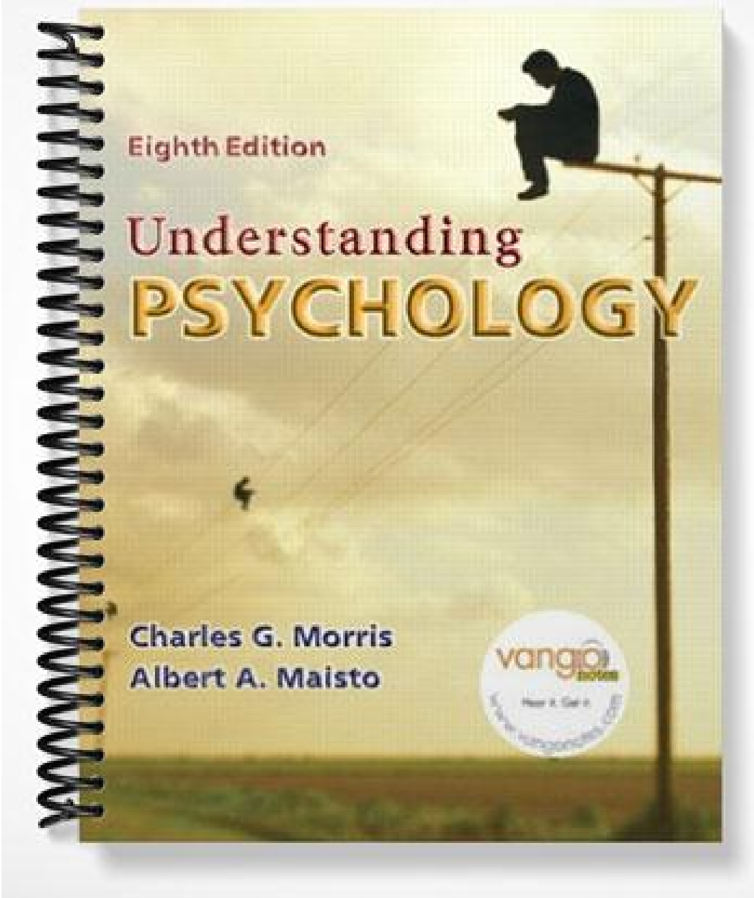
SOLUTIONS MANUAL



Chapter 2

The Biological Basis of Behavior

CHAPTER OUTLINE

I. Enduring Issues in the Biological Basis of Behavior
II. Neurons: The Messengers
  A The Neural Impulse
  B. The Synapse
  C. Neural Plasticity and Neurogenesis
III. The Central Nervous System
  A. The Organization of the Nervous System
  B. The Brain
  C. Hemispheric Specialization
  D. Tools for Studying the Brain
  E. The Spinal Cord
IV. The Peripheral Nervous System
V. The Endocrine System
VI. Genes, Evolution, and Behavior
  A. Genetics
  B. Behavior Genetics
  C. Social Implications
  D. Evolutionary Psychology

LEARNING OBJECTIVES

After reading this chapter, students should be able to:

1. Define the terms neuroscience and psychobiology.
2. Draw and describe all the components of a typical myelinated neuron. Trace the path of a neural impulse and explain what happens when the impulse reaches the terminal button.
3. Discuss the importance of glial cells.
4. Demonstrate and discuss both the resting membrane potential and the action potential.
5. Illustrate and describe the synapse. Identify the roles of various neurotransmitters and receptors, and explain how drugs can alter synapse function.
6. Discuss the importance of neural plasticity.
7. Diagram, label, and state the functions of the various parts of the inner right hemisphere.
8. Diagram, label, and state the functions of each component of the cerebral cortex.
9. Locate and state the various components of the limbic system.
10. Devise a split-brain experiment.
11. Compare and contrast the various tools available for studying the nervous system.
12. Trace a spinal cord reflex.
13. Compare and contrast the sympathetic and parasympathetic nervous systems.
14. Describe the functions of the endocrine system. Explain how hormones released by the endocrine system affect metabolism, blood-sugar level, sex characteristics, and the body’s reaction of stress.
15. Explain the relationship between chromosomes, genes, and DNA.
16. Distinguish between genotype and phenotype.
17. Outline the methods used by human behavioral geneticists.
18. Explain the concepts of dominant and recessive genes.
19. Discuss the social implications of behavior genetics.
20. Report how natural selection may influence human social behavior.

LECTURE SUGGESTIONS AND DISCUSSION TOPICS

Brain Metaphors

Metaphors are powerful tools in psychology, because they help us to understand systems that aren’t directly observable through reference to things that are more familiar and perhaps better understood (Weiner, 1991). Our understanding of the human brain and its activity has been helped through a reliance on metaphor. The metaphors used, however, have changed over time.

- Hydraulic models. Thinkers such as Galen and Descartes described the brain as a pneumatic/hydraulic system, relying on the “new-fangled” plumbing systems dominant during their lifetimes. Galen, for example, believed that the liver generated “spirits” or gases that flowed to the brain, where they then formed “animal spirits” that flowed throughout the nervous system. Descartes expanded on this view, adding that the pineal gland (the supposed seat of the soul) acted on the animal spirits to direct reasoning and other behaviors. In short, the brain was a septic tank, storing, mixing, and directing the flow of spirit gases throughout the body for the purposes of behavior and action.

- Mechanical and telephone models. With the advent of new technology came new metaphors for the brain. During the Industrial Revolution machine metaphors dominated, and in particular the brain was conceived as a complex mechanical apparatus involving (metaphorical) levers, gears, trip hammers, and pulleys. During the 1920s, the brain developed into a slightly more sophisticated machine resembling a switchboard; the new technology of the telephone provided a new metaphor. Inputs, patch cords, outputs, and busy signals (though no “call waiting”) dominated explanations of brain activity. This metaphor, however, faltered by viewing the brain as a system that shut down periodically, as when no one was dialing a number. We now know, of course, that the brain is continually active.

- Computer models. Current metaphors for the brain rely on computer technology. Input, output, memory, storage, information processing, and circuitry are all terms that seem equally suited to talking about computer chips or neurons. Although perhaps a better metaphor than plumbing or telephones, the computer model still has its shortcomings. As a descriptive device, however, this metaphor can at least suggest limits in our understanding and point the way to profitable areas of research.

McGuigan, F. J. (1994). Biological psychology: A cybernetic science. Englewood Cliffs, NJ: Prentice Hall.

Weiner, B. (1991). Metaphors in motivation and attribution. American Psychologist, 46, 921–930.

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.

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 more than a decade. What she has learned is that a stew of neurochemicals in the paraventricular nucleus, housed in the hypothalamus, plays a crucial role in helping to determine what we eat and when. Two in particular—Neuropeptide Y and galanin—help guide the brain's craving for carbohydrates and for fat.

Here's how they work. Neuropeptide Y (NPY) is responsible for turning on and off our desire for carbohydrates. Animal studies have shown a striking correlation between NPY and carbohydrate intake; the more NPY produced, the more carbohydrates eaten, both in terms of meal size and duration. Earlier in the sequence, the stress hormone cortisol seems responsible, along with other factors, for upping the production of Neuropeptide Y. This stress —> cortisol —> Neuropeptide Y —> carbohydrate craving sequence may help explain overweight due to high carbohydrate intake. But weight, and craving, rely on fat intake as well. Leibowitz has found that the neuropeptide galanin plays a critical role in this case. Galanin is the on/off switch for fat craving, correlating positively with fat intake; the more galanin produced, the heavier an animal will become. Galanin also triggers other hormones to process the fat consumed into stored fat. Galanin itself is triggered by metabolic cues resulting not only from burning fat as energy, but also from another source: estrogen.

Neuropeptide Y triggers a craving for carbohydrate, and 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.

Women, Men, and PETs

The 1990s were dubbed "the decade of the brain," and it is true that remarkable advances were made by the neurosciences in discovering how the brain operates. Several studies suggest that the operation of men's and women's brains may differ in significant ways.

For example, Ruben Gur and his colleagues at the University of Pennsylvania recorded PET scans of men and women who were asked to think of nothing in particular. That is, the research participants were instructed to relax and let their brains idle as they exerted as little mental effort as possible. The researchers found that for most participants the task was difficult to complete: PET scans revealed that these idle minds nonetheless hummed with activity. The locus of that activity, however, differed across the sexes. Men's brains often showed activity in the limbic system, whereas women's often showed activity in the posterior cyngulate gyrus. The meaning of these differences is difficult to interpret; the difficulty is compounded by the 13 men and 4 women who showed patterns of activity characteristic of their opposite-sex peers. As an early peek into the brain, however, they hint that the centers of activity for "blank" brains differ for women and men.

In a separate study, researchers at the University of California, Irvine, asked 22 men and 22 women to solve SAT math problems while undergoing a PET scan. Half of each group had SAT math scores above 700, whereas the other half had scores below 540. The temporal lobes of the 700+ men showed heightened activity during the math task, although this was not true for the women: the 700+ women's temporal lobes were no more intensively used than those of the 540-group women. Richard Haier, who helped lead the study, speculates that women in the top group might be using their brains more efficiently than women in the average-scoring group. More generally, although both men and women did well at the task, their brains were operating differently to accomplish it.

Ruben and Raquel Gur also studied men's and women's brains in response to emotional expressions. Shown pictures of either happy or sad faces, both men and women were quite adept at spotting happiness. Women, however, could identify sadness about 90% of the time, regardless of whether it was on the face of a man or a woman. By comparison, men were accurate in spotting sadness 90% of the time on a man's face, but only 70% of the time if the expression was posed by a woman. Once again, PET scans revealed that women's brains didn't have to work as hard at this task as did men's; in fact, women's limbic systems were less active than the limbic systems of the poor-scoring men.

There are a number of other differences between women's and men's brains. Women tend to have a larger corpus callosum than men, for example. Women may also have a higher concentration of neurons in their cortexes than men. But the meaning behind these differences is a matter far from decided.

Begley, S. (1995, March 27). Gray matters. Newsweek, pp. 48–54.

"Would You Like a Smoking or Non-Smoking Brain?..."

Most people who have tried to quit smoking report that it is at best a hit-or-miss proposition: a few days off the coffin nails, and the body dearly longs for that wispy blue smoke. Despite claims made by the tobacco industry, the culprit seems to be nicotine, an addictive substance that produces craving and withdrawal. Evidence from the Brookhaven National Laboratory suggests that nicotine alone may not be responsible for addiction to smoking. Rather, the action of certain enzymes in the brain may also contribute to the pleasures of cigarettes.

All addictive substances—cocaine, heroin, cigarettes—cause an increase in dopamine (a pleasure-enhancing neurotransmitter). Dr. Joanna Fowler led a research team that studied live images of smokers' and nonsmokers' brains. They found that an enzyme called monoamine oxidase B, or MAO B for short, was 40% less active in smokers. MAO B is responsible for breaking down dopamine. Therefore, when MAO B is inhibited, dopamine levels continue to remain high, which in turn allows smoking to remain pleasurable. The trick now is to find the ingredient in tobacco smoke that inhibits MAO B.

Oddly enough, these same findings may account for the fact that smokers are about half as likely as nonsmokers to develop Parkinson's disease, which is characterized by decreased dopamine levels. If smokers' dopamine remains high it may contribute to staving off the onset of Parkinson's. Although this observation is hardly a reason to start smoking, it at least suggests that drugs that are effective in treating Parkinson's disease might be adapted for use in treating smoking addiction.

Leary, W. E. (1996, February 22). Brain enzyme linked to smoking addiction. Austin American-Statesman, A5.

Understanding Hemisphere Function

It seems clear that parts of the brain are specialized to perform different functions. To some extent this is an old idea, dating back to the time of phrenology. Phrenologists believed that specific functions were localized to specific parts of the brain, and they developed elaborate maps showing the location of functions. Most importantly, they believed that well-developed functions were indicated by bumps in the skull, which could be palpated by the skilled phrenologist.

After phrenology was discredited, there was a great deal of doubt as to whether functions were localized in the brain. Much of the research in the early part of the 19th century seemed to suggest that the brain was diffusely organized and that specific functions were not localized. In fact, Paul Broca's (1861) description of a speech center localized in the frontal lobe on the left side of the brain is one of the first pieces of evidence for localization of a specific function in the brain. Broca based his localization of the speech area on his observations of a single individual who had lost his ability to speak many years earlier, while retaining the ability to understand what was said to him. At autopsy, Broca noted the area of most severe and enduring brain damage, and concluded that this part of the brain was responsible for the ability to speak.

At about the same time, two Prussian surgeons, Fritsch and Hitzig, were able to demonstrate that there is a specific area of the brain that controls movement (now called the motor cortex). Whereas Broca used the lesion method to arrive at his localization of what we now call a motor speech area, Fritsch and Hitzig used a primitive version of electrical brain stimulation to delineate areas of "excitable cortex," which meant cortex that triggered movements when stimulated. Fritsch and Hitzig used "galvanic stimulation" to delineate the extent of the motor cortex in dogs, and even did some electrical brain stimulation patients on dying soldiers with open head wounds during one of the Prussian Wars. They demonstrated that the motor cortex is confined to a specific strip of cortex in the back part of the frontal lobes in humans.

Many studies since then have confirmed that functions are localized to specific parts of the brain. Although present-day methods such as PET scan or fMRI have helped to refine our understanding of functional localization in the brain, much of our understanding of functional localization was arrived at through studies in the early twentieth century, mainly using the lesion method. The two "great wars" produced a large number of young men with brain injuries (mainly from gunshots). Researchers who looked at the relationships between the location of the injuries and the functions that were lost were able to map the localization of most of the major functions in the brain, including all of the major sensory and motor areas. Thus, although neuroscientists continue to refine our understanding of the ways that the brain carries out and integrates its multiple functions, the basic map of functions in the brain has been available for more than half a century.

Broca, P. (1861). Perte de la parole, ramollissement chronique et destruction partielle du lobe antérieur gauche du cerveau. Bulletin de la Société Anthropologique, 2, 235–238. (This paper has been translated into English by Christopher Green and is published in its entirety on Green's Classics in the History of Psychology Web site at http://psychclassics.yorku.ca/Broca/perte-e.htm)

Fritsch, G., & Hitzig, E. (1960). On the electrical excitability of the cerebrum. In G. Von Bonin (ed.), Some papers on the cerebral cortex. Springfield: Charles C. Thomas.

Psychophysiological Measurement

The text discusses various strategies for measuring activity in the brain, focusing especially on more recently developed techniques such as PET, SPECT, or MRI. There are, of course, other bodily systems and other techniques for measuring them, many of which rely on the electrophysical activity of the body.

- EMG—Electromyography. An electromyogram records the action potential given off by contracting muscle fibers. A common example is the recording of facial EMG, in which either inserted electrodes or surface electrodes record the activity of muscles as they pose various expressions.

- EGG—Electrogastrography. Electrogastrograms provide a record of smooth muscle activity in the abdomen. The contractions of the stomach or intestines, for example, can be measured by comparing the readings from a surface electrode attached to the abdomen with those of an electrode attached to the forearm. In the special case of measuring contractions in the esophagus, surface electrodes are attached to a balloon, which is "swallowed" by the person being measured. EGG may be used successfully to gain information about fear, anxiety, or other emotional states.

- EOG—Electrooculography. Readings from electrodes placed around the posterior of the eyes are the basis for EOG. Electrical signals result from both small saccadic eye movements as well as more gross movements that can be directly observed. EOG can be used for measuring rapid eye movements during sleep.

- EKG—Electrocardiography. EKG records changes in electrical potential associated with the heartbeat. Electrodes are placed at various locations on the body, and their recordings yield five waves that can be analyzed: P-waves, Q-waves, R-waves, S-waves, and T-waves. EKG may be used by psychologists to supplement observations relevant to stress, heart disease, or Type A behavior patterns.

- EDA—Electrodermal Activity. Formerly called galvanic skin response, skin resistance, and skin conductance, EDA refers to the electrical activity of the skin. As activity in the sympathetic nervous system increases, it causes the eccrine glands to produce sweat. This activity of the eccrine glands can be measured by EDA, regardless of whether or not sweat actually rises to the skin surface. The folklore of "sweaty palms" associated with a liar might be measured using this technique.

- EEG—Electroencephalography. As discussed in the text, EEG provides information about the electrical activity of the brain, as recorded by surface electrodes attached to the scalp. EEG has been used in a variety of ways to gather information about brain activity under a wide range of circumstances.

- Pneumography. Pneumographs measure the frequency and amplitude of breathing, and are obtained through a relatively straightforward procedure. A rubber tube placed around the chest expands and contracts in response to the person's inhalations and exhalations. These changes can then be recorded with either an ink pen or electrical signal.

McGuigan, F. J. (1994). Biological psychology: A cybernetic science. Englewood Cliffs, NJ: Prentice Hall.

En Garde! Dualism versus Monism

Rene Descartes certainly didn't lack for credentials. As the "Father of Rationalism," "Father of Modern Philosophy," and originator of Cartesian geometry, he had more than enough interests to fill his spare time. But his role as "Father of Skepticism" helped popularize a major change in thinking about the nature of human experience. Dualism, or the doctrine that mind and body are of two distinct natures, is one of the key philosophical problems inherited by psychology. In both philosophy and psychology there have been several attempts to reconcile the mind and body.

On the dualism side of the argument, psychophysical parallelism and psychophysical interactionism have been advanced as explanations for the workings of mind and body. Parallelism has it that mental and physical events are independent of one another but occur simultaneously. Philosophers such as Leibnitz, for example, held that the activities of the mind and body were predetermined, and that both simply ran their course in a carefully orchestrated, synchronized, yet independent fashion. Interactionists, on the other hand, hold that mental and physical events are related in a causal way, such that the mind can influence the body and vice-versa. Descartes championed this idea with his notion that humans are "pilots in a ship": mental beings who guide physical bodies through the world. Both psychophysical parallelism and psychophysical interactionism agree that the mind and body are of two different natures, and disagree over how closely those natures may interact.

Monists, by comparison, argue that there is one nature to things, although they disagree about whether it is primarily mental or primarily physical. Subjective idealism (or "mentalism," as it is often called) argues that there is only the mental world, and that the reality of the physical world is suspect. George Berkeley, for example, provided numerous arguments as to why the essence of existence is to be perceived; when not in direct perception, the physical world cannot support the claim of its existence. (Berkeley, by the way, apparently hated walks in the forest, for fear of all those falling trees that he may or may not have heard.) In contrast, materialistic monism takes the position that there is only physical "stuff" to the world, such that ideas, thoughts, and images are actually physical events in the body. Many modern biological scientists would agree with this form of monism, arguing that the brain is primary while the "mind" is either illusory or epiphenomenal.

Add to this mix a handful of specialty doctrines and you've got quite an argument. But why all the fuss? As research on mind and behavior grows to embrace evidence gathered in the neurosciences, what once was a stuffy philosophical issue takes on a new importance. Many thinkers, especially those in the materialist camp, would claim that we are closer and closer to identifying the neural connections and chemical actions that produce our experience of "an idea." Fueled by the boom in neural network modeling, the notion that the circuitry of the brain can be mapped to identify where thoughts, images, memories, creativity, and similar "mental activities" originate seems more like science and less like science fiction. Whether dualism will be completely resolved to everyone's satisfaction seems doubtful, but biopsychologists and neuropsychologists continue to contribute data to address this philosophical puzzle.

Dennett, D. C. (1991). Consciousness explained. Boston: Little, Brown, and Company.

McGuigan, F. J. (1994). Biological psychology: A cybernetic science. Englewood Cliffs, NJ: Prentice Hall.

Ryle, G. (1949). The concept of mind. London: Hutchinson.

The Phineas Gage Story

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 $1^{1}/_{4}$ inches at its base and a weight of $13^{1}/_{4}$ 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 $^{1}/_{4}$ inch in diameter.

The accounts of Gage’s frontal lobe damage and personality change are well-known, and are corroborated by Harlow’s presentation. Details of Gage’s subsequent life (he lived 12 years after the accident) are less known. Gage apparently tried to regain his job as a railroad foreman, but his erratic behavior and altered personality made it impossible for him 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, Gage eventually died, having suffered several more seizures. Although an autopsy was not performed, Gage’s relatives agreed to donate his skull and the iron rod (which Gage 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.

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.

Handedness, Eyedness, Footedness, Facedness

Although the title sounds like a Dr. Seuss rhyme, it actually denotes something sensible to neuroscientists. Most people are familiar with the concept of handedness. The human population is distributed across many people who are adept at using their right hands for most tasks, some who have greater skill using the left hand, and a smaller proportion of those who are equally skilled using either hand (or who alternate hands for certain tasks). The concepts of footedness, leggedness, eyedness, and facedness may be less familiar to the layperson, although they stem from the same principle as handedness.

The basis of these distinctions lies in the concept of laterality. Just as the cerebral hemispheres show specialization (e.g., left hemisphere language functions, right hemisphere visual-spatial functions), so too are there preferences or asymmetries in other body regions. The concept of eyedness, then, refers to the preference for using one eye over another, such as when squinting to site down the crosshairs of a rifle or to thread a needle. Footedness and leggedness similarly refer to a preference for one limb over the other; drummers and soccer players will attest to the importance of being equally adept at using either foot, and to the difficulty in achieving that. Finally, facedness refers to the strength with which information is conveyed by the right or left side of the face. It has been suggested that verbal information shows a right-face bias whereas emotional expressions are more strongly shown on the left side of the face, although these conclusions remain somewhat controversial.

Why are these distinctions useful? They play their largest role in the areas of sensation and perception, engineering psychology, and neuropsychology. Studies of reaction time, human-machine interaction, ergonomic design, and so on, take into account the preferences and dominances of some body systems over others. In the case of facedness and emotional expression, researchers are working to illuminate the link between facial expressions and cerebral laterality. Given the right hemisphere's greater role in emotional activities, the contralateral control between the right hemisphere and the left hemiface becomes an important proving ground for investigating both brain functions and the qualities of expression.

Borod, J. C., Caron, H. S., & Koff, E. (1981). Asymmetry of facial expression related to handedness, footedness, and eyedness: A quantitative study. Cortex, 17, 381–390.

Ekman, P., Hagar, C. J., & Friesen, W. V. (1981). The symmetry of emotional and deliberate facial actions. Psychophysiology, 18, 101–106.

Friedlander, W. J. (1971). Some aspects of eyedness. Cortex, 7, 357–371.

McGuigan, F. J. (1994). Biological psychology: A cybernetic science. Englewood Cliffs, NJ: Prentice Hall.

Sackheim, H. A., Gur, R. C., & Saucy, M. C. (1978). Emotions are expressed more intensely on the left side of the face. Science, 202, 434–436.

Hey, Simpleton!

"The culmination of evolution." "Master of the universe." "Erect-walking swell young fops." There's no shortage of appellations humans heap upon themselves in recognition of their arguably advanced position among the species. Some genetic research suggests, however, that the praise might be premature.

Francis Collins and Eric Lander, researchers working with data from the National Human Genome Research Institute, led a team that discovered that humans have about 20,000 to 25,000 genes, fewer than the 30,000 to 40,000 they had previously estimated in 2001. Big deal? Yeah, sort of. A flowering houseplant has about 20,000 to 25,000 genes. As does a small worm. So, worm-boy, there's your genetic company: We're about as genetically complex as other not-so-complex living things.

So why isn't a worm writing this piece? (Hey, watch it!) Because clearly it's not just the parts, but rather how those parts are assembled, that makes a difference. Granted, these are only the genes that tell cells how to make proteins, but some of those genes make multiple proteins, and some make more complex proteins. Some of our biological complexity, then, comes from combinations of proteins rather than individual proteins, so it's somewhat a case where "less is more."

By the way, in case you're curious: Rice has about 40,000 genes; corn, about 50,000. But at least we've got the fruit fly's 13,600 genes beat ... by a little.

Ritter, M. (October 21, 2004). Human complexity built with fewer genetic bricks. Austin American-Statesman, A1, A13.

DISCUSSION TOPICS

- How might the structure and function of the central nervous system be different if neural impulses could travel both directions in a neuron?

- We have seen that each cerebral hemisphere is responsible for somewhat different functions, although typically the two hemispheres work together. How might our knowledge of hemispheric specialization be put to some sort of practical use?

- How might the human race (or human behavior) be different if we had evolved with a dominant right hemisphere?

- Should people with genetic abnormalities associated with psychological disorders be prohibited from reproducing? If so, which disorders? What if they are just carriers of a recessive gene? Should people routinely be screened for genetic problems before having children?

- After reading Chapter 2, you are aware that the frontal lobes and portions of the limbic system are important in the control of emotions. Surgery that severs the connections to and from these portions of the brain or surgery that removes them (partially or entirely) can have a profound effect on behavior. Similarly, electrically stimulating these portions of the brain can have a significant effect on behavior. Under what circumstances (if any) do you think psychosurgery or electrical stimulation of people's brains might be warranted? Should those with a chronic history of criminal offenses be treated with psychosurgery or electrical brain stimulation? What do you think of psychosurgery or brain stimulation as an alternative to the death penalty?

- Chapter 2 alludes to an interesting phenomenon: In almost all higher organisms, sensory information from the left side of the body goes to the right half of the brain and vice versa. Moreover, motor control of the left side of the body occurs in the right half of the brain, and vice versa. Two prominent physiologists once said, "No one has the remotest idea why there should be this amazing tendency for nervous system pathways to cross."

DEMONSTRATIONS AND ACTIVITIES

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 placed end-to-end in sequence on top of the dominoes. By placing the all-domino row and the stick-domino row parallel to each other and pushing the first domino in each, you can demonstrate how much faster the action potential can travel if it can jump from node to node rather than having to be passed on sequentially, single domino by single domino. Ask your students to discuss how this effect relates to myelinization.

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

Hemispheric Communication and the Split Brain

Even after reading the textbook and listening to your lecture, many students may have difficulty conceptualizing the effects of a split-brain operation on an individual's behavior. Morris (1991) described five activities designed to simulate the behavior of split-brain patients. All of the activities have the same basic setup. You will need to solicit two right-handed volunteers and seat them next to each other at a table, preferably in the same chair. The volunteer on the left represents the left hemisphere, and the other student is the right hemisphere. The students are instructed to place their outer hands behind their backs and their inner hands on the table with their hands crossed, representing the right and left hands of the split-brain patient. Finally, the student representing the right hemisphere is instructed to remain silent for the remainder of the activity. In one of the activities described by Morris, both students are blindfolded and a familiar object (Morris suggested a retractable ball-point pen) is placed in the left hand of the "split-brain patient" (the hand associated with the right hemisphere). Then ask the "right hemisphere" student if he or she can identify the object, reminding him or her that they must do so nonverbally. Next, ask the "right hemisphere" to try to communicate, without using language, what the object is to the "left hemisphere." Your more creative volunteers may engage in behaviors that attempt to communicate what the object is through sound or touch. If your "right hemisphere" has difficulty in figuring out how to communicate, ask the class for suggestions. This demonstration can be used to elicit discussion about why only the "left hemisphere" student can talk, the laterality of the different senses, and how split-brain patients are able to adjust their behavior to accommodate. You should refer to Morris's original article for descriptions of the other activities.

Morris, E. J. (1991). Classroom demonstration of behavioral effects of the split-brain operation. Teaching of Psychology, 18, 226–228.

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.

Hemispheric Lateralization

Kemble (1987) described three demonstrations designed to illustrate cerebral lateralization. One of these demonstrations explores the cerebral lateralization of language. This demonstration requires a wooden dowel stick (about 1.25 cm in diameter and 92 cm long), a stopwatch, and several difficult verbal problems (for example, reciting the alphabet backwards or spelling a long word backwards). After identifying a student volunteer, he or she is given between 5 and 10 minutes to practice balancing the dowel on the index finger of both hands. Approximately the same amount of time should be spent practicing with each hand. Following the practice period, the student is then asked to balance the dowel eight times, four per hand in a variable order, and the amount of time that he or she balances the dowel is recorded. However, during half of the trials for each hand, the student is asked to perform one of the verbal problems out loud, while the other trials are conducted in silence. Since the verbal task requires a high degree of activity in the left hemisphere, and the left hemisphere controls the right hand, the competition between the verbal and motor activity will consistently result in a decrease in balancing time for the right hand compared to that of the left hand when performing the verbal task. Kemble also suggested comparing the performance of male and female subjects since gender differences are often observed in this demonstration. This can provide an opportunity to discuss how and why these gender differences occur. The other demonstrations described by Kemble illustrate the effects of cerebral lateralization on pattern recognition.

Kemble, E. D. (1987). Cerebral lateralization. In V. P. Makosky, L. G. Whittemore, & A. M. Rogers (Eds.), Activities handbook for the teaching of psychology, Vol. 2 (pp. 33–36). Washington, DC: American Psychological Association.

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.

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 him or her. 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.

The Dollar Bill Drop

After engaging in the neural network exercise, consider 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 divide themselves 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 quickly 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.

Reaction Time and Neural Processing

Yet another exercise that illustrates the speed of neural processing is suggested by Harcum (1988). The point made by this simple but effective exercise is that reaction times increase as more response choices become available (i.e., because more difficult choices in responses involve more neuronal paths and more synapses, both of which slow neural transmission). Depending on your class size, recruit two equal groups of students (10 to 20 per group is ideal) and have each group stand together at the front of the room. First, explain that all subjects are to respond as quickly as possible to the name of a U.S. President. Then, give written instructions to each group so that neither group knows the instructions given to the other. One group should be instructed to raise their right hands if the president served before Abraham Lincoln and to raise their left hands if the president served after Lincoln. The other group should be instructed simply to raise their left hands when they a hear a president's name. Ask participants and audience members to note which group reacts more quickly. When all students are poised and ready to go (i.e., hands level with shoulders and ready to raise), say "ready?" and then "Ford." The group with the simpler reaction time task will be obviously faster than the group whose task requires a choice.

Harcum, E. R. (1988). Reaction time as a behavioral demonstration of neural mechanisms for a large introductory psychology class. Teaching of Psychology, 4, 208–209.

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.

DEBATE

Are Genetic Explanations for ADHD Faulty?

Attention Deficit Hyperactivity Disorder (ADHD), like Attention Deficit Disorder (ADD), has been increasingly diagnosed among schoolchildren, adolescents, and even adults. The origins of ADHD remain a matter of some debate. Although there is evidence that genetics plays a substantial role in the development of ADHD, not all researchers agree on the extent of its influence. Some writers, in fact, prefer to devote more attention to exploring social and psychological explanations for the disorder. Given that many disorders (e.g., schizophrenia, depression) have revealed their genetic underpinnings (and that substantial research money and time have been allocated to pursuing these explanations), the origins of ADHD offer a case for further discussion. Ask your students to become conversant with the arguments on both sides of this issue.

Slife, B. (2003). Taking sides: Clashing views on controversial psychological issues (13th ed.). Guilford, CT: Dushkin Publishing Group.

STUDENT ASSIGNMENTS

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, much like Figure 2-6 in the text) on a clean white sheet of unlined paper. For each of the following sections of the brain, students should color (using map pencils) 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.

Reunited Twins

Although twin studies (particularly studies of identical twins reared apart) seem to confirm genetic links to intelligence, psychological disorder, and some complex personality traits, critics become skeptical when the same research reveals eerie (and ostensibly genetically-based) similarities between twins on such things as aftershave brand, selection of hobbies, attraction to tattoos, and even child name preferences. Although amazing behavioral similarities do indeed turn up between identical twins raised apart (see Rosen, 1987), Wyatt and his colleagues (1994) suggest that, rather than being genetically based, these similarities are merely selected examples of coincidences that are inevitable given the hundreds or even thousands of questions typically asked of reunited twins by eager researchers. In other words, it is likely that similar "amazing" coincidences would be found if genetically unrelated people were asked a large number of questions about their behavior.

To illustrate this point, Lester Sdorow (1994) designed the "Identical Twins Reunited Questionnaire" and accompanying exercise. For this assignment, students should first read the articles by Rosen (1987) and Wyatt et. al (1994); you can put these on reserve in the library. Next, you'll need to distribute one copy of the ITRQ to each student. Handout 2-1 contains the questionnaire (which, as you can see, asks students about their behaviors, relationships, and characteristics) along with instructions for the assignment. After students have completed their surveys, you should collect them and identify pairs of students who are the most similar. [Note: You may want to take the surveys home with you and present the results during the next class period.] Once you have described for your class the "reunited twins" among them, instruct them to write a 2–3 page paper discussing how the results from the class study bear on the rationale for reunited twin studies. Ask students to incorporate into their papers insights from the Wyatt et al. study and an additional reference of their choosing from Psychological Abstracts. [Note: This assignment can also be used in Chapter 10, which covers personality.]

Rosen, C. M. (1987, September). The eerie world of reunited twins. Discover, pp. 36–46.

Sdorow, L. (1994). The Frankenstein course: Teaching assistants, laboratory exercises, and papers in introductory psychology. Paper presented at the Southwest Regional Conference for Teachers of Psychology, Fort Worth. Used by permission of the author.

Wyatt, W. J., Posey, A., Welker, W., & Seamonds, C. (1984). Natural levels of similarities between identical twins and between unrelated people. The Skeptical Inquirer, 9, 62–66.

Psychology in Literature: The Man Who Mistook His Wife for a Hat

Oliver Sacks's (1985) 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: HarperCollins.

VIDEO

The Autonomic Nervous System (28 min, FHS). Describes the role of the autonomic nervous system in controlling the glands and organs. It also addresses how meditation, autosuggestion, and hypnosis can be used to control autonomic functions.

Biology and Behavior (1980, 22 min, PENN). Examines the biological roots of behavior, including close-ups on classic issues such as nature vs. nurture and basic studies in taste aversion, imprinting, and instinctive drift.

Biology of Behavior (1990, 30 min, IM). This video gives an overview of the nervous system, including material on neurotransmitters, neurons, and the fight or flight response.

The Birth of a Brain (1983, 33 min, CRM). Hereditary and environmental influences on brain development are emphasized. A live birth may make this film unsuitable for less mature audiences.

The Brain, Part 1: The Enlightened Machine (1984, 60 min, ANN/CPB). Gives an overview of the study of the brain from Franz Gall to the present and reviews neurotransmitters functioning at the synapse.

The Brain, Part 6: The Two Brains (1984, 60 min, ANN/CPB). Explores split-brain studies and what they indicate about hemispheric functioning, the relationship between thought and language, and the issues of sex differences in the brain.

The Brain, Part 8: States of Mind (1984, 60 min, ANN/CPB). The limits of our knowledge about the brain are the focus of this program. Research in genetics, artificial intelligence, and medicine are discussed to shed light on this mysterious gray lump.

Teaching Modules from The Brain (30 segments from The Brain series, ANN/CPB). These self-contained modules offer brief glimpses into the lives of split-brain patients, the story of Phineas Gage, the brain basis of schizophrenia, REM, speech, and aspects of stress and health.

The Brain (50 min, IM). This BBC program uses animation and models of the brain to tour the structures and functions of the brain.

The Brain (23 min, FHS). This "Brain" begins with an exploration of dreams, follows with a detailed look at the nervous system and how it works, and ends with a discussion of EEG and NMRI as techniques for peering into the brain.

The Brain (28 min, FHS). And this "Brain" takes a cellular approach. The relationship between cell assemblies and complex processes such as hearing, vision, and language form the focus of this video.

Brain Sex (1993, 3 volumes, 150 min total, IM). Differences between the sexes in areas such as learning, appetite, expectations, and behavior are examined. Parts of this 3-volume set can be profitably used in a variety of contexts.

Brain Story (50 min each, FHS). This 6-part series, produced by the BBC, takes a fascinating look at current and recent brain science. Videos include The Biochemistry of Feelings, How the Brain Develops, How the Brain Sees the World, and What Is Consciousness?

Chemistry of Love (1985, 30 min, IM). Love, lust, and fidelity may have as much to do with evolution as they do with societal norms. This video explains why.

Discovering Psychology, Part 3: The Behaving Brain (2000, 30 min, ANN/CPB). Provides an overview of brain structure and function through a description of the biochemical reactions involved in thoughts, feelings, and actions.

Discovering Psychology, Part 4: The Responsive Brain (2000, 30 min, ANN/CPB). Explores the interaction between the development of brain structures and function and the environment.

Discovering Psychology, Part 14: The Mind Hidden and Divided (2000, 30 min, ANN/CPB). Examines the influence of the subconscious mind on thought and behavior. The segment on the split-brain phenomenon is relevant to this chapter.

Discovering Psychology, Part 25: A Union of Opposites (2000, 30 min, ANN/CPB). A unique approach to a seldom addressed topic, this program presents "a yin-yang model of complementary opposites" to facilitate an understanding of the basic principles thought to govern human nature and animal behavior. A useful means of addressing the nature-nurture debate.

Endocrine Control: Systems in Balance (1997, 30 min, IM). This video focuses on the endocrine system's role in regulating and controlling other bodily systems.

Epilepsy: Breaking the Barrier (28 min, FHS). Footage of grand mal seizures in progress bring home the often debilitating affliction of epilepsy. Various treatments, including drug therapy and surgical interventions, are described.

Hormones (28 min, FHS). Illustrates the role of hormones in controlling a variety of bodily functions.

The Human Brain (1997, 25 min, IM). The focus of this video is that brain functioning can be enhanced by the proper environment. Recovery from brain injury, brain surgery techniques, and silicon retinas are used as examples.

Inside Information: The Brain and How It Works (58 min, FHS). This award-winning film contains interviews with leading researchers, who discuss how and why the brain works, and works as it does. Pattern recognition, computer analogs, and individual brain structures are also discussed.

Is Your Brain Really Necessary? (1988, 50 min, FHS). This must-see video follows the lives of three people who have undergone drastic brain surgery (e.g., hemispherectomies). Their subsequent levels of functioning should prove illuminating to your students.

Journey to the Centers of the Brain (5 Parts, 58 min each, FHS). This series explores different topics related to the brain. For example, The Electric Ape looks at brain structure and function, whereas Bubble Bubble Toil and Trouble examines neural circuitry, and Through a Glass Darkly looks at brain imaging techniques.

Left Brain, Right Brain (1979, 56 min, FLI). Norman Geschwind narrates this intriguing look at hemispheric specialization. Wada tests and split-brain operations illustrate the semi-independent functioning of the hemispheres.

Living with Tourette's (24 min, PENN). Combines case studies of individuals with Tourette's syndrome with an examination of chemical imbalances in the brain associated with the disorder.

The Mind: Development (60 min, PBS). Focusing on particular brain cells, this program (part of a 9-part series) examines brain development from conception to age six.

Mind Games (Brain Functions) (1999, 30 min, IM). The focus here is on the effects of trauma, disease, and mental illness on the brain. Scanning techniques and methods of "repairing" the brain are highlighted.

Nerves (1992, 24 min, IM). As the title suggests, this video is a bundle of nerves. Action potentials, synapses, agonists and antagonists, brain slices, and neurons all take a bow.

Nervous System (1993, 14 min, IM). Using animation, this program demonstrates the action potential and neurotransmitter activity. It also discusses disorders of the nervous system, including Alzheimer's disease, Parkinson's disease, depression, and anxiety.

The Neural Connection (1997, 30 min, IM). Receptors galore: Thermoreceptors, chemoreceptors, mechanoreceptors, nocireceptors, and photoreceptors display their charms to teach about neural connections and neural impulses.

Neuron and Neural Transmission (2001, 30 min, IM). The structure of neurons and their ability to communicate with one another are the focus of this video. Of special interest is a discussion of how neurological disorders disrupt neural communication.

Neuropsychology (23 min, FHS). How a tangled collection of cells produces memory, emotion, language, and thought is the subject of this film. Particular attention is given to recognizing facial expressions and intellectual functioning.

The Secret Life of the Brain (2002, 60 min, IM). This 5-part series examines how the brain develops from birth through old age.

Sex Hormones and Sexual Destiny (26 min, FHS). Examines the role of hormones on "masculine" and "feminine" behavior, sex differences in brain structure, and environmental influences on male and female behavior.

Split-Brain and Conscious Experience (18 min, PENN). Discusses the pioneering work conducted by Michael Gazzaniga on the split-brain phenomenon using epileptic patients with severed corpus callosums.

Two Brains (1984, 55 min, ANN/CPB). Hemispheric specialization and split-brain surgery is highlighted. A woman with a severed corpus callosum is featured.

Who Are You? (60 min, FHS). Genetic influences on behavior are reviewed through an examination of several twin studies. Also included are case studies of individuals, such as the sober son of an alcoholic who fears taking a drink.

MULTIMEDIA

Video Classics

Probing the Cerebral Cortex

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.

Web Links

Amazing Case of Phineas Gage
http://www.epub.org.br/cm/n02/historia/phineas.htm
Account by Renato M. E. Sabbatini, Ph.D., published in the online journal Brain & Mind.

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.

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

Biological and Physiological Resources

http://psych.athabascau.ca/html/aupr/biological.shtml

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

Biological Psychology

http://www.csuchico.edu/psy/BioPsych/definition.html

Information about the field from the biological psychologists at California State University, Chico.

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 & Mind—Electronic Magazine on Neuroscience

http://www.epub.org.br/cm/

Includes a wealth of short articles devoted to the brain.

Brain Briefings—Society for Neuroscience

http://www.sfn.org/content/Publications/BrainBriefings/index.html

A series of 2-page reports that describes clinical applications of basic neuroscience research. Includes reports in the following areas: brain injury, brain mechanisms, development, drugs, eating, emotions, exercise, gender, memory, nervous system disorders and diseases, nervous system repair, pain, the senses, sleep, and technology.

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.

Central Nervous System—CliniWeb International

http://www.ohsu.edu/cliniweb/A8/A8.186.html

Lots of links to information about the central nervous system. See MRI images, link to research labs, and learn about the brain and spinal cord.

Comprehensive Behavioral and Cognitive Sciences

http://mentalhelp.net/guide/pro02.htm

Includes theory and therapy. This site includes Web links with descriptions and ratings of each source. Useful for spicing up your lectures or for more detailed study by your students.

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.

Dogma Overturned

http://www.sciam.com/1998/1198issue/1198infocus.html

Upending a long-held theory, a study finds that humans can grow new brain neurons throughout life—even into old age. Research summary published in Scientific American.

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.

fMRI Reveals the Brain Areas Involved in Working Memory

http://www.nimh.nih.gov/events/prfmri.htm

An NIH press release (April 9, 1997) describing how functional magnetic resonance imaging (fMRI) has been used to delineate brain areas involved in working memory.

Functional Divisions of the Cerebral Cortex

http://faculty.washington.edu/chudler/functional.html

Succinct information about the location and functions of the major functional subdivisions of the cerebral cortex, presented by Eric Chudler. Link to self-test available at the end (not interactive; print it out):

http://faculty.washington.edu/chudler/pdf/revcort.pdf

(You must have Adobe Acrobat to view and print the quiz.)

Harvard Brain

http://www.hcs.harvard.edu/~husn/BRAIN/index.html

The brains behind Harvard University? No, just a journal published by the Harvard Undergraduate Society for Neuroscience.

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.

How Do Nerve Cells Communicate?

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

Information prepared by the Society for Neuroscience.

The Human Brain: A Learning Tool

http://uta.maymt.edu/~psychol/brain.html

These close-up pictures of the brain's lobes can be added to your classroom presentations. Link to this site, turn on your classroom's media projector, and let the action begin.

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

Localization of Function Exercise

http://www.gpc.peachnet.edu/~bbrown/psyc1501/brain/locfunct.htm

Allows students to simulate the effects of stimulating the brain, recording electrical activity from the brain, or creating lesions in the brain, then to try to figure out the functions of various parts of the brain based on the data they have collected. Developed by Dr. Barbara Brown of Georgia Perimeter College.

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.

Mapping the Brain

http://www.epub.org.br/cm/n03/tecnologia/eeg.htm

Article on the use of various methods of recording brain activity to map the location of functional areas of the brain, by Renato Sabbatini, Ph.D. Published in the online journal Brain & Mind.

Neural Processes Tutorial

http://psych.hanover.edu/Krantz/neurotut.html

An excellent interactive animated tutorial.

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.

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 they 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.

PET Scan: A New Window into the Brain

http://www.epub.org.br/cm/n01/pet/pet.htm

Article on uses of the PET scan to study brain function, by Renato Sabbatini, Ph.D. Published in the online journal Brain & Mind.

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.

Practice Quiz

http://www.gpc.peachnet.edu/~bbrown/psyc1501/brain/quiz.htm

Covers material from the “Neurons, Hormones, and the Brain” chapter of the Wade and Tavris text. Prepared by Barbara Brown of Georgia Perimeter College.

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.”

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.

Split Brain Consciousness

http://www.macalester.edu/~psych/whathap/UBNRP/Split_Brain/Split_Brain_Consciousness.html

Nice summary of information on the effects of cutting the corpus callosum, with links to further information on split brain experiments and hemispheric specialization.

Synapses

http://www.gpc.peachnet.edu/~bbrown/psyc1501/brain/synapses.htm

Contains basic information about synapses and an animation of neurotransmitter release and binding to receptors at a synapse.

Views of the Brain

http://rpiwww.mdacc.tmc.edu:80/se/anatomy/brain/

Gross anatomical photographs of left, right, anterior, superior, and inferior views of the brain.

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 Happened to Phineas?

http://www2.mc.maricopa.edu/anthro/origins/phineas.html

The story of Phineas Gage, as told by James Shreve.

What Is Mind?

http://www.epub.org.br/cm/n04/editori4_i.htm

Article about the relationship between mind and brain, by Silvia Helena Cardoso, Ph.D. Published in the online journal Brain & Mind.

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.

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.

TRANSPARENCIES

HANDOUT 2-1: Reunited Twins Assignment

Research on identical twins who have been reunited later in life after having been separated in infancy has revealed some amazing similarities. But researchers typically ask the reunited twins hundreds or even thousands of questions. Perhaps their amazing similarities are coincidences and not attributable to their identical heredity. This questionnaire has been designed to assess whether unrelated persons will also be similar in unusual ways or in several not-so-unusual ways. The results of this questionnaire will be announced in class. For this assignment, you will write a brief paper discussing the findings. Did students show surprising similarities? If so, what are some of the possible explanations? What does this say about research on identical twins who have been reunited?

IDENTICAL TWINS REUNITED QUESTIONNAIRE

Instructions: Give your response to the following questions; if you prefer not to answer a particular question, feel free to leave it blank.

1. Academic major: ______________________________
2. Favorite musical group/performer: ______________________________
3. Mother's name: ______________________________
4. Favorite dessert: ______________________________
5. Boyfriend's/girlfriend's first name: ______________________________
6. Favorite television show: ______________________________
7. Political affiliation: (Dem/Rep/Ind/Other): ______________________________
8. Favorite food: ______________________________
9. Favorite actor: ______________________________
10. Favorite actress: ______________________________
11. Favorite movie: ______________________________
12. Favorite hobby: ______________________________
13. Favorite sport to watch: ______________________________
14. Favorite sport to play: ______________________________
15. Favorite professional sports team: ______________________________
16. Favorite author: ______________________________
17. Father's name: ______________________________
18. Most distinctive habit: ______________________________
19. Favorite politician: ______________________________

20. Favorite professional athlete: ______________________________

21. Most disliked food: ______________________________

22. Favorite automobile: ______________________________

23. Favorite kind of pet animal: ______________________________

24. Professional goal: ______________________________

25. Most recent non-course book read: ______________________________

Sdorow, L. (1994). The Frankenstein course: Teaching assistants, laboratory exercises, and papers in introductory psychology. Paper presented at the Southwest Regional Conference for Teachers of Psychology, Fort Worth. Reprinted by permission of the author.