MODULE 6

The Cerebral Cortex and Our Divided Brain

Module Preview

The cerebral cortex, representing the highest level of brain development, is responsible for our most complex functions. Each hemisphere of the cerebral cortex has four geographical areas: the frontal, parietal, occipital, and temporal lobes. Although small, well-defined regions within these lobes control muscle movement and receive information from the body senses, most of the cortex—its association areas—are free to process other information.

Experiments on split-brain patients suggest that, for most people, the left hemisphere is the more verbal and the right hemisphere excels in visual perception and the recognition of emotion. Studies of people with intact brains indicate that each hemisphere makes unique contributions to the integrated functions of the brain.

Module Guide

The Cerebral Cortex

- ➤ Lectures: Einstein's Brain and Genius; Kim Peek's Brain; Neural Prosthetics; Hemispherectomy; The Sodium Amobarbital Test; Language on Two Sides of the Brain?
- ➤ Exercises: Neuroscience and Moral Judgments; The Sensory Homunculus
- ➤ Project: The Human Brain Coloring Book
- ➤ ActivePsych: *Scientific American Frontiers,* 3rd ed.: *Brain and Behavior: Phineas Gage Revisited* and *Brain Plasticity: Rewiring the Visual Cortex*
- ➤ Videos: *Discovering Psychology, Updated Edition: Cognitive Neuroscience;* Segment 8 of the Scientific American *Frontiers* series, 2nd ed.: *Old Brain, New Tricks;* Module 7 of *The Mind* series, 2nd ed.: *The Frontal Lobes: Cognition and Awareness;* Program 3 of *Moving Images: Exploring Psychology Through Film: Brain and Behavior: A Contemporary Phineas Gage;* Module 25 of *The Brain* series, 2nd ed.: *The Frontal Lobes and Behavior: The Story of Phineas Gage;* Program 10 of *Moving Images: Exploring Psychology Through Film: Sensation Without Perception: Visual Prosopagnosia;* Module 18 of *The Mind* series, 2nd ed.: *Effects of Mental and Physical Activity on Brain/Mind*

6-1. *Describe the structure of the cerebral cortex, and explain the various functions of the four lobes.*

The ***cerebral cortex,*** a thin surface layer of interconnected neural cells, is our body's ultimate control and information-processing center. *Glial cells* support, nourish, and protect the nerve cells of the cerebral cortex. The ***frontal lobes,*** just behind the forehead, are involved in speaking, muscle movements, and planning and making judgments. The ***parietal lobes,*** at the top of head and toward the rear, receive sensory input for touch and body position. The ***occipital lobes,*** at the back of the head, include visual areas. The ***temporal lobes,*** just above the ears, include auditory areas. Each lobe performs many functions and interacts with other areas of the cortex.

6-2. *Summarize some of the findings on the functions of the motor cortex and the sensory cortex, and discuss the importance of the association areas.*

The ***motor cortex,*** an arch-shaped region at the rear of the frontal lobes, controls voluntary muscle movements on the opposite side of the body. Body parts requiring the most precise control occupy the greatest amount of cortical space. In an effort to find the source of motor control, researchers have recorded messages from brain areas involved in planning and intention, leading to the testing of neural prosthetics for paralyzed patients. The ***sensory cortex,*** a region at the front of the parietal lobes, registers and processes body sensations. The most sensitive body parts require the largest amount of space in the sensory cortex.

The ***association areas*** are not involved in primary motor or sensory functions. Rather, they integrate and act on information processed by the sensory areas. They are involved in higher mental functions, such as learning, remembering, thinking, and speaking. Association areas are found in all four lobes. Complex human abilities, such as memory and language, result from the intricate coordination of many brain areas.

➤ Videos: Modules 7 and 32 of *The Brain* series, 2nd ed.: *Brain Anomaly and Plasticity: Hydrocephalus* and *Neurorehabilitation;* Program 4 of *Moving Images: Exploring Psychology Through Film*: *Brain Reorganization: Phantom Limb Sensation; Psychology: The Human Experience,* Modules 4 and 5: *A Case Study of Brain Damage* and *Brain Plasticity*
➤ Instructor Video Tool Kit: *Planning, Life Goals, and the Frontal Lobe; Language and Brain Plasticity; Rewiring the Brain*

6-3. *Discuss the brain's plasticity following injury or illness.*

Research indicates that some neural tissue can reorganize in response to damage. When one brain area is damaged, others may in time take over some of its function. For example, if you lose a finger, the sensory cortex that received its input will begin to receive input from the adjacent fingers, which become more sensitive. Our brains are most ***plastic*** when we are young children. *Constraint-induced therapy* rewires the brain by restraining a fully functioning limb and forcing use of the "bad hand" or the uncooperative leg. Eventually, the therapy reprograms the brain, improving the dexterity of a brain-damaged child or even an adult stroke victim. New evidence reveals that adult humans can also generate new brain cells. Monkey brains illustrate ***neurogenesis*** by forming thousands of new neurons each day.

➤ Exercise: Behavioral Effects of the Split-Brain Operation
➤ Exercise/Project: The Wagner Preference Inventory
➤ Project/Exercise: Hemispheric Specialization
➤ Lecture: The Wada Sodium Amobarbital Test
➤ Instructor Video Tool Kit: *The Split Brain: Lessons on Language, Vision, and Free Will; The Split Brain: Lessons on Cognition and the Cerebral Hemispheres*
➤ ActivePsych: *Scientific American Frontiers,* 3rd ed.: *Achieving Hemispheric Balance: Improving Sports Performance*
➤ PsychSim 5: Hemispheric Specialization
➤ Videos: Segment 7 of the Scientific American *Frontiers* series, 2nd ed.: *Severed Corpus Callosum;* Module 5 of *The Brain* series, 2nd ed.: *The Divided Brain*

Our Divided Brain

6-4. *Describe split-brain research.*

A ***split brain*** is one in which the ***corpus callosum,*** the wide band of axon fibers that connects the two brain hemispheres, has been severed. Experiments on split-brain patients have refined our knowledge of each hemisphere's special functions (called hemispheric specialization or *lateralization*). In the laboratory, investigators ask a split-brain patient to look at a designated spot, then send information to either the left or right hemisphere (by flashing it to the right or left visual field).

Right-Left Differences in the Intact Brain

6-5. *Describe the functions of our left and right hemispheres.*

Quizzing each hemisphere separately, researchers have confirmed that for most people, the left hemisphere is the more verbal and the right hemisphere excels in visual perception and the recognition of emotion. Studies of people with intact brains have confirmed that the right and left hemispheres each make unique contributions. For example, the left hemisphere makes quick, literal interpretations of language, and the right hemisphere excels in making inferences.

➤ Lectures: Left-Handedness; The Right Brain Movement
➤ Exercise: Handedness and Health

6-6. *Discuss research findings on brain organization and handedness.*

About 10 percent of us are left-handed. Almost all right-handers process speech primarily in the left hemisphere. Left-handers are more diverse. Seven in ten process speech in the left hemisphere and the rest either process speech in the right hemisphere or use both hemispheres. Left-handers are more numerous among those with reading disabilities, allergies, and migraine headaches. Left-handedness is also more common among musicians, mathematicians, professional baseball and cricket players, architects, and artists. The advantages and disadvantages of being a lefty seem roughly equal.

Roger Sperry sees the mind and brain as a holistic system: The brain creates and controls the emergent mind, which in turn influences the brain.