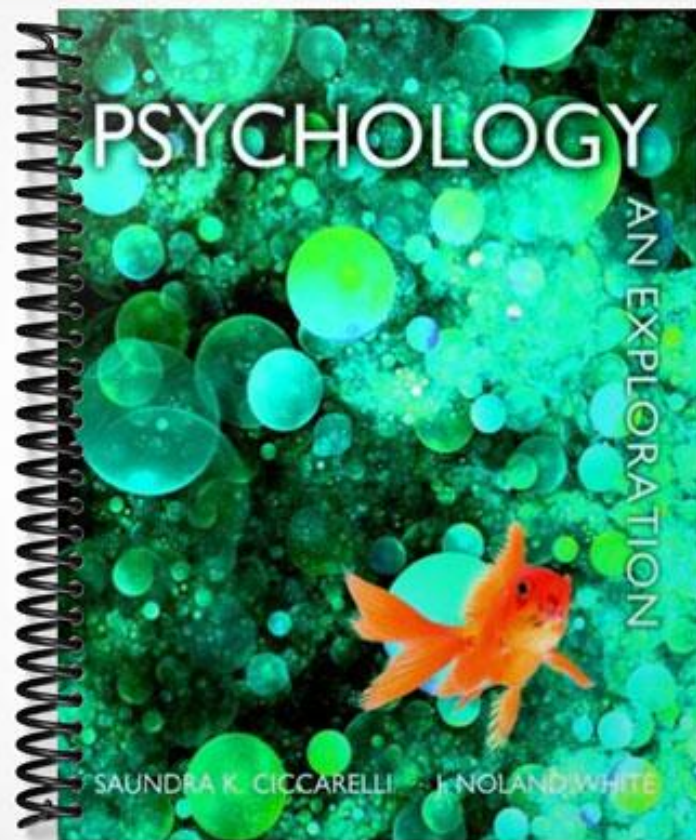


SOLUTIONS MANUAL



SAUNDRA K. CICCARELLI J. NOLAND WHITE

2/ THE BIOLOGICAL PERSPECTIVE

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► LECTURE GUIDE

AN OVERVIEW OF THE NERVOUS SYSTEM (TEXT P. 38)

Lecture Launchers/Discussions Topics:

- [Leading Off the Chapter](#)

Classroom Activities, Demonstrations, and Exercises:

- [Handout Transparency Master 2.5: The Basic Structure of the Neuron](#)

Web Resources:

- [General Resources for Biological Psychology](#)

2.1 What are the nervous system, neurons, and nerves, and how do they relate to one another? (text p. 38)

- The nervous system is a complex network of cells that carry information to and from all parts of the body.

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NEURONS AND NERVES: BUILDING THE NETWORK (TEXT P. 38)

Lecture Launchers/Discussions 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](#)

Video Resources:

- [Neurons and Synapses](#)
- [Synaptic Development](#)
- [Brain and Nervous System](#)

Multimedia Resources:

- [Learn More: Cajal: his influence and discoveries \(in-text icon p. 38\)](#)
- [Explore More: simulation on neurons and neurotransmitters \(in-text icon p. 40\)](#)
- [Dendritic Spreading: Forming Interconnections in the Brain](#)
- [Action Potential](#)
- [Nerve Impulse](#)
- [Afferent and Efferent Neurons](#)
- [The Synapse](#)
- [Neuronal Transmission](#)

- Structure of the Neuron: the Nervous System's Building Block
 - The brain is made up of two types of cells, neurons and glial cells.
 - Neurons have dendrites, which receive input, a soma or cell body, and axons, which carry the neural message to other cells.
 - Glial cells separate, support, and insulate the neurons from each other and make up 90% of the brain.
 - Myelin insulates and protects the axons of neurons that travel in the body.
 - These axons bundle together in “cables” called nerves. Myelin also speeds up the neural message.
- Generating the Message Within the Neuron—The Neural Impulse

- A neuron contains charged particles called ions. When at rest, the neuron is negatively charged on the inside and positively charged on the outside (the resting potential). When stimulated, this reverses the charge by allowing positive sodium ions to enter the cell. The action potential is the sequence of electrical charges moving down the cell.
- Neurons fire in an all-or-nothing manner. It is the speed and number of neurons firing that tells researchers the strength of the stimulus.

2.2 How do the neurons use neurotransmitters to communicate with each other and with the body? (text p. 42)

- Sending the Message to Other Cells: The Synapse
 - Synaptic vesicles in the end of the axon terminal release neurotransmitter chemicals in to the synapse, or gap, between one cell and the next.
 - The neurotransmitter molecules fit into receptor sites on the next cell, stimulating or inhibiting that cell's firing.
 - There are excitatory and inhibitory synapses.
- Neurotransmitters: Messengers of the Network
 - The first known neurotransmitter was acetylcholine. It stimulates muscles and helps in memory formation. Curare is a poison that blocks its affect.
 - Endorphins are neural regulators that control our pain response.

LINK to Chapter Five: Memory, p.182 and Chapter Eight: Motivation and Emotion, p. 273

- Cleaning Up the Synapse: Reuptake and Enzymes
 - Most neurotransmitters are taken back into the synaptic vesicles in a process called reuptake.
 - Acetylcholine is cleared out of the synapse by enzymes which break up the molecules.

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THE CENTRAL NERVOUS SYSTEM—THE “CENTRAL PROCESSING UNIT” (TEXT P. 46)

Lecture Launchers/Discussions Topics:

- [The Perception of Phantom Pain](#)
- [The Brain](#)
- [The Cranial Nerves](#)

Web Resources:

- [The Nervous System](#)

Video Resources

- [Agonizing Silence](#)
- [Autistic Children](#)

Multimedia Resources:

- [Hear More: Psychology in the News podcast \(in-text icon p. 48\)](#)
- [Organization of the Nervous System](#)
- [Simulation: Overview of the Nervous System](#)

2.3 How do the brain and spinal cord interact? (text p. 46)

- The Brain
 - The brain makes sense of the information received from the senses, makes decisions, and sends commands out to the rest of the body.
- The Spinal Cord

- The spinal cord serves two functions: the outer part of the cord transmits messages to and from the brain, while the inner part controls life-saving reflexes such as the pain response.
- Spinal cord reflexes involve sensory neurons, interneurons, and motor neurons, forming a simple reflex arc.
- Great strides are being made in spinal cord repair and the growth of new neurons in the central nervous system.
- The central nervous system consists of the brain and the spinal cord.

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THE PERIPHERAL NERVOUS SYSTEM—NERVES ON THE EDGE (TEXT P. 49)

Classroom Activities, Demonstrations, and Exercises:

- [The Automatic Nervous System](#)

Web Resources:

- [The Nervous System](#)

Media Resources:

- [Simulation on the Autonomic Nervous System](#)

2.4 How do the somatic and autonomic nervous systems allow people and animals to interact with their surroundings and control the body's automatic functions? (text p. 49)

- The Somatic Nervous System
 - The somatic nervous system contains the sensory pathway, or neurons carrying messages to the central nervous system, and the motor pathway, or neurons carrying messages from the central nervous system to the voluntary muscles.
- The Autonomic Nervous System
 - The autonomic nervous system consists of the parasympathetic division and the sympathetic division.
 - The sympathetic division is our fight-or-flight system, reacting to stress.
 - The parasympathetic division restores and maintains normal day-to-day functioning of the organs.

LINK to *Chapter Nine: Stress and Health*, p. 314

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PEEKING INSIDE THE BRAIN (TEXT P. 52)

Lecture Launchers/Discussions Topics:

- [Berger's Wave](#)

Classroom Activities, Demonstrations, and Exercises:

- [Mapping the Brain](#)
- [Review of Brain Imaging Techniques](#)
- [Trip to the Hospital](#)

Web Resources:

- [The Brain](#)

Video Resources:

- [Brain Building](#)
- [MKM and Brain Scans](#)
- [The Brain: An Inside Look](#)

Multimedia Resources on MyPsychLab:

- [See More: Wilder Penfield and Electric Brain Simulation \(in-text icon p. 52\)](#)
- [Brain Imaging](#)
- [MKM and Brain Scans](#)

2.5 How do psychologists study the brain and how it works? (text p. 52)

- Clinical Studies
 - We can study the brain by using deep lesioning to destroy certain areas of the brain in laboratory animals, or by electrically stimulating those areas (ESB).
 - We can use case studies of human brain damage to learn about the brain's functions, but cannot easily generalize from one case to another.
- The EEG
 - The EEG machine allows researchers to look at the activity of the surface of the brain through the use of microelectrodes placed on the scalp and connected to an amplifier and a computer for data recording and analysis.

LINK to Chapter Six: *Consciousness and Cognition*, p. 192

- CT Scans
 - CT scans are computer-aided X-rays of the brain and show a great deal of brain structure.
- MRI Scans
 - MRI scans use a magnetic field and a computer to give researchers an even more detailed look at the structure of the brain.
- PET Scans
 - PET scans use a radioactive sugar injected into the bloodstream to track the activity of brain cells, which is enhanced and color-coded by a computer.
- Functional MRI (fMRI)
 - By tracking changes in the oxygen levels of the blood, fMRI can tell researchers what areas of the brain are active.

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FROM THE BOTTOM UP: STRUCTURES OF THE BRAIN (TEXT P. 54)

Lecture Launchers/Discussions Topics:

- [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](#)

Classroom Activities, Demonstrations, and Exercises:

- [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*](#)

APS Reader:

- [The Occipital Cortex in the Blind: Lessons about Plasticity and Vision](#)
- [Beyond Fear: Emotional Memory Mechanisms in the Human Brain](#)

Forty Studies

- [One Brain or Two?](#)
- [More Experience = Bigger Brain](#)

Web Resources:

- [The Brain](#)
- [Phineas Gage](#)

Video Resources:

- [How the Human Genome Map Affects You](#)
- [Exercise Your Brain](#)

Multimedia Resources on MyPsychLab:

- [See More: video on the Hindbrain](#)
- [How Does the Brain Work?](#)
- [Explore More: simulation on lower brain structures \(in-text icon p. 56\)](#)
- [See More: video of the surface anatomy of the brain \(in-text icon p. 58\)](#)
- [Learn More: curious facts about right and left handedness \(in-text icon p. 63\)](#)
- [The Visual Cortex](#)
- [The Mind's Organization of Conceptual Knowledge](#)
- [Split-Brain Experiments](#)

2.6 What are the different structures of the bottom part of the brain and what do they do? (text p. 55)

- The Hindbrain
 - The medulla is at the very bottom of the brain and top of the spinal column. It controls life-sustaining functions such as breathing and swallowing. The nerves from each side of the body also cross over in this structure to opposite sides.
 - The pons is above the medulla and acts as a bridge between the lower part of the brain and the upper part. It influences sleep, dreaming, arousal, and coordination of movement on the left and right sides of the body.
 - The reticular formation runs through the medulla and the pons, and controls our selective attention and arousal.
 - The cerebellum is found at the base and back of the brain, and coordinates fine, rapid motor movement, learned reflexes, posture, and muscle tone.

2.7 What are the structures of the brain that control emotion, learning, memory, and motivation? (text p. 56)

- Structures Under the Cortex
 - The thalamus is the switching station that sends sensory information to the proper areas of the cortex.
 - The hypothalamus controls hunger, thirst, sleep, sexual behavior, sleeping and waking, and emotions. It also controls the pituitary gland.
 - The limbic system consists of the thalamus, hypothalamus, hippocampus, amygdala, and the fornix.
 - The hippocampus is the part of the brain responsible for storing memories and remember locations of objects.
 - The amygdala controls our fear responses and memory of fearful stimuli.
 - The fornix connects the hippocampus to the mamillary bodies.

LINK to Chapter Three: *Sensation and Perception*, p. 76

- The Cortex
 - The cortex is about one tenth of an inch in thickness. Its wrinkles, or corticalization, allow for greater surface area and are associated with human's greater intelligence as compared with other animals.

2.8 What parts of the cortex control the different senses and the movement of the body? (text p. 59)

- The cortex is divided into two cerebral hemispheres connected by a thick band of neurons called the corpus callosum.
- The occipital lobes at the back and base of each hemisphere process vision and contain the primary visual cortex.
- The parietal lobes at the top and back of the cortex contain the somatosensory area, which processes our sense of touch, temperature, and body position. Taste is also processed in this lobe.
- The temporal lobes contain the primary auditory area and are also involved in understanding language.
- The frontal lobes contain the motor cortex, which controls the voluntary muscles, and are also where all the higher mental functions occur, such as planning and complex decision making. In the left frontal lobe is an area for producing speech.

2.9 What parts of the cortex are responsible for higher forms of thought, such as language? (text p. 61)

- The Association Areas of the Cortex
 - The association areas are particularly found in the frontal lobes. These areas help people make sense of the information they receive from the lower areas of the brain.
 - An area called Broca's area in the left frontal lobe is responsible for producing fluent, understandable speech. If damaged, the person has Broca's aphasia in which words will be halting and pronounced incorrectly.
 - An area called Wernicke's area in the left temporal lobe is responsible for the understanding of language. If damaged, the person has Wernicke's aphasia in which speech is fluent but nonsensical. The wrong words are used.
 - Spatial neglect comes from damage to the association areas on one side of the cortex, usually the right side. A person with this condition will ignore information from the opposite side of the body or the opposite visual field.

2.10 How does the left side of the brain differ from the right side? (text p. 62)

- Studies with split-brain patients, in which the corpus callosum has been severed to correct epilepsy, reveal that the left side of the brain seems to control language, writing, logical thought, analysis, and mathematical abilities. The left side also processes information sequentially.
- The right side of the brain processes globally, and controls emotional expression, spatial perception, recognition of faces, patterns, melodies, and emotions.
- The left hemisphere controls spoken language in most individuals.

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THE CHEMICAL CONNECTION: THE ENDOCRINE GLANDS (TEXT P. 64)

Lecture Launchers/Discussions Topics:

- Too Much or Too Little: Hormone Imbalances
- Would You Like Fries With That Peptide?

Activities, Demonstrations, and Exercises:

- Twenty Questions

Video Resources:

- [Men, Women and Sex Differences](#)

Multimedia Resources on MyPsychLab:

- [The Endocrine System](#)

2.11 How do the hormones released by glands interact with the nervous system and affect behavior? (text p. 64)

LINK to *Chapter Eight: Motivation and Emotion*, p. 290

- Hormones are secreted directly into the bloodstream, influencing the activity of the muscles and organs.
- The Pituitary Gland
 - The pituitary gland is found in the brain just below the hypothalamus. It has two parts, the anterior and the posterior.
 - It controls the levels of salt and water in our system and, in women, the onset of labor and lactation.
 - It also controls the secreting of growth hormones and influences the activity of the other glands.
- The Pineal Gland
 - The pineal gland is located near the back of the brain.
 - It secretes the hormone melatonin, which regulates the sleep-wake cycle.

LINK to *Chapter Six: Consciousness and Cognition*, p. 192

- The Thyroid Gland
 - The thyroid gland is located inside the neck and controls metabolism (the burning of energy) by secreting thyroxin.
- The Pancreas
 - The pancreas controls the level of sugar in the blood by secreting insulin and glucagons.
 - Too much insulin produces hypoglycemia, while too little causes diabetes.
- The Gonads
 - The gonads are the ovaries in women and testes in men.
 - They secrete hormones to regulate sexual growth, activity, and reproduction.
- The Adrenal Glands
 - The adrenal glands, one on top of each kidney, control our stress reaction through the adrenal medulla's secretion of epinephrine and norepinephrine.
 - The adrenal cortex secretes over thirty different corticoids (hormones) controlling salt intake, stress, and sexual development.

LINK to *Chapter Nine: Stress and Health*, p. 314

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APPLYING PSYCHOLOGY TO EVERYDAY LIFE: REFLECTIONS ON MIRROR NEURONS (TEXT P. 66)

- Mirror neurons are special brain cells that fire not only when we perform a motor action but also when we see someone else perform the same action.
- Their discovery has changed the way researchers think about social interactions and perception.

- Instead of trying to understand someone only through thinking, it is very possible that mirror neurons are the neurological foundation that allow us to simulate intentions and the emotions behind those actions.
- The roles of mirror neurons are currently being investigated in disorders that involve deficits in social interaction, including autism spectrum disorder.

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CHAPTER SUMMARY (TEXT P. 67)

Classroom Activities, Demonstrations, and Exercises

- [Crossword Puzzle Chapter 2](#)
- [Fill-in-the-Blank Exercise Chapter 2](#)

Multimedia on MyPsychLab

- [Audio file of the chapter \(in text icon p. 67\)](#)
- [Test Yourself—practice quizzes \(in-text icon p. 70\)](#)

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▼ CHAPTER 2

Learning Objectives

- 2.1 What are the nervous system, neurons, and nerves, and how do they relate to one another?
- 2.2 How do neurons use neurotransmitters to communicate with each other and with the body?
- 2.3 How do the brain and spinal cord interact?
- 2.4 How do the somatic and autonomic nervous systems allow people and animals to interact with their surroundings and control the body's automatic functions?
- 2.5 How do psychologists study the brain and how it works?
- 2.6 What are the different structures of the bottom part of the brain and what do they do?
- 2.7 What are the structures of the brain that control emotion, learning, memory, and motivation?
- 2.8 What parts of the cortex control the different senses and the movement of the body?
- 2.9 What parts of the cortex are responsible for higher forms of thought, such as language?
- 2.10 How does the left side of the brain differ from the right side?
- 2.11 How do the hormones released by glands interact with the nervous system and affect behavior?

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▼ CHAPTER 2

Rapid Review

(From Ciccarelli/White *Psychology: An Exploration Study Guide and Concept Notes* by Brenda Fonseca ISBN 0132302845)

The **nervous system** is made up of a complex network of cells throughout your body. Since psychology is the study of behavior and mental processes, understanding how the nervous system works provides fundamental information about what is going on inside your body when you engage in a specific behavior, feel a particular emotion, or have an abstract thought. The field of study that deals with these types of questions is called **neuroscience**. The role of the nervous system is to carry information. Without your nervous system, you would not be able to think, feel, or act. The cells in the nervous system that carry information are called **neurons**. Information enters a neuron at the **dendrites**, flows through the cell body (or **soma**) and down the **axon** in order to pass the information on to the next cell. Although, neurons are the cells that carry the information, most of the nervous system consists of **glial cells**. Glial cells provide food, support, and insulation to the neuron cells. The insulation around the neuron is called **myelin** and works in a way very similar to the plastic coating of an electrical wire. Bundles of myelin-coated axons are wrapped together in cable like structures called **nerves**.

Neurons use an electrical signal to send information from one end of its cell to the other. At rest, a neuron has a negative charge inside and a positive charge outside. When a signal arrives, gates in the cell wall next to the signal open and the positive charge moves inside. The positive charge inside the cell causes the next set of gates to open and those positive charges move inside. In this way, the electrical signal makes its way down the length of the cell. The movement of the electrical signal is called an **action potential**. After the action potential is over, the positive charges get pumped back out of the cell and the neuron returns to its negatively charged state. This condition is called the **resting potential**. A neuron acts in an **all-or-none** manner. This means the neuron either has an action potential or it does not. The neuron indicates the strength of the signal by how many action potentials are produced or “fired” within a certain amount of time.

Neurons pass information on to target cells using a chemical signal. When the electrical signal travels down the axon and reaches the other end of the neuron called the **axon terminal**, it enters the very tip of the terminal called the **synaptic knob** and causes the **neurotransmitters** in the **synaptic vesicles** to be released into the fluid-filled space between the two cells. This fluid-filled space is called the **synapse** or the **synaptic gap**. The neurotransmitters are the chemical signals the neuron uses to communicate with its target cell. The neurotransmitters fit into the **receptor sites** of the target cell and create a new electrical signal that then can be transmitted down the length of the target cell.

Neurotransmitters can have two different effects on the target cell. If the neurotransmitter increases the likelihood of an action potential in the target cell, the connection is called an **excitatory synapse**. If the neurotransmitter decreases the likelihood of an action potential, the connection is called an **inhibitory synapse**. **Agonists** and **antagonists** are chemicals that are not naturally found in our body but that can fit into the receptor sites of target cells when they get into our nervous system. Agonists lead to a similar response in the target cell as the neurotransmitter itself, while antagonists block or reduce the action of the neurotransmitter on the target cell. There are at least 50-100 different types of neurotransmitters in the human body. **Acetylcholine** was the first to be discovered; it is an excitatory neurotransmitter that causes your muscles to contract. Gamma amino butyric acid (**GABA**) is an inhibitory neurotransmitter that decreases the activity level of neurons in your brain. **Serotonin** is both an excitatory and inhibitory neurotransmitter and has been linked with sleep, mood, and appetite. Low levels of the neurotransmitter **dopamine** have been found to cause Parkinson’s disease and increased levels of dopamine have been linked to the psychological disorder known as schizophrenia. **Endorphin** is a special neurotransmitter called a neural regulator that controls the release of other neurotransmitters. When endorphin is released in the body, they neurons transmitting information about pain are not able to fire action potentials. All the

different types of neurotransmitters are cleared out of the synaptic gap through the process of **reuptake**, diffusion, or by being broken apart by an enzyme.

The **central nervous system (CNS)** is made up of the brain and the **spinal cord**. The spinal cord is a long bundle of neurons that transmits messages between the brain and the body. The cell bodies or somas of the neurons are located along the inside of the spinal cord and the cell axons run along the outside of the spinal cord. **Afferent (sensory) neurons** send information from our senses to the spinal cord. For example, sensory neurons would relay information about a sharp pain in your finger. **Efferent (motor) neurons** send commands from the spinal cord to our muscles, such as a command to pull your finger back. **Interneurons** connect sensory and motor neurons and help to coordinate the signals. All three of these neurons act together in the spinal cord to form a **reflex arc**. The ability of the brain and spinal cord to change both in structure and function is referred to as **neuroplasticity**. One type of cell that facilitates these changes are **stem cells**.

The **peripheral nervous system (PNS)** is made up of all the nerves and neurons that are NOT in the brain or spinal cord. This includes all the nerves that connect to your eyes, ears, skin, mouth, and muscles. The PNS is divided into two parts, the **somatic nervous system** and the **autonomic nervous system (ANS)**. The somatic nervous system consists of all the nerves coming from our sensory systems, called the **sensory pathway**, and all the nerves going to the skeletal muscles that control our voluntary movements, called the **motor pathway**. The autonomic nervous system is made up of the nerves going to and from our organs, glands, and involuntary muscles and is divided into two parts: the **sympathetic division** and the **parasympathetic division**. The sympathetic division turns on the body's fight-or-flight reactions, which include responses such as increased heart rate, increased breathing, and dilation of your pupils. The parasympathetic division controls your body when you are in a state of rest to keep the heart beating regularly, to control normal breathing, and to coordinate digestion. The parasympathetic division is active most of the time.

Researchers have used animal models to learn a great deal about the human brain. Two of the most common techniques used in animals involve either destroying a specific area of the brain (**deep lesioning**) or stimulating a specific brain area (**electrical stimulation of the brain or ESB**) to see the effect. In work with humans, researchers have developed several methods to observe the structure and activity of a living brain. If a researcher wants a picture of the structure of the brain, she might choose a **CT scan** or an **MRI**. Computed tomography (CT) scans use x-rays to create images of the structures within the brain. Magnetic resonance images (MRIs) use a magnetic field to "take a picture" of the brain. MRIs provide much greater detail than CT scans. On the other hand, if a researcher wanted to record the activity of the brain, he might select an **EEG**, **fMRI**, or **PET scan**. An electroencephalogram (EEG) provides a record of the electrical activity of groups of neurons just below the surface of the skull. A functional magnetic resonance image (fMRI) uses magnetic fields in the same way as an MRI, but goes a step further and pieces the pictures together to show changes over a short period of time. A positron emission tomography (PET) scan involves injecting a person with a low dose of a radioactive substance and then recording the activity of that substance in the person's brain.

The brain can be roughly divided into three sections: the brainstem, the cortex, and the structures under the cortex. The **brainstem** is the lowest part of the brain that connects to the spinal cord. The outer wrinkled covering of the brain is the **cortex**, and the structures under the cortex are essentially everything between the brainstem and the cortex. The brainstem contains four important structures. The **medulla**, controls life-sustaining functions such as heart beat, breathing, and swallowing. The **pons** influences sleep, dreaming, and coordination of movements. The **reticular formation** plays a crucial role in attention and arousal, and the **cerebellum** controls all of the movements we make without really "thinking" about it.

One main group of structures under the cortex is the **limbic system**. The limbic system includes the **thalamus**, **olfactory bulbs**, **hypothalamus**, **hippocampus**, and **amygdala**. The thalamus receives input from your sensory systems, processes it, and then passes it on to the appropriate area of the cortex. (The **olfactory bulbs**, just under the front part of the brain, receive signals from the neurons in the sinus cavity to provide the sense of smell. The sense of smell is the only sense that cannot be affected by

damage to the thalamus.) The hypothalamus interacts with the endocrine system to regulate body temperature, thirst, hunger, sleeping, sexual activity, and mood. It appears that the hippocampus is critical for the formation of long-term memories and for memories of the locations of objects. The amygdala is a small almond-shaped structure that is involved in our response to fear.

The outer part of the brain, or **cortex**, is divided into right and left sections called **cerebral hemispheres**. The two hemispheres communicate with each other through a thick band of neurons called the **corpus callosum**. Each cerebral hemisphere can be roughly divided into four sections. These sections are called lobes. The **occipital lobes** are at the back of the brain and process visual information. The **parietal lobes** are located at the top and back half of the brain and deal with information regarding touch, temperature, body position, and possibly taste. This area contains the **somatosensory cortex**, an area of neurons running down the front of the parietal lobes on either side of the brain. The **temporal lobes** are just behind your temples and process auditory information. The **frontal lobes** are located at the front of your head and are responsible for higher mental functions such as planning, personality, and decision making, as well as language and motor movements. Motor movements are controlled by a band of neurons located at the back of the frontal lobe called the **motor cortex**.

Association areas are the areas within each of the lobes that are responsible for “making sense” of all the incoming information. **Broca’s area** is located in the left frontal lobe in most people and is responsible for the language production. A person with damage to this area would have trouble producing the words that he or she wants to speak. This condition is referred to as **Broca’s aphasia**. The comprehension of language takes place in **Wernicke’s area** located in the left temporal lobe. If this area of the brain is damaged, individuals are often still able to speak fluently, but their words do not make sense. This type of language disorder is referred to as **Wernicke’s aphasia**. Damage to the right parietal and occipital lobes can cause a condition known as **unilateral spatial neglect** where the individual ignores objects in their left visual field.

The **cerebrum** is made up of the two cerebral hemispheres and the structures connecting them. The **split-brain research** studies of Roger Sperry helped scientists to figure out that the two cerebral hemispheres are not identical. The left hemisphere is typically more active when a person is using language, math, and other analytical skills, while the right hemisphere shows more activity during tasks of perception, recognition, and expression of emotions. This split in the tasks of the brain is referred to as lateralization.

The **endocrine glands** represent a second communication system in the body. The endocrine glands secrete chemicals called **hormones** directly into the bloodstream. The **pituitary gland** is located in the brain and secretes the hormones that control milk production, salt levels, and the activity of other glands. The **pineal gland** is also located in the brain and regulates the sleep cycle through the secretion of melatonin. The **thyroid gland** is located in the neck and releases a hormone that regulates metabolism. The **pancreas** controls the level of blood sugar in the body, while the **gonad** sex glands – called the **ovaries** in females and the **testes** in males, regulate sexual behavior and reproduction. The **adrenal glands** play a critical role in regulating the body’s response to stress.

Mirror neurons, neurons that fire when we perform an action and also when we see someone else perform that action, may explain a great deal of the social learning that takes place in humans from infancy on.

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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.

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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 than 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?

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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).

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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 though 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.

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- Brena, S. F., & Sammons, E. E. (1979). Phantom urinary bladder pain – Case report. *Pain*, 7, 197–201.
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- 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.

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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).

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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.

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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.

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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 Mejias, 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. X-ray images of the imbedded nails can be found at the USA Today link on the next page. 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.

http://www.usatoday.com/news/nation/2004-05-05-nail-head_x.htm

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/FROTOPAGE>

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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 (“black out”), 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.

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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 having an iron tamping rod 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.

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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 work place. 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 work place 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.

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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 Demonstrations and 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.

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Lecture/Discussion: Brain's Bilingual Broca

Se potete parlare Italiano, allora 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.

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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.

Swordlow, 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.

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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). 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.

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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 carbohydrate. 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 \Rightarrow cortisol \Rightarrow Neuropeptide Y \Rightarrow 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 carbohydrate, 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>

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▼ CLASSROOM ACTIVITIES, DEMONSTRATIONS, AND EXERCISES

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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.

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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.

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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 myelination.

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

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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.

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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.

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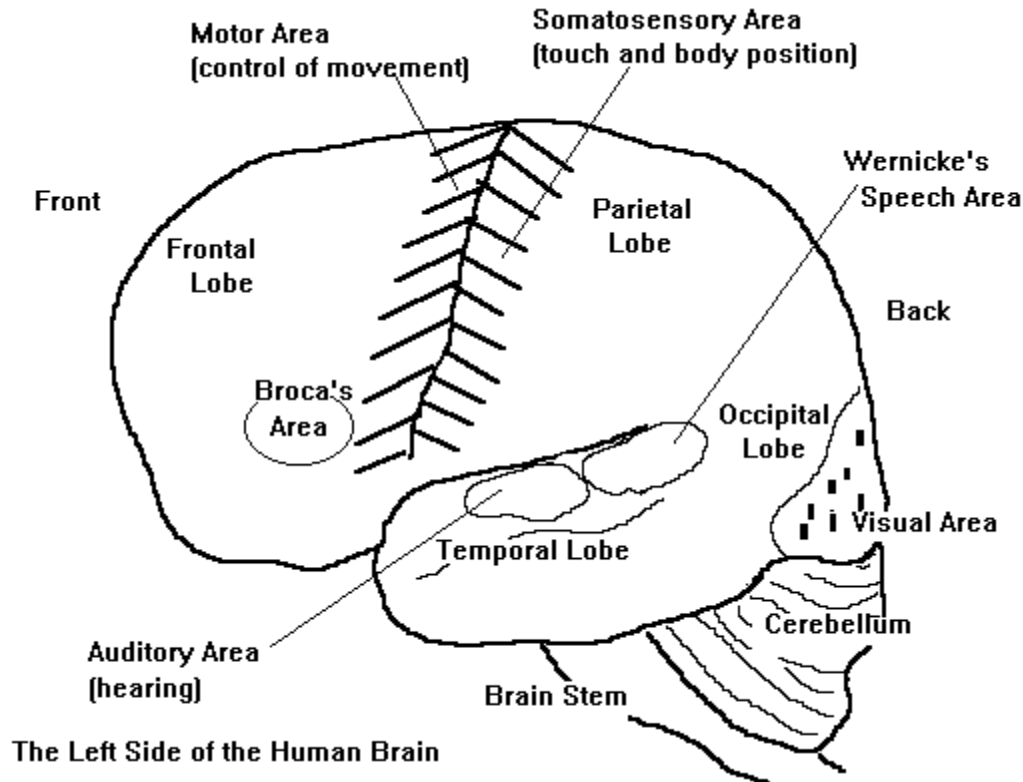
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Activity: Mapping the Brain

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 2.1](#). 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.

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.

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.

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.

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.

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.

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.

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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)

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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.

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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.

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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.

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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’s 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.

Kemle, 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.

Kemle, E. D., Filipi, T., & Gravlin, L. (1985). Some simple classroom experiments on cerebral lateralization. *Teaching of Psychology, 12*, 81–83.

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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 2.2**. 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.

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Activity: Looking Left, Looking Right

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

Materials: Left and Right Hemisphere Questions (Handout 2.2)

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.

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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 2 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.

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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: The Structures of the Brain](#)

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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: The Chemical Connection](#)

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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 2.3** to students as a homework or in-class review assignment.

The answers for the crossword puzzle are:

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. **CorpusCallosum**
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](#)

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Activity: Fill in the Blank

Copy and distribute **Handout Master 2.6** to students as a homework or in-class review assignment.

Answer Key: Chapter 2 The Biological Perspective Fill-in-the-Blanks

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 Activities, Demonstrations and Exercises for Chapter 2**

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▼ HANDOUT MASTERS

- [2.1 Mapping the Brain](#)
- [2.2 Localization of Function Exercise](#)
- [2.3 Crossword Puzzle](#)
- [2.4 The Automatic Nervous System](#)
- [2.5 The Basic Structure of the Neuron](#)
- [2.6 Fill-in-the-Blank Exercise](#)

For student note-taking in the classroom, there are the handouts available for **both** the **Interactive PowerPoint** slides (ISBN 0132302799) and the **Secondary PowerPoint** slides (ISBN 0205786146) which accompany Ciccarelli/White *Psychology: An Exploration*. The PPT handouts can be accessed on the Instructors Resource DVD (ISBN 0132302837), as well as for download at www.pearsonhighered.com/irc.

In addition to these options, there is also a **Concept Notes section** in the student Study Guide. The Study Guide and Concept Notes (ISBN 0132302845) includes a chapter summary and practice exams structured around the chapter learning objectives. The popular Concept Map note-taking feature is included in the Study Guide. Each of the chapter's visual summaries is included; section-level concept maps and key illustrations are provided to students along with a notes page so they can follow along with an instructor's lecture, see the relevant text content, and take notes alongside. The Study Guide and Concept Notes is perforated and three-hole punched so students can pull out and use what they need.

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Handout Master 2.1

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 Activity: Mapping the Brain

▶ Return to Lecture Guide: Peeking Inside the Brain

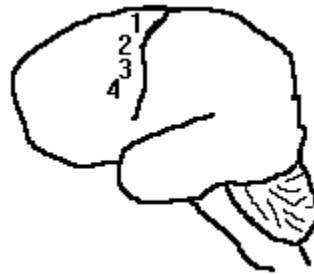
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Handout Master 2.2

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.



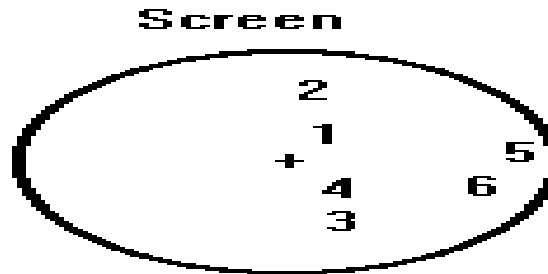
- Case 1: a.** What method is being used to study brain function?
- b.** What does this part of the brain do?
- c.** What can you say about the representation of this function in the brain based on this information (what are the rules of organization)?

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.



- Case 2: 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.



Case 3: 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.



Case 4: 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.



Case 5: 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.

Case 6: 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.

Case 7: 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: An Overview of the Nervous System

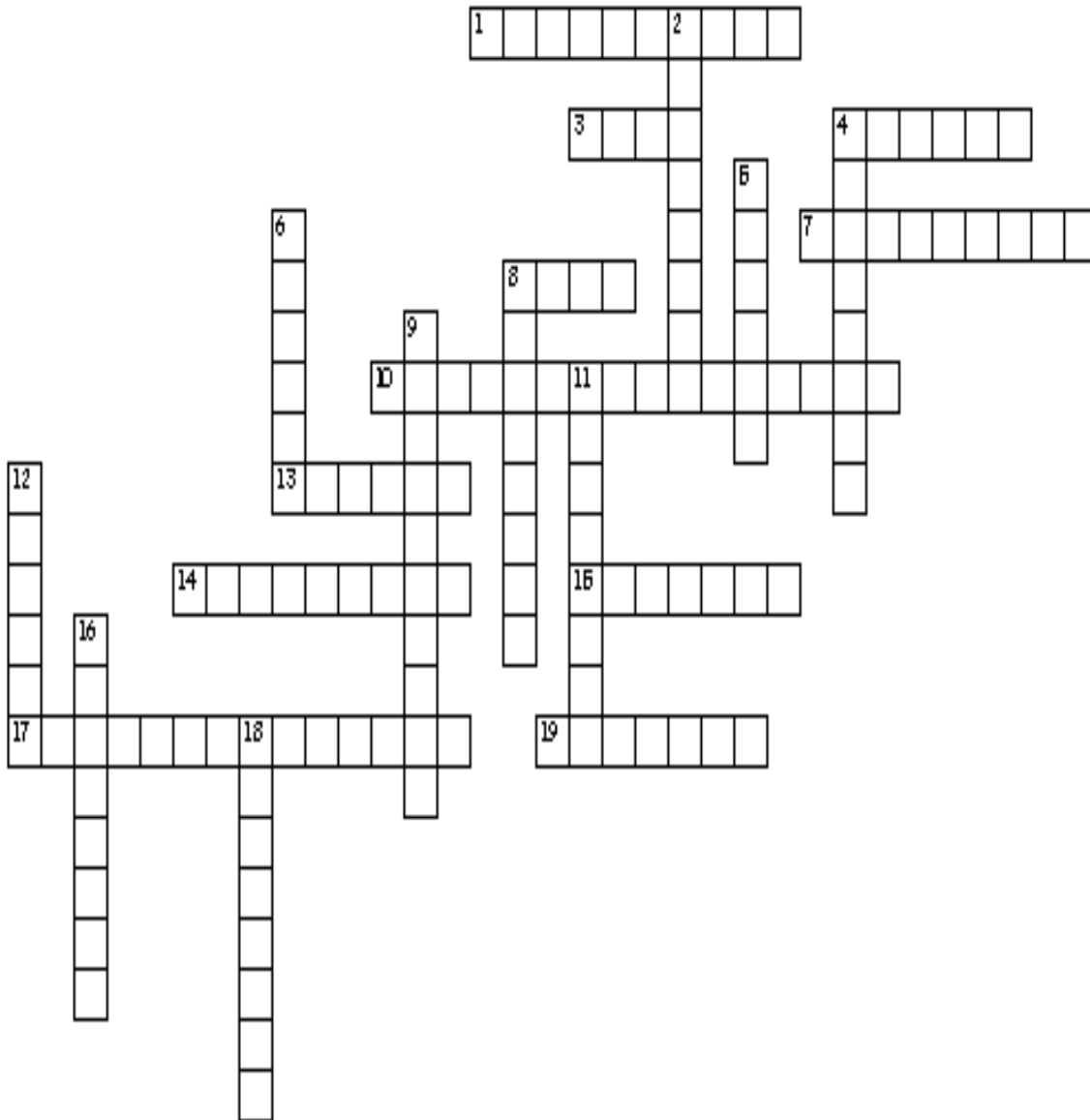
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Handout Master 2.3

Crossword Puzzle Activity

Chapter 2: The Biological Perspective



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 2 \(answers\)](#)

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Handout Master 2.4

The Automatic Nervous System

Describe how each organ is affected by the sympathetic and parasympathetic nervous system.

<i>Organ</i>	<i>Sympathetic</i>	<i>Parasympathetic</i>
Adrenal Medulla		
Bladder		
Blood Vessels Abdomen Muscles Skin		
Heart		
Intestines		
Liver		
Lungs		
Pupil of Eye		
Salivary Glands		
Sweat Glands		

► [Return to Lecture Guide: The Peripheral Nervous System](#)

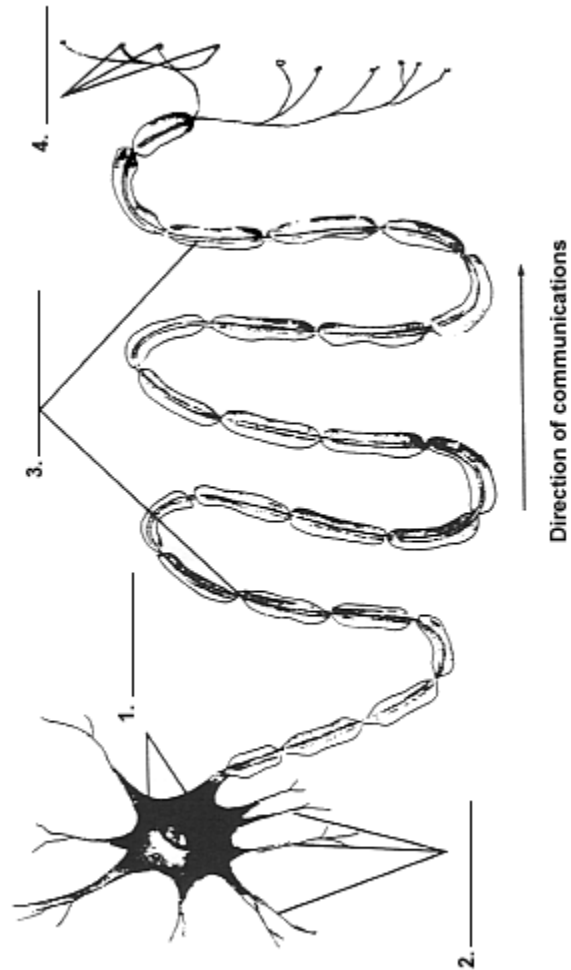
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Handout Master 2.5

The Basic Structure of the Neuron

Identify the parts of the neuron discussed in the text.



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Handout Master 2.6

Fill-in-the-Blank Class Activity

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 the _____.
5. The cell body of the neuron, responsible for maintaining the life of the cell and containing 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 is 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 _____ neuron.
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 consists of nerves which control all of the *involuntary* muscles, organs, glands, and sensory pathway nerves.
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 a(n) _____.
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. _____ 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 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 is called the _____.
32. The _____ are the areas of the cortex located just behind the temples, containing the neurons responsible for the sense of hearing and meaningful speech.
33. The _____ are the 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:

adrenal glands
agonists
all or none
amygdala
autonomic nervous
axon
cerebellum
corpus callosum
cortex
dendrites
electroencephalograph
endocrine
excitatory
frontal Lobes
hippocampus
ions
myelin
nerves
nervous system
neuron
neurotransmitters
occipital cortex
parietal cortex
peripheral nervous
pons
resting potential
reticular formation
sensory
soma
somatic nervous
spinal cord
sympathetic division
synaptic vesicles
temporal lobes
thalamus

► Return to Activity: Fill in the Blank Chapter 2 (answers)

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▼ APS: READINGS FROM THE ASSOCIATION OF PSYCHOLOGICAL SCIENCE

Current Directions in Introductory Psychology, Second Edition (0137143508)

Edited by Abigail A. Baird, with Michele M. Tugade and Heather B. Veague

Available for packaging at no charge with Ciccarelli/White *Psychology: An Exploration*

This new and exciting American Psychological Reader includes timely, cutting-edge articles, giving readers a real-world perspective from a reliable source *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.

Amir Amedi, Lotfi B. Merabet, Felix Bermpohl, Alvaro Pascual-Leone

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

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.

Kevin S. LaBar

Beyond Fear: Emotional Memory Mechanisms in the Human Brain. (Vol. 16, No. 4, 2007, pp. 173—177) 64 of the APS reader

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: Structures of the Brain](#)

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▼ *Forty Studies that Changed Psychology: Explorations into the History of Psychological Research, Sixth Edition (013603599X)*

By Roger Hock

Available for packaging with Ciccarelli/White *Psychology: An Exploration*

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.

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▼ WEB RESOURCES

General/Comprehensive

Biological and Physiological Resources: <http://psych.athabasca.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 Lecture Guide: An Overview of the Nervous System](#)

▲ [Return to Chapter 2: 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.

How do Nerve Cells Communicate?

<http://www.sfn.org/content/Publications/BrainBackgrounders/communication.htm>

Information prepared by the Society for Neuroscience.

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.

Neural Processes Tutorial: <http://psych.hanover.edu/Krantz/neurotut.html>

An excellent interactive animated tutorial.

► [Return to Lecture Guide: Neurons and Nerves](#)

▲ [Return to Chapter 2: Table of Contents](#)

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 Central Nervous System](#) or ► [Return to Lecture Guide: The Peripheral Nervous System](#)
▲ [Return to Chapter 2: 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://www.brainconnection.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 Reorganization: http://www.sfn.org/content/Publications/BrainBriefings/brain_reorg.html

Brief information on how the brain changes with experience, prepared by the Society for Neuroscience.

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.

History of Phrenology: <http://pages.britishlibrary.net/phrenology/>

Follow the bumpy road to discovering phrenology's past from a professor of history at the University of Cambridge.

Human Corpus Callosum: <http://www.indiana.edu/~pietsch/callosum.html>

Information and links about the corpus callosum and “split-brain surgery” by Paul Pietsch.

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>

NPAC/OLDA Visible Human Viewer: <http://www.dhpc.adelaide.edu.au/projects/vishuman2/VisibleHuman.html>

A little tricky to use, but by following the instructions on this page you can view images of the brain in one of several planes. Currently, only photos are available, but these are quite nice. MRI and CT scans in the same planes are planned for the future.

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.

She Brains / He 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.

What is the Cerebellum? <http://www.sfn.org/content/Publications/BrainBackgrounders/cerebellum.htm>

Information about the structure and function of the cerebellum, prepared by the Society for Neuroscience.

► [Return to Lecture Guide: Peeking Inside the Brain](#) or ► [Return to Lecture Guide: Structures of the Brain](#)

▲ [Return to Chapter 2: 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: Structures of the Brain](#)

▲ [Return to Chapter 2: Table of Contents](#)

▼ 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!

NEW 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!

Lecture Launcher Video for Introductory Psychology (ISBN 013048640X)

This 60-minute videotape includes twenty-five segments covering all of the major topics in introductory psychology. All of the segments have been selected from videotapes in the Films for Humanities & Sciences collection. The segments are intended to provide brief illustrations of concepts, and to serve as a starting point for classroom discussions.

FILMS FOR HUMANITIES AND SCIENCES VIDEO LIBRARY (<http://www.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 ISBN's.

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

▼ VIDEO CLIPS AVAILABLE FOR CHAPTER 2 THE BIOLOGICAL PERSPECTIVE

- ☞ [Neurons and Synapses](#) (1:10)
- ☞ [Synaptic Development](#) (0:36)
- ☞ [Brain and Nervous System](#) (1:00)
- ☞ [Agonizing Silence](#) (13:43)
- ☞ [Autistic Children](#) (21:49)
- ☞ [Brain Building](#) (1:38)
- ☞ [MKM and Brain Scans](#) (3:08)
- ☞ [The Brain: An Inside Look](#) (1:05)
- ☞ [How the Human Genome Map Affects You](#) (1:21)
- ☞ [Exercise Your Brain](#) (1:40)
- ☞ [Men, Women and Sex Differences](#) (2:10)

▲ [Return to Chapter 2: Table of Contents](#)

▼ DESCRIPTIONS OF VIDEO CLIPS:

▼ From Introductory Psychology Teaching Films Boxed Set ISBN (0131754327)

Disc #1 Behavioral Neuroscience:

Neurons and Synapses

Source: *Films for Humanities & Sciences*

Video: *Brain and Nervous System*

Run Time: 1:10

Description: This video relies on “reporters” who describe various aspects of the nervous system. In this segment, a reporter provides a brief description of neurons and synapses using an example of a pain warning message traveling from the brain to a hand on a hot stove.

Uses: The format of this segment favors simplicity over detail. Use this as a basis for more fully describing the electrochemical nature of synaptic transmission. The straightforward presentation should pique students' interests, although a more thorough explanation of synapses is warranted.

► [Return to Lecture Guide: Neurons and Nerves](#)

Synaptic Development

Source: *Pearson Education*

Run Time: 0:36

Description: This video presents an animation demonstrating the process of synaptic development and pruning. In the months after birth, the brain grows rapidly. Axons and dendrites grow longer, and like a maturing tree, grow quickly and sprout new limbs. As the number of dendrites increase, so does the number of synapses, reaching a peak at about the first birthday. Soon after, synapses begin to disappear gradually, a phenomenon known as synaptic pruning. Remaining connections increase in power. Thus, beginning in infancy and continuing into early adolescence, the brain goes through its own version of “downsizing,” weeding out unnecessary connections between neurons and increasing the efficiency of those that remain. As you watch the simulation, pay particular attention to the interplay of atrophy (depicted by the thinning lines) and the increase in power of those that are selected to remain (depicted by a thickening line).

► **Return to Lecture Guide: Neurons and Nerves**

Agonizing Silence

Source: *ABC News – 20/20 (6/14/1999)*

Run Time: 13:43

Description: A child suddenly withdraws into a world of silence, victims of a bizarre disorder called “selective mutism.”

Uses: This clip shows how therapy may help individuals overcome disorders that can impede social, cognitive and educational development. It could be used to start a conversation about human development or treatment of psychological disorders of childhood.

► **Return to Lecture Guide: Central Nervous System**

Autistic Children

Source: *ABC News – Primetime Live (4/22/2004)*

Run Time: 21:49

Description: Shows the disorder of autism in the seemingly “perfect” family, and how the family mobilizes to combat the disorder.

Uses: This clip could be used to start a discussion about the protection of children with disabilities under the federal Americans with Disabilities Act, as well as school districts’ responsibilities to develop an Individualized Education Plan for each disabled child. It could also be used as an introduction to patient rights advocacy and legal rights of children needing special education.

► **Return to Lecture Guide: Central Nervous System**

Brain Building

Source: *ScienCentral*

Run Time: 1:38

Discussion: According to this video the brain matures in different stages. The ages 5–20 appear to be the most productive time of brain development. This age span is the best time to learn to play a musical instrument, a new sport or new studies.

Use: This video can be used in a discussion of child development. It can also be used in a discussion of brain development

► **Return to Lecture Guide: Peeking Inside the Brain**

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

MKM and Brain Scans

Source: *Pearson*

Run Time: 3:08

Discussion: Report on surgical microscope procedure along with brain scans allow for great precision in neurosurgery. Second report on how new technologies are helping us learn about treatment for migraine sufferers.

► **Return to Lecture Guide: Peeking Inside the Brain**

How the Human Genome Map Affects You

Source: Pearson

Run Time: 1:21

Discussion: Report on potential changes in the medical world with the discoveries from the Human Genome project.

► **Return to Lecture Guide: Structures of the Brain**

Exercise Your Brain

Source: Pearson

Run Time: 1:40

Discussion: The importance of aerobic exercise in countering the aging of the brain and the use of MRI in uncovering these findings.

► **Return to Lecture Guide: Structures of the Brain**

▼ **From: Lecture Launcher Video for Introductory Psychology (ISBN 013048640X):**

VIDEO TITLE:	SEGMENT TITLE:	RUN TIME
Brain and Nervous System	Neurons and Synapses	1:00

Description: This video relies on “reporters” who describe various aspects of the nervous system. In this segment, a reporter provides a brief description of neurons and synapses using an example of a pain warning message traveling from the brain to a hand on a hot stove.

Uses: The format of this segment favors simplicity over detail. Use this as a basis for more fully describing the electrochemical nature of synaptic transmission. The straightforward presentation should pique students’ interests, although a more thorough explanation of synapses is warranted.

► **Return to Lecture Guide: Neurons and Nerves**

VIDEO TITLE:	SEGMENT TITLE:	RUN TIME:
The Brain: An Inside Look	The Brain and Nervous System	1:05

Description: This brief animated sequence provides a clear description of the brain, central nervous system, peripheral nervous system, cerebral cortex, and cerebral hemispheres.

Uses: This clip is suitable for starting a lecture on the brain and nervous system. This quick overview will introduce students to the major divisions of the nervous system and allow you to elaborate on each element during your classroom presentation.

► **Return to Lecture Guide: Peeking Inside the Brain**

VIDEO TITLE:	SEGMENT TITLE:	RUN TIME
Men, Women, and Sex Differences	Sex Differences in Behavior	2:10

Description: John Stossel of ABCNews explores the origins of sex differences. Are they biological, environmental, or a combination of the two? In this segment, researchers examine men’s and women’s different capacities for memory and direction. Hormones (such as testosterone) are implicated as a possible agent for producing “biologically male” and “biologically female” behaviors.

Uses: Women and men do a lot that’s different. They also do a lot that’s the same. Easy answers to the complex question of what causes sex differences in behavior are sought after but not always found. Broach this subject with your students by showing this clip to stimulate a discussion of the origins of sex differences.

► **Return to Lecture Guide: The Chemical Connection**

▲ **Return to Chapter 2: Table of Contents**

▼ MULTIMEDIA RESOURCES

On-line Resources: MyPsychLab

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 on-line 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. Instructors can bring into these resources to class, or easily post on-line for students to access.

Assessment and Ability to Adapt MyPsychLab is designed with instructor flexibility in mind—you decide the extent of integration into your course—from independent self-assessment for students, to total course management. For sample syllabi with ideas on incorporating MPL, case studies, as well as data and feedback from students and answers to FAQ's, see the Appendix in this manual, as well as on-line at www.mypsychlab.com.

MyPsychLab Highlights for Chapter 2: The Biological Perspective

Neurons and Neural Impulses

This collection of modules introduces students to the basics of biological psychology. *Neurons and Neural Impulses* addresses the nervous system, three types of neurons, and the structure of the neuron. *Nervous System Chemicals and Their Effects* explains the synapse and neurotransmitters (excitation and inhibition and clearing the synapse) and three types of chemical messengers (neurotransmitters, neuromodulators, and hormones). *Major Brain Systems and Functions* describes the brain and brain stem.

Psychology in the News (2:37)









Psychology in the News podcast on Stem Cell Therapy connects real world events to the chapter content. Have students listen and then open up the discussion in class on recent research using stem cells, including Parkinson's, and Alzheimer's disease as highlighted in the podcast.

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.





Chapter 2 Multimedia Content available at www.mypsychlab.com

Neurons and Nerves

-  Learn More: Cajal: his influence and discoveries
-  Explore More: simulation on Neurons and Neurotransmitters
-  Simulation on Dendritic Spreading: Forming Interconnections in the Brain
-  Simulation on Action Potential
-  Simulation on the Nerves and Neural Impulses
-  Simulation on Afferent and Efferent Neurons
-  Simulation on The Synapse
-  Simulation Neuronal Transmission


► **[Return to Lecture Guide: Neurons and Nerves](#)**

The Central Nervous System

-  Psychology in the News podcast—audio clip discussing recent updates on stem cell therapy
-  Hear More: Organization of the Nervous System (enhanced podcast)
-  Simulation: Overview of the Nervous System
-  Video on Autistic Children




► **Return to Lecture Guide: The Central Nervous System**

The Peripheral Nervous System

-  Simulation: The Autonomic Nervous System









► **Return to Lecture Guide: The Peripheral Nervous System**

Peeking Inside the Brain

-  Video Classic: Wilder Penfield and Electric Brain Stimulation
-  Video on Brain Imaging
-  Video on new MKM and Brain Scans


► **Return to Lecture Guide: Peeking Inside the Brain**

From the Bottom Up: Structures of the Brain

-  Explore More: simulation on lower brain structures: The Limbic System, The Cerebral Cortex, The Broca and Wernicke Areas, The Cerebral Hemispheres (in text icon p. 70)
-  See More: video podcast of the surface anatomy of a human brain (in text icon p. 72)
-  Learn More: curious facts about right and left handedness (in text icon p. 79)
-  Simulation on brain structures: The Visual Cortex
-  Simulation: The Mind's Organization of Conceptual Knowledge
-  Split-Brain Experiments
-  Video on the Hindbrain
-  Video: How Does the Brain Work?




► **Return to Lecture Guide: Structures of the Brain**

The Chemical Connection: The Endocrine Glands

-  Simulation: The Endocrine System

► **Return to Lecture Guide: The Chemical Connection**

Chapter Summary

-  Listen to your chapter (audio files of the complete chapter)
-  Flashcards (students can download and print these cards)
-  Practice Tests

► **Return to Lecture Guide: Chapter Summary**

▲ **Return to Chapter 2: Table of Contents**

▼TRANSPARENCIES

Two sets of transparencies are available:

I. Prentice Hall Transparencies for Introductory Psychology (ISBN 0131926993):

- T8: Divisions of the Nervous System
- T9: Major Endocrine Glands
- T10: Structure of the Neuron
- T11: How Neurons Communicate
- T12: Effects, Locations, and Functions of Neurotransmitters
- T13: Divisions of the Brain
- T14: The Cerebral Cortex
- T15: A Typical Split-Brain Operation

II. Allyn & Bacon Transparencies for Introductory Psychology (ISBN 0205398626):

- Biology of Behavior
- 16 The Secret of DNA
- 17 The Major Structures of the Neuron
- 18 Sensory Neurons, Motor Neurons, and Interneurons
- 19 The Action Potential
- 20 Neurotransmitters
- 21 Five Key Neurotransmitters and Their Functions
- 22 Reflexes: The Action of Afferent and Efferent Neurons
- 23 Divisions of the Human Nervous System
- 24 The Autonomic Nervous System
- 25 The Human Brain - A Cross-Section
- 26 Structures of the Brain
- 27 Major Regions of the Cerebral Cortex
- 28 The Principal Structures in the Limbic System
- 29 Two Views of the Cerebral Hemispheres
- 30 The Motor Cortex and the Somatosensory Cortex
- 31 The Eyes, Optic Chiasm, and Cerebral Hemispheres
- 32 Lateralized Functions of the Brain
- 33 The Effects of Severing the Corpus Callosum
- 34 Parallel Versus Serial Processing
- 35 The Neural Basis of Human Speech
- 36 Gazzaniga and LeDoux Experiment
- 37 The Endocrine Glands
- 38 Homozygous and Heterozygous Genotypes

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▼ CLASSROOM or PERSONAL RESPONSE SYSTEM (“Clicker” Questions)

Pearson Education has partnerships with leading classroom response systems on the market. For more information about Classroom Response Systems and our partnerships, please go to <http://www.pearsonhighered.com/crs>.

The classroom response questions created for Ciccarelli/White *Psychology: An Exploration* (ISBN 0205784852) are designed to assess your students’ progress in the class. Students become active learners and the immediate feedback provides you with insight into their learning. Clicker questions are available for download at the instructor’s resource center at www.pearsonhighered.com/irc, as well as on the as well as on the Instructor’s Resource DVD (ISBN 0132302837). The second edition slides include two sections for each chapter: definitional and application questions, as well as a section with Critical Thinking and Student Opinion slides.

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▼ PEER INSTRUCTION CLICKER ACTIVITIES

If you are interested in applying more peer instruction in your class, try the new Pearson Peer Instruction Clicker Activities (ISBN 0205784860). The structure of the slides/activities is to ask a question, have students respond, then discuss in small groups and answer the question again. Examples of the type of questions include: *Given the structure of the ear, why do your grandparents turn up the TV so much? Or John was in a car accident and now can’t see people’s faces—where was he sitting in the car when the accident occurred?* Each Peer Instruction item includes instructor’s notes to facilitate discussion. Guidelines on how to implement peer instruction in the classroom are also included.

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▼ *Psychology: An Exploration* POWERPOINT SLIDES

Two distinct sets of PowerPoint slide collections are available:

1. The Interactive PowerPoint slides by Derek Borman (Mesa Community College) (ISBN 0132302799) bring the powerful Ciccarelli/White design right into the classroom, drawing students into the lecture and providing wonderful interactive exercises, visuals, and videos.

Detailed instructor notes for the slides are available for download at www.pearsonhighered.com/irc, as well as ready-to-use classroom handouts, with a place for students to take notes. NOTE--the slides themselves are too large for download. The slides and all support materials (including student and instructor notes) are available on the Instructors Resource DVD (ISBN 0132302837).

2. The second set of PowerPoint slides, by Fred Whitford (Montana State University) (ISBN 0205786146) is available for download at www.pearsonhighered.com/irc. These slides provide a more traditional approach to presenting the material, with clear excerpts of the text material, photos, and artwork also included.

Note—student handouts** for **both** the **Interactive PowerPoint** and the **Secondary PowerPoint** slides are available on the Instructors Resource DVD, as well as for download at www.pearsonhighered.com/irc

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▼ **ACCESSING ALL RESOURCES** for Ciccarelli/White *Psychology: An Exploration*

For a list of all student resources available with Ciccarelli/White, go to www.mypearsonstore.com, enter the text ISBN (0132302721) and check out the “Everything That Goes With It” section under the book cover.

For access to the instructor supplements for Ciccarelli/White *Psychology: An Exploration*, 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 Ciccarelli/White *Psychology: An Exploration* 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>.

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