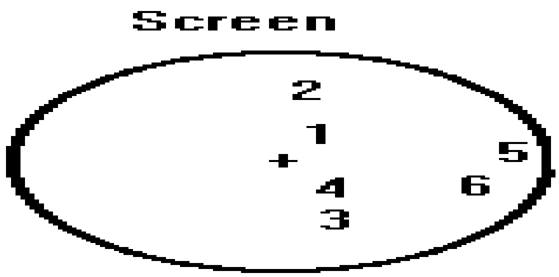


a. What method is being used to study brain function?

b. What does the area of the brain marked J do?

c. What can we say about the lateralization of this function based on the information provided?

Case 3. Dr. Brightman is doing surgery on a patient to remove a rapidly growing tumor in the patient's brain. The patient is awake during the surgery. To check out where he is, Dr. Brightman applies a brief pulse of electricity to various areas of the brain and asks the patient to describe the sensation. The patient is looking up at a screen with a cross in the middle of it; he is fixating on the cross. After each point on the brain is touched, the patient reports seeing flashing lights and points to the area on the screen where he sees the lights.

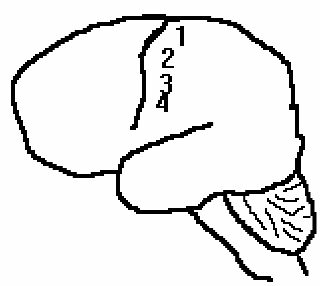


a. What method is being used to study brain function?

b. What does this area of the brain do?

c. What can we say about how this function is mapped on the brain based on the information provided?

Case 4. Dr. Penfield is operating on the brain of a young woman with intractable epilepsy. He is going to remove the part of the brain where the seizure starts. He does not want to remove the wrong part, so the patient is awake during surgery, and Dr. Penfield identifies where he is in the brain by applying brief pulses of electricity to various parts of her brain. As Dr. Penfield touches each part of her brain, the patient reports feeling a tingling sensation on various parts of her body. At point 1 she feels tingling on her right thigh. At point 2 she feels tingling on the right part of her rib cage. At point 3 she reports a tingling on her right hand. At point 4 she feels a sensation on the right side of her face.

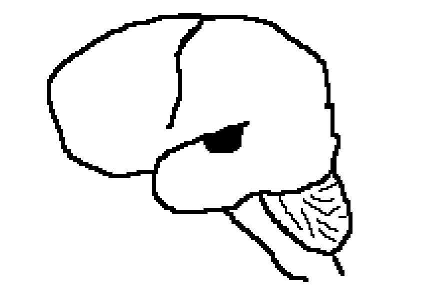


a. What method is being used to study brain function?

b. What function is localized in this part of the brain?

c. How is this function mapped on the brain (how is it organized)?

Case 5. Dr. Lashley is doing experiments on brain function. He persuades a Doe College student to participate in his experiment. The student is injected with radioactive glucose and then asked to listen to recordings of various sounds for half an hour in a darkened room. Then the student's head is scanned to determine where in the brain the radioactivity has collected. The most intensely radioactive area is indicated on the drawing below.



a. What method is being used to study brain function?

b. What does this area do?

Case 6. Dr. Gross places an electrode in part of the hypothalamus of a rat and measures the electrical activity in the hypothalamus during various activities. She finds that the part of the hypothalamus where the electrode is located is most active just before the rat eats.

a. What method is being used to study brain function?

b. What does this part of the hypothalamus do?

Case 7. Dr. Sperry cuts the corpus callosum of a young woman to stop the spread of intractable epilepsy from one side of the brain to the other. After the woman has had time to recover from the surgery, Dr. Sperry tests her on various tasks. Dr. Sperry finds no impairment on most tasks. There are two exceptions. When the patient is asked to close her eyes and name an object placed in her hand, she can do so correctly for things placed in her right hand, but not for things placed in her left hand. (She has no problems with paralysis or lack of sensation, however.) When she is given a task where she is asked to close her eyes and feel something with her left hand, then pick it out of a group of objects using her right hand, she is also unable to do so.

a. What method is being used to study function?

b. What does the corpus callosum do?

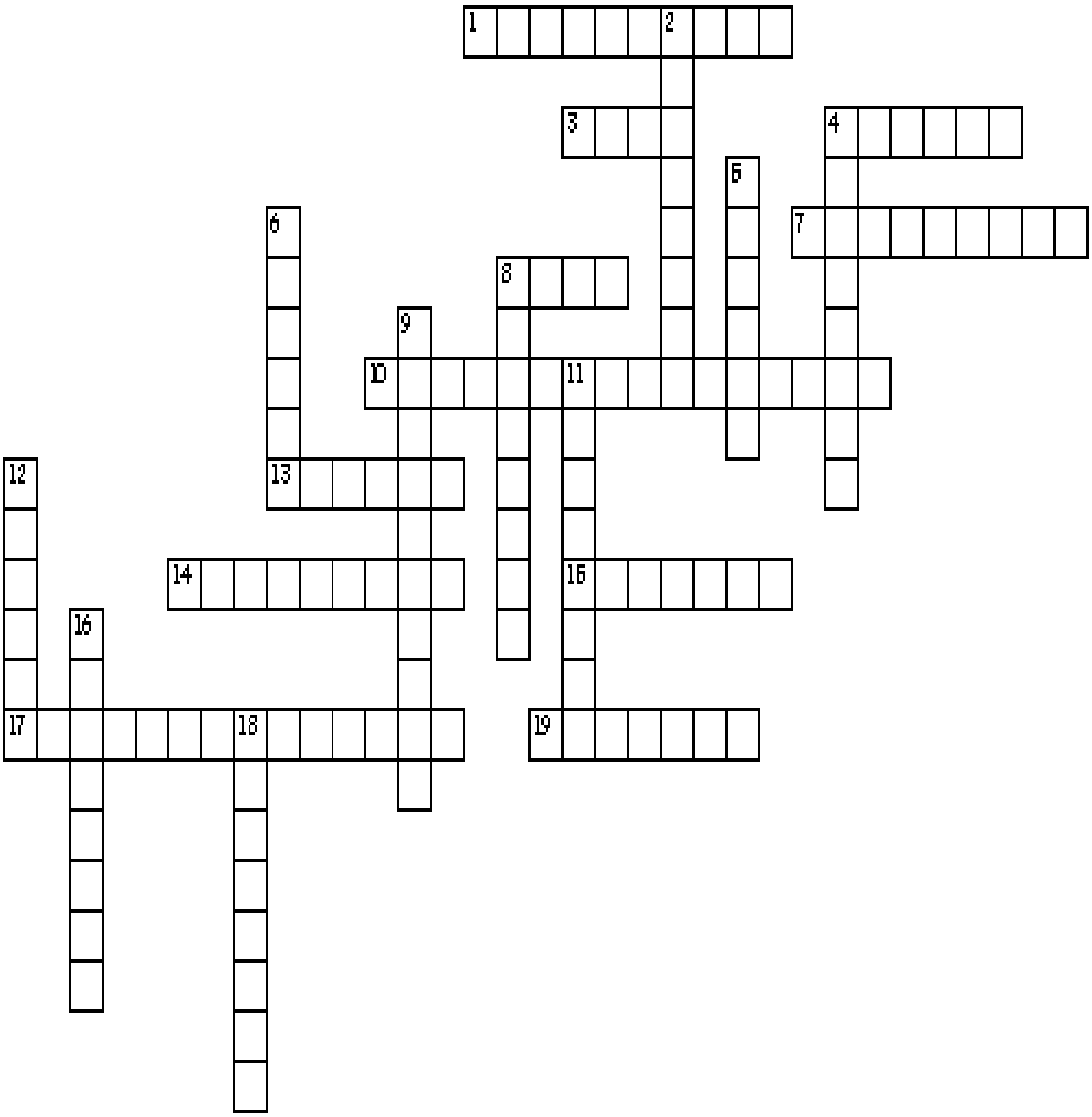
c. What accounts for the two specific impairments described here?

► **Return to Lecture Guide: Biology and Behavior**
▼ **Return to Classroom Activities, Demonstrations, and Exercises for Chapter 3**
▲ **Return to Chapter 3: Table of Contents**
▼ **Return to List of Handout Masters for Chapter 3**

Handout Master 3.3

Crossword Puzzle Activity

Chapter 3: The Biological and Evolutionary Bases of Behavior



Across

1. Neurotransmitter that causes the receiving cell to stop firing.
3. The cell body of the neuron, responsible for maintaining the life of the cell.
4. Endocrine gland located near the base of the cerebrum which secretes melatonin.
7. Glands that secrete chemicals called hormones directly into the bloodstream.
8. Long tube-like structure that carries the neural message to other cells.
10. Chemical found in the synaptic vesicles which, when released, has an effect on the next cell.
13. Bundles of axons coated in myelin that travel together through the body.
14. Branch-like structures that receive messages from other neurons.
15. Endocrine gland found in the neck that regulates metabolism.
17. Thick band of neurons that connects the right and left cerebral hemispheres.
19. Part of the nervous system consisting of the brain and spinal cord.

Down

2. Part of the limbic system located in the center of the brain, it acts as a relay from the lower part of the brain to the proper areas of the cortex.
4. Endocrine gland that controls the levels of sugar in the blood.
5. Fatty substances produced by certain glial cells that coat the axons of neurons to insulate, protect, and speed up the neural impulse.
6. The basic cell that makes up the nervous system and which receives and sends messages within that system.
8. Chemical substances that mimic or enhance the effects of a neurotransmitter on the receptor sites of the next cell.
9. Part of the lower brain that controls and coordinates involuntary, rapid, fine motor movement.
11. Process by which neurotransmitters are taken back into the synaptic vesicles.
12. A group of several brain structures located under the cortex and involved in learning, emotion, memory, and motivation.
16. Chemicals released into the bloodstream by endocrine glands.
18. Brain structure located near the hippocampus, responsible for fear responses and memory of fear.

► Return to Activity: Crossword Puzzle Chapter 3 for Answers
▼ Return to List of Handout Masters for Chapter 3
▲ Return to Chapter 3: Table of Contents

Handout Master 3.4

Fill in the Blank Activity

Chapter 3: The Biological and Evolutionary Bases of Behavior

1. An extensive network of specialized cells that carry information to and from all parts of the body is called the _________________ ______________.
2. The basic cell that makes up the nervous system and which receives and sends messages within that system is called a __________________.
3. The long tube-like structure that carries the neural message to other cells on the neuron is the _______________
4. On a neuron, the branch-like structures that receive messages from other neurons are known as the ___________________.
5. The cell body of the neuron, responsible for maintaining the life of the cell and contains the mitochondria is the _________________.
6. The fatty substances produced by certain glial cells that coat the axons of neurons to insulate, protect, and speed up the neural impulse are known as the _________________.
7. The bundles of axons in the body that travel together through the body are known as the ______________.
8. The charged particles located inside and outside of the neuron are called ____________.
9. The state of the neuron when not firing a neural impulse is known as the ________________ ____________________.
10. _____________________ refers to the fact that a neuron either fires completely or does not fire at all.
11. The _____________ _____________ are sack-like structures found inside the synaptic knob containing chemicals.
12. __________________________ are chemicals found in the synaptic vesicles which, when released, have an effect on the next cell.
13. The ______________________ neurotransmitter causes the receiving cell to fire.
14. The __________________________ mimic or enhance the effects of a neurotransmitter on the receptor sites of the next cell, increasing or decreasing the activity of that cell.
15. The __________________ _______________ is a long bundle of neurons that carries messages to and from the body to the brain that is responsible for very fast, lifesaving reflexes.
16. A neuron that carries information from the senses to the central nervous system and is also known as the afferent is called a ____________________ ________________ .
17. All nerves and neurons that are not contained in the brain and spinal cord but that run through the body itself are in the __________________ ____________________ system.

18. The division of the PNS consisting of nerves that carry information from the senses to the CNS and from the CNS to the voluntary muscles of the body is the ______________ ________________ system.

19. The ___________________ _________________ system division of the PNS consisting of nerves that control all of the *involuntary* muscles, organs, and glands sensory pathway nerves coming from the sensory organs to the CNS consisting of sensory neurons.

20. The part of the ANS that is responsible for reacting to stressful events and bodily arousal is called the _______________________ __________________ of the nervous system.

21. A machine designed to record the brain wave patterns produced by electrical activity of the surface of the brain is called an _________________________.

22. The part of the lower brain located behind the pons that controls and coordinates involuntary, rapid, fine motor movement is called the ______________________.

23. The part of the limbic system located in the center of the brain, this structure relays sensory information from the lower part of the brain to the proper areas of the cortex and processes some sensory information before sending it to its proper area and is called the _______________________.

24. The larger swelling above the medulla that connects the top of the brain to the bottom and that plays a part in sleep, dreaming, left–right body coordination, and arousal is called the ___________________.

25. The _____________________ ________________ is an area of neurons running through the middle of the medulla and the pons and slightly beyond that is responsible for selective attention.

26. The _______________________ is a curved structure located within each temporal lobe, responsible for the formation of long-term memories and the storage of memory for location of objects.

27. The ____________________ is a brain structure located near the hippocampus, responsible for fear responses and memory of fear.

28. The _______________ is the outermost covering of the brain consisting of densely packed neurons, responsible for higher thought processes and interpretation of sensory input.

29. The thick band of neurons that connects the right and left cerebral hemispheres is called the _________________ _______________.

30. The section of the brain located at the rear and bottom of each cerebral hemisphere containing the visual centers of the brain is the called the ________________ _______________.

31. The sections of the brain located at the top and back of each cerebral hemisphere containing the centers for touch, taste, and temperature sensations are called the _______________________ ____________________________.

32. The __________________ _________________ is the area of the cortex located just behind the temples containing the neurons responsible for the sense of hearing and meaningful speech.

33. The ____________________ ______________________ are areas of the cortex located in the front and top of the brain, responsible for higher mental processes and decision making as well as the production of fluent speech.

34. The _____________________ glands secrete chemicals called hormones *directly* into the bloodstream.

35. The endocrine glands located on top of each kidney that secrete over 30 different hormones to deal with stress, regulate salt intake, and provide a secondary source of sex hormones affecting the sexual changes that occur during adolescence are called the ___________________ ____________________.

Words to Use:

1. Adrenal glands
2. Agonists
3. All or none
4. Amygdala
5. Autonomic nervous
6. Axon
7. Cerebellum
8. Corpus callosum
9. Cortex
10. Dendrites
11. Electroencephalograph
12. Endocrine
13. Excitatory
14. Frontal lobes
15. Hippocampus
16. Ions
17. Myelin
18. Nerves
19. Nervous system
20. Neuron
21. Neurotransmitters
22. Occipital cortex
23. Parietal cortex
24. Peripheral nervous
25. Pons
26. Resting potential
27. Reticular formation
28. Sensory
29. Soma
30. Somatic nervous
31. Spinal cord
32. Sympathetic division
33. Synaptic vesicles
34. Temporal lobes
35. Thalamus

► Return to Lecture Guide: Chapter Summary
► Return to Activity: Fill in the Blank Chapter 3 for Answers
▼ Return to List of Handout Masters for Chapter 3
▲ Return to Chapter 3: Table of Contents

APS: READINGS FROM THE ASSOCIATION OF PSYCHOLOGICAL SCIENCE

Current Directions in Introductory Psychology, Second Edition (0-13-714350-8)
Edited by Abigail A. Baird, with Michele M. Tugade and Heather B. Veague

This new and exciting American Psychological Reader includes timely, cutting-edge articles, giving readers a real-world perspective from a reliable source, the *Current Directions in Psychological Science* journal. This reader includes over 20 articles that have been carefully selected and taken from the very accessible *Current Directions in Psychological Science* journal. Articles discuss today's most current and pressing issues in introductory psychology and are broken down into these main sections: Scientific Thinking; Nature/Nurture; Consciousness; Individual Differences; and Applications.

The Occipital Cortex in the Blind: Lessons About Plasticity and Vision. (Vol. 14, No. 16, 2005, pp. 306–311) p. 47 of the APS Reader
Amir Amedi, Lotfi B. Merabet, Felix Bermpohl, Alvaro Pascual-Leone

Studying the brains of blind individuals provides a unique opportunity to investigate how the brain changes and adapts in response to afferent (input) and efferent (output) demands. We discuss evidence suggesting that regions of the brain normally associated with the processing of visual information undergo remarkable dynamic change in response to blindness. These neuroplastic changes implicate not only processing carried out by the remaining senses but also higher cognitive functions such as language and memory. A strong emphasis is placed on evidence obtained from advanced neuroimaging techniques that allow researchers to identify areas of human brain activity, as well as from lesion approaches (both reversible and irreversible) to address the functional relevance and role of these activated areas. A possible mechanism and conceptual framework for these physiological and behavioral changes is proposed.

Beyond Fear: Emotional Memory Mechanisms in the Human Brain. (Vol. 16, No. 4, 2007, pp. 173–177) p. 64 of the APS Reader
Kevin S. LaBar

Neurobiological accounts of emotional memory have been derived largely from animal models investigating the encoding and retention of memories for events that signal threat. This literature has implicated the amygdala, a structure in the brain's temporal lobe, in the learning and consolidation of fear memories. Its role in fear conditioning has been confirmed, but the human amygdala also interacts with cortical regions to mediate other aspects of emotional memory. These include the encoding and consolidation of pleasant and unpleasant arousing events into long-term memory, the narrowing of focus on central emotional information, the retrieval of prior emotional events and contexts, and the subjective experience of recollection and emotional intensity during retrieval. Along with other mechanisms that do not involve the amygdala, these functions ensure that significant life events leave a lasting impression in memory.

► Return to Lecture Guide: Biology and Behavior
▲ Return to Chapter 3: Table of Contents

FORTY STUDIES THAT CHANGED PSYCHOLOGY: EXPLORATIONS INTO THE HISTORY OF PSYCHOLOGICAL RESEARCH, 6/E (013603599X)

By Roger Hock

This unique book closes the gap between psychology textbooks and the research that made them possible by offering a first hand glimpse into 40 of the most famous studies in the history of the field, and subsequent studies that expanded upon each study's influence. Readers are able to grasp the process and excitement of scientific discovery as they experience an insider's look at the studies that continue today to be cited most frequently, stirred up the most controversy when they were first published, sparked the most subsequent related research, opened new fields of psychological exploration, and changed most dramatically our knowledge of human behavior.

Studies examined in Biology and Human Behavior:

One Brain or Two?

Gazzaniga, M. S. (1967). The split brain in man. *Scientific American, 217*(2)*,* 24–29.

More Experience = Bigger Brain

Rosenzweig, M. R., Bennett, E. L., & Diamond, M. C. (1972). Brain changes in response to experience. *Scientific American, 226*(2), 22–29.

► Return to Lecture Guide: Biology and Behavior
▲ Return to Chapter 3: Table of Contents

WEB RESOURCES

General/Comprehensive

Biological and Physiological Resources: http://psych.athabascau.ca/html/aupr/biological.shtml
Links to several sites and interesting topical articles relevant to biological and physiological psychology. A good starting point for a number of assignments, such as writing short papers or assembling study guide terms. Maintained by the Centre for Psychology Resources at Athabasca University, Alberta, Canada.

Neuroguide.com—Neurosciences on the Internet: http://www.neuroguide.com/
A resource for all things related to neuroscience: databases, diseases, research centers, software, biology, psychology, journals, tutorials, and so much more.

Neuropsychology Central: http://www.neuropsychologycentral.com/
Links to resources related to neuropsychology, including brain images, and extensive, well-organized, links to other sites.

Neuroscience for Kids: http://faculty.washington.edu/chudler/neurok.html
Don't be put off by the name! This site can be enjoyed by people of all ages who want to learn about the brain. Fun, superbly organized site providing information and links to other neuroscience sites. Includes informative pages regarding Brain Basics, Higher Functions, Spinal Cord, Peripheral Nervous System, The Neuron, Sensory Systems, Methods and Techniques, Drug Effects, and Neurological and Mental Disorders. Even includes a nice answer to the perennial question "Is it true that we only use 10% of our brain?" http://faculty.washington.edu/chudler/tenper.html

Whole Brain Atlas: http://www.med.harvard.edu:80/AANLIB/home.html
Prepared by Keith Johnson, M.D. and J. Alex Becker at Harvard University. Site includes brain images, information about imaging techniques, and information about specific brain disorders.

▲ Return to Chapter 3: Table of Contents

Neurons/Neural Processes

Basic Neural Processes Tutorials: http://psych.hanover.edu/Krantz/neurotut.html
A good site for your students to help them learn about basic brain functioning.

Making Connections—The Synapse: http://faculty.washington.edu/chudler/synapse.html
Clear, comprehensible, explanation of how synapses work, with nice illustrations, prepared by Eric Chudler.

► Return to Lecture Guide: The Nervous System in Action
▲ Return to Chapter 3: Table of Contents

The Nervous System

Autonomic Nervous System: http://faculty.washington.edu/chudler/auto.html
Succinct summary of information about the structure and function of the autonomic nervous system, prepared by Eric Chudler.

Self-Quiz for Chapter on the Human Nervous System: http://www.psychwww.com/selfquiz/ch02mcq.htm
Self-quiz prepared by Russ Dewey at Georgia Southern University. Covers material typically found in an introductory psychology textbook chapter with a title like "Brain and Behavior" or "Neuropsychology."

► Return to Lecture Guide: The Nervous System in Action
▲ Return to Chapter 3: Table of Contents

The Brain

Brain and Behavior: http://serendip.brynmawr.edu/bb/
This mega-site contains lots of links to information about the brain, behavior, and the bond between the two. Students can complete several interactive exercises to learn more about brain functions.

Brain Connection: The Brain and Learning: http://brainconnection.positscience.com
A newspaper-style web page that contains interesting articles, news reports, activities, and commentary on brain-related issues.

Brain Function and Pathology: http://www.waiting.com/brainfunction.html
Concise table of diagrams of brain structures, descriptions of brain functions, and descriptions of signs and symptoms associated with brain structures and functions.

Brain Model Tutorial: http://pegasus.cc.ucf.edu/~Brainmd1/brain.html
This tutorial teaches students about the various parts of the human brain and allows them to test their knowledge of brain structures.

Brain: Right Down the Middle: http://faculty.washington.edu/chudler/sagittal.html
Useful drawing and succinct information about the location and functions of brain structures that can be seen on the midsagittal plane, presented by Eric Chudler.

***Conversations with Neil's Brain* (1994):** http://www.williamcalvin.com/index.html
An Online Book by William H. Calvin & George A. Ojemann of University of Washington. Teachers are allowed to print and photocopy chapters for educational use.

Cross Sections of the Human Brain: http://www.neuropat.dote.hu/caud.gif
A cross-sectional image of the human brain. Good to have on hand if you need one. Show your students and help them identify the various structures.

Drugs, Brains and Behavior: http://www.rci.rutgers.edu/~lwh/drugs/
An online textbook detailing the effects of various substances on the brain, authored by C. Robin Timmons & Leonard W. Hamilton.

Lobes of the Brain: http://faculty.washington.edu/chudler/lobe.html
Succinct information about the location and functions of the four lobes of the cerebrum, presented by Eric Chudler. Includes link to "Lobes of the Brain Review," a very brief quiz on functions associated with major lobes of the brain. Answers provided online: http://faculty.washington.edu/chudler/revlobe.html

One Brain…or Two?: http://faculty.washington.edu/chudler/split.html
Information on lateralization of function and how the functions of the hemispheres may be studied, presented by Eric Chudler.

He Brains / She Brains: http://faculty.washington.edu/chudler/heshe.html
Nice summary of evidence for sex-related differences in brain structure, prepared by Eric Chudler.

What Does Handedness Have to Do with Brain Lateralization (and Who Cares?):
http://www.indiana.edu/~primate/brain.html
Very nice page on lateralization of function in the brain.

► Return to Lecture Guide: Biology and Behavior
▲ Return to Chapter 3: Table of Contents

Phineas Gage

Phineas Gage Information Page: http://www.deakin.edu.au/hbs/GAGEPAGE
Everything you ever wanted to know about Phineas Gage is on this page prepared by Malcolm Macmillan at Deakin University, Victoria, Australia.

► Return to Lecture Guide: Biology and Behavior
▲ Return to Chapter 3: Table of Contents

VIDEO RESOURCES

NEW MyPsychLab Video Series

Episode 3: Biological Psychology

1. The Big Picture: My Brain Made Me Do It
2. The Basics: How the Brain Works? Part 1
3. The Basics: How the Brain Works? Part 2
4. Special Topics: The Plastic Brain
5. Thinking Like a Psychologist: The Pre-Frontal Cortex: The Good, The Bad, and The Criminal
6. In the Real World Application: Too Much, or Too Little, of a Good Thing
7. What's In It For Me?: Biology of the High

Episode 4: Evolution and Genes

1. The Big Picture: Genes, Evolution, and Human Behavior
2. The Basics: Genetic Mechanisms and Behavioral Genetics
3. Special Topics: Epigenetics—A Revolutionary Science
4. Thinking Like a Psychologist: Evolutionary Psychology—Why We Do the Things We Do
5. In the Real World Application: Taking Control of Our Genes

This new video series offers instructors and students the most current and cutting-edge introductory psychology video content available anywhere. These exclusive videos take the viewer into today's research laboratories, inside the body and brain through breathtaking animations, and out into the street for real-world applications. Guided by the Design, Development and Review team, a diverse group of introductory psychology professors, this comprehensive new series features 17 half-hour episodes organized around the major topics of the introductory psychology course syllabus. For maximum flexibility, each 30-minute episode features several brief clips that bring psychology to life.

FEATURES

Format

The MyPsychLab video series was designed with flexibility in mind. Each half-hour episode in the MyPsychLab video series is made up of several five-minute clips, which can be viewed separately or together:

- *The Big Picture* introduces the topic of the episode and draws in the viewer.
- *The Basics* uses the power of video to present foundational topics, especially those that students find difficult to understand.
- *Special Topics* dives deeper into high-interest and often cutting-edge topics, showing research in action.
- *Thinking Like a Psychologist* models critical thinking and explores research methods.
- *In the Real World* focuses on applications of psychological research.
- *What's In It for Me?* These clips show students the relevance of psychological research to their lives.

Flexible Delivery

Students can access the videos anytime within MyPsychLab, and each clip is accompanied by enriching self-assessment quizzes. Instructors can access the videos for classroom presentation in MyPsychLab or on DVD (0205035817).

OTHER PEARSON PSYCHOLOGY VIDEO COLLECTIONS:

Introductory Psychology Teaching Films Boxed Set ISBN (0131754327)

Offering you an easy-to-use multi-DVD set of videos, more than 100 short video clips of 5–15 minutes in length from many of the most popular video sources for Psychology content, such as ABC News; the Films for the Humanities series; PBS; and more!

Pearson Education Teaching Films Introductory Psychology: Instructor's Library 2-Disk DVD Annual Edition (ISBN 0205652808)

Annual updates of the most popular video sources for Psychology content, such as ABC News; the Films for the Humanities series; PBS; and more in 5–15 minute clips on an easy-to-use DVD!

FILMS FOR HUMANITIES AND SCIENCES VIDEO LIBRARY (http://www.ffh.films.com)

Qualified adopters can select videos on various topics in psychology from the extensive library of *Films for the Humanities and Sciences*. Contact your local sales representative for a list of videos and ISBNs.

Other video series are available, ask your Pearson sales representative for more details.

▲ Return to Chapter 3: Table of Contents

MULTIMEDIA RESOURCES

Online Resources: MyPsychLab www.mypsychlab.com

See/Hear/Learn/Explore More Icons integrated in the text lead to web-based expansions on topics, allowing instructors and students access to extra information, videos, podcasts, and simulations. The in-text icons are not exhaustive—there are many more resources available to instructors and students online at www.MyPsychLab.com.

What Is MyPsychLab? MyPsychLab is a learning and assessment tool that enables instructors to assess student performance and adapt course content. Students benefit from the ability to test themselves on key content, track their progress, and utilize individually tailored study plan. In addition to the activities students can access in their customized study plans, instructors are provided with extra lecture notes, video clips, and activities that reflect the content areas their class is still struggling with. Instructors can bring these resources to class, or easily post online for students to access.

Instructors and students have been using MyPsychLab for over 10 years. To date, over 600,000 students have used MyPsychLab. During that time, three white papers on the efficacy of MyPsychLab were published. Both the white papers and user feedback show compelling results: MyPsychLab helps students succeed and improve their test scores. One of the key ways MyPsychLab improves student outcomes is by providing continuous assessment as part of the learning process. Over the years, both instructor and student feedback have guided numerous improvements, making MyPsychLab even more flexible and effective.

Pearson is committed to helping instructors and students succeed with MyPsychLab.

To that end, we offer a Psychology Faculty Advisor Program designed to provide peer to-peer support for new users of MyPsychLab. Experienced Faculty Advisors help instructors understand how MyPsychLab can improve student performance. To learn more about the Faculty Advisor Program, please contact your local Pearson representative.

In addition to the eText and complete audio files, the New MyPsychLab video series, MyPsychLab offers these valuable and unique tools:

- **MyPsychLab assessment questions:** over 3,000 questions, distinct from the test bank, but designed to help instructors easily assign additional quizzes and tests, that can be graded automatically and loaded into an instructor's grade book.

- **MyPsychLab study plan:** students have access to a **personalized study plan**, based on Bloom's Taxonomy, arranges content from less complex thinking (like remembering and understanding) to more complex critical thinking (like applying and analyzing). This layered approach promotes better critical-thinking skills, and helps students succeed in the course and beyond.

- **NEW Experiments Tool:** Online experiments help students understand scientific principles and practice through active learning—fifty new experiments, inventories, and surveys are available through MyPsychLab.

- **APA assessments:** A unique bank of assessment items allows instructors to assess student progress against the American Psychological Association's Learning Goals and Outcomes. These assessments have been keyed to the APA's latest progressive Learning Outcomes (basic, developing, advanced).

- **ClassPrep** available in MyPsychLab. Finding, sorting, organizing, and presenting your instructor resources is faster and easier than ever before with ClassPrep. This fully searchable database contains hundreds and hundreds of our best teacher resources, such as lecture launchers and discussion topics, in-class and out-of-class activities and assignments, handouts, as well as video clips, photos, illustrations, charts, graphs, and animations. Instructors can search or browse by topic, and it is easy to sort your results by type, such as photo, document, or animation. You can create personalized folders to organize and store what you like, or you can download resources. You can also upload your own content and present directly from ClassPrep, or make it available online directly to your students.

MyPsychLab Highlights for Chapter 3: The Biological and Evolutionary Bases of Behavior

NEW Experiments Tool to promote active learning

Experiment: Hemispheric Specialization
Survey: Do You Fly or Fight?

Audio File of the Chapter

A helpful study tool for students—they can listen to a complete audio file of the chapter. Suggest they listen while they read, or use the audio file as a review of key material.

▲ Return to Chapter 3: Table of Contents

POWERPOINTS

New Interactive PowerPoint Slides

These slides, available on the Instructor's Resource DVD (ISBN 0205898777), bring the *Psychology and Life* design right into the classroom, drawing students into the lecture and providing wonderful interactive activities, visuals, and videos. A video walkthrough is available and provides clear guidelines on using and customizing the slides. The slides are built around the text's learning objectives and offer many links across content areas. Icons integrated throughout the slides indicate interactive exercise, simulations, and activities that can be accessed directly from the slides if instructors want to use these resources in the classroom.

Standard Lecture PowerPoint Slides

A set of standard lecture PowerPoint slides, prepared by Christopher T. Arra, Ph.D, Northern Virginia Community College, is also offered and includes detailed outlines of key points for each chapter supported by selected visuals from the textbook. A separate *Art and Figure* version of these presentations contains all art from the textbook for which Pearson has been granted electronic permissions.

Both sets of PowerPoint slides are available for download at the instructor's resource center at www.pearsonhighered.com/irc, as well as on the Instructor's Resource DVD (ISBN 0205898777).

▲ Return to Chapter 3: Table of Contents

ACCESSING ALL RESOURCES for *Psychology and Life, Twentieth Edition*

For a list of all student resources available with *Psychology and Life*, go to www.mypearsonstore.com, enter the text ISBN (0205859135) and check out the "Everything That Goes With It" section under the book cover.

For access to the instructor supplements for *Psychology and Life, Twentieth Edition*, simply go to http://pearsonhighered.com/irc and follow the directions to register (or log in if you already have a Pearson user name and password).

Once you have registered and your status as an instructor is verified, you will be e-mailed a login name and password. Use your login name and password to access the catalogue. Click on the "online catalogue" link, click on "psychology" followed by "introductory psychology" and then the Gerrig ***Psychology and Life, Twentieth Edition*** text. Under the description of each supplement is a link that allows you to download and save the supplement to your desktop.

For technical support for any of your Pearson products, you and your students can contact http://247.pearsoned.com.

▲ Return to Chapter 3: Table of Contents