

INTRODUCTION TO  
PSYCHOLOGY

LOUIS 

# Introduction to Psychology



# INTRODUCTION TO PSYCHOLOGY

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## The Creation of This Book

This textbook was created as part of the Interactive OER for Dual Enrollment project, facilitated by [LOUIS: The Louisiana Library Network](#) and funded by a \$2 million [Open Textbooks Pilot Program grant from the Department of Education](#).

This project supports the extension of access to high-quality post-secondary opportunities to high school students across Louisiana and beyond by creating materials that can be adopted for dual enrollment environments. Dual enrollment is the opportunity for a student to be enrolled in high school and college at the same time.

The cohort-developed OER course materials are released under a license that permits their free use, reuse, modification and sharing with others. This includes a corresponding course available in [MoodleNet](#) and [Canvas Commons](#) that can be imported to other Learning Management System platforms. For access/questions, contact [Affordable Learning Louisiana](#).

If you are adopting this textbook, we would be glad to know of your use via this [brief survey](#).

## Review Statement

This textbook and its accompanying course materials went through at least two review processes:

- Peer reviewers, coordinated by Jared Eusea, River Parish Community College, used an online course development standard rubric for assessing the quality and content of each course to ensure that the courses developed through Interactive OER for Dual Enrollment support online learners in that environment. The evaluation framework reflects a commitment to accessibility and usability for all learners.
  - Reviewers
    - Jared Eusea
    - Nicole Shaw
    - Danielle Williams
- The Institute for the Study of Knowledge Management in Education (ISKME) collaborated with LOUIS to review course materials and ensure their appropriateness for dual enrollment audiences. Review criteria were drawn from factors that apply across dual enrollment courses and subject areas, such as determining appropriate reading levels, assessing the fit of topics and examples for high school DE students; applying high-level principles for quality curriculum design, including designing for

accessibility, appropriate student knowledge checks, and effective scaffolding of student tasks and prior knowledge requirements, addressing adaptability and open educational practices, and principles related to inclusion and representational social justice.

- Reviewers
  - Thadius Batiste
  - Tremika Cleary

# INTRODUCTION

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Is Psychology a science? What do our dreams really mean? What causes and treats mental illness? What factors are involved in human behavior? This text aims to answer these questions along with many others. A comprehensive review of the behavior of humans as well as other animals will be provided through each chapter. Topics such as learning, memory, emotions, behavioral disorders, and personality will be explored. The purpose of this text is to provide you with general information in Psychology, which will contribute to your overall body of knowledge.

Upon successful completion of this course, the student will be able to:

- Describe ethical principles that guide psychologists in research and therapy.
- Describe Psychology as a science and identify research methods in Psychology.
- Summarize historical and contemporary theoretical perspectives in Psychology.
- Identify factors in physiological and psychological processes involved in human behavior.
- Describe relations among individuals, groups, and society utilizing discipline-specific terminology.

# ADAPTATION STATEMENT

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*Introduction to Psychology* was created by Burt Ashworth, Sonia Cooper, Manyu Li, Ashley Ojo, Bhrea' Vavasseur, and Michael Waller through the Interactive OER for Dual Enrollment Introduction to Psychology Cohort, from LOUIS: The Louisiana Library Network and the Louisiana Board of Regents, funded through an Open Textbooks Pilot grant from the Fund for the Improvement of Postsecondary Education, U.S. Department of Education, 2021–2022. Most content was adapted and remixed from other open textbooks, as indicated below. Unless stated otherwise, *Introduction to Psychology* (c) 2022 is licensed under a [Creative Commons-Attribution-NonCommercial-ShareAlike 4.0 International license](#).

In *Introduction to Psychology*, gender-neutral language (they/their) has been used intentionally. In addition, while general ideas and content may remain unchanged from the sources from which this adapted version is based, word choice, phrasing, and organization of content within each chapter may have changed.

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## **Introduction to Psychology**

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Adaptations:

- Chapter title changed to “The Science of Psychology”
- Chapter sections reorganized.
- Added chapter learning objectives
- Edited sections’ learning objectives.
- Added a new paragraph on the scientific method and a figure to demonstrate the scientific process.

## Physiological Aspects of Psychology

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## PART I

## INTRODUCTION TO PSYCHOLOGY



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Clive Wearing is an accomplished musician who lost his ability to form new memories when he became sick at the age of 46. While he can remember how to play the piano perfectly, he cannot remember what he ate for breakfast just an hour ago (Sacks, 2007). James Wannerton experiences a taste sensation that is associated with the sound of words. His former girlfriend’s name tastes like rhubarb (Mundasad, 2013). John Nash is a brilliant mathematician and Nobel Prize winner. However, while he was a professor at MIT, he would tell people that the *New York Times* contained coded messages from extraterrestrial beings that were intended for him. He also began to hear voices and became suspicious of the people around him. Soon thereafter, Nash was diagnosed with schizophrenia and admitted to a state-run mental institution (O’Connor & Robertson, 2002). Nash was the subject of the 2001 movie *A Beautiful Mind*. Why did these people have these experiences? How does the human brain work? And what is the connection between the brain’s internal processes and people’s external behaviors? This textbook will introduce you to various ways that the field of psychology has explored these questions.



1.

# WHAT IS PSYCHOLOGY?

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## Learning Objectives

By the end of this section, you will be able to:

- Understand the etymology of the word “psychology”
- Define psychology
- Understand the merits of an education in psychology

**Psychology** is defined as *the scientific study of mind and behavior*. In Greek mythology, Psyche was a mortal woman whose beauty was so great that it rivaled that of the goddess Aphrodite. Aphrodite became so jealous of Psyche that she sent her son, Eros, to make Psyche fall in love with the ugliest man in the world. However, Eros accidentally pricked himself with the tip of his arrow and fell madly in love with Psyche himself. He took Psyche to his palace and showered her with gifts, yet she could never see his face. While visiting Psyche, her sisters roused suspicion in Psyche about her mysterious lover, and eventually, Psyche betrayed Eros’ wishes to remain unseen to her. Because of this betrayal, Eros abandoned Psyche. When Psyche appealed to Aphrodite to reunite her with Eros, Aphrodite gave her a series of impossible tasks to complete. Psyche managed to complete all of these trials; ultimately, her perseverance paid off as she was reunited with Eros and was ultimately transformed into a goddess herself (Ashliman, 2001; Greek Myths & Greek Mythology, 2014).



Antonio Canova's sculpture depicts Eros and Psyche.

Psyche comes to represent the human soul's triumph over the misfortunes of life in the pursuit of true happiness (Bulfinch, 1855); in fact, the Greek word **psyche** means *soul*, and it is often represented as a butterfly. The word **psychology** was coined at a time when the concepts of soul and mind were not as clearly distinguished (Green, 2001). The root **-ology** denotes *the scientific study of*, so the term *psychology* refers to the scientific study of the mind. Since science studies only observable phenomena and the mind is not directly observable, we expand this definition to the scientific study of mind and behavior.

The scientific study of any aspect of the world uses the scientific method to acquire knowledge. To apply the scientific method, a researcher with a question about how or why something happens will propose a tentative explanation, called a hypothesis, to explain the phenomenon. A hypothesis is not just any explanation; it should fit into the context of a scientific theory. A **scientific theory** is *a broad explanation or group of explanations for some aspect of the natural world that is consistently supported by evidence over time*. A theory is the best understanding that we have of that part of the natural world. Armed with the hypothesis, the researcher then makes observations or, better still, carries out an experiment to test the validity of the hypothesis. That test and its results are then published so that others can check the results or build on them. It is necessary that any explanation in science be testable, which means that the phenomenon must be perceivable and measurable. For example, “a bird sings because it is happy” is not a testable hypothesis, since we have no way to measure the happiness of a bird. We must ask a different question, perhaps about the brain state of the bird, since this can be measured. In general, science deals only with matter and energy—that is, those things that can be measured—and it cannot arrive at knowledge about values and morality. This is one reason why our scientific understanding of the mind is so limited, since thoughts, at least as we experience them, are neither matter nor energy. The scientific method is also a form of empiricism. An **empirical method** for *acquiring knowledge*

*is one based on observation, including experimentation, rather than a method based only on forms of logical argument or previous authorities.*

It was not until the late 1800s that psychology became accepted as its own academic discipline. Before this time, the workings of the mind were considered under the auspices of philosophy. Given that any behavior is, at its roots, biological, some areas of psychology take on aspects of a natural science like biology. No biological organism exists in isolation, and our behavior is influenced by our interactions with others. Therefore, psychology is also a social science.

## Merits of an Education in Psychology

Often, students take their first psychology course because they are interested in helping others and want to learn more about themselves and why they act the way they do. Sometimes, students take a psychology course because it either satisfies a general education requirement or is required for a program of study such as nursing or pre-med. Many of these students develop such an interest in the area that they go on to declare psychology as their major. As a result, psychology is one of the most popular majors on college campuses across the United States (Johnson & Lubin, 2011). Several well-known individuals were psychology majors. Just a few famous names on this list are Facebook's creator Mark Zuckerberg, television personality and political satirist Jon Stewart, actress Natalie Portman, and filmmaker Wes Craven (Halonen, 2011). About 6 percent of all bachelor's degrees granted in the United States are in the discipline of psychology (U.S. Department of Education, 2013).

An education in psychology is valuable for a number of reasons. Psychology students hone critical thinking skills and are trained in the use of the scientific method. Critical thinking is the active application of a set of skills to information for the understanding and evaluation of that information. The evaluation of information—assessing its reliability and usefulness—is an important skill in a world full of competing “facts,” many of which are designed to be misleading. For example, critical thinking involves maintaining an attitude of skepticism, recognizing internal biases, making use of logical thinking, asking appropriate questions, and making observations. Psychology students also can develop better communication skills during the course of their undergraduate coursework (American Psychological Association, 2011). Together, these factors increase students' scientific literacy and prepare students to critically evaluate the various sources of information they encounter.

In addition to these broad-based skills, psychology students come to understand the complex factors that shape one's behavior. They appreciate the interaction of our biology, our environment, and our experiences in determining who we are and how we will behave. They learn about basic principles that guide how we think and behave, and they come to recognize the tremendous diversity that exists across individuals and across cultural boundaries (American Psychological Association, 2011).

Watch a brief video that describes some of the questions a student should consider before deciding to major in psychology: [Why Major in Psychology?](#)



*One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://louis.pressbooks.pub/intropsychology/?p=136#oembed-1>*

## Summary

“Psychology” derives from the roots *psyche* (meaning soul) and *-ology* (meaning scientific study of). Thus, “psychology” is defined as the scientific study of mind and behavior. Students of psychology develop critical thinking skills, become familiar with the scientific method, and recognize the complexity of behavior.

---

## Review Questions



*An interactive H5P element has been excluded from this version of the text. You can view it online here:*

<https://louis.pressbooks.pub/intropsychology/?p=136#h5p-26>

## Critical Thinking Questions

Why do you think psychology courses like this one are often requirements of so many different programs of study?

Psychology courses deal with a number of issues that are helpful in a variety of settings. The text made mention of the types of skills as well as the knowledge base with which students of psychology become familiar. As mentioned in the link to learning, psychology is often helpful/valued in fields in which interacting with others is a major part of the job.

Why do you think many people might be skeptical about psychology being a science? One goal of psychology is the study of the mind. Science cannot directly study the mind, because it is not a form of matter or energy. This might create some skepticism about the scientific nature of psychology.

## Personal Application Question

Why are you taking this course? What do you hope to learn about during this course?

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## 2.

# HISTORY OF PSYCHOLOGY

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## Learning Objectives

By the end of this section, you will be able to:

- Understand the importance of Wundt and James in the development of psychology
- Appreciate Freud's influence on psychology
- Understand the basic tenets of Gestalt psychology
- Appreciate the important role that behaviorism played in psychology's history
- Understand basic tenets of humanism
- Understand how the cognitive revolution shifted psychology's focus back to the mind

Psychology is a relatively young science with its experimental roots in the 19th century, compared, for example, to human physiology, which dates much earlier. As mentioned, anyone interested in exploring issues related to the mind generally did so in a philosophical context prior to the 19th century. Two men, who worked in the 19th century, are generally credited as being the founders of psychology as a science and academic discipline that's distinct from philosophy. Their names were Wilhelm Wundt and William James. This section will provide an overview of the shifts in paradigms that have influenced psychology from Wundt and James through today.

## Wundt and Structuralism

Wilhelm Wundt (1832–1920) was a German scientist who was the first person to be referred to as a psychologist. His famous book entitled *Principles of Physiological Psychology* was published in 1873. Wundt viewed psychology as a scientific study of conscious experience, and he believed that the goal of psychology was to identify components of consciousness and how those components combined to result in our conscious

experience. Wundt used introspection (he called it “internal perception”), *a process by which someone examines their own conscious experience as objectively as possible*, making the human mind like any other aspect of nature that a scientist observed. Wundt’s version of introspection used only very specific experimental conditions in which an external stimulus was designed to produce a scientifically observable experience of the mind (Danziger, 1980). The first stringent requirement was the use of “trained” or practiced observers, who could immediately observe and report a reaction. The second requirement was the use of repeatable stimuli that always produced the same experience in the subject and allowed the subject to expect and thus be fully attentive to the inner reaction. These experimental requirements were put in place to eliminate “interpretation” in the reporting of internal experiences and to counter the argument that there is no way to know that an individual is observing their mind or consciousness accurately since it cannot be seen by any other person. *This attempt to understand the structure or characteristics of the mind was known as structuralism*. Wundt established his psychology laboratory at the University at Leipzig in 1879. In this laboratory, Wundt and his students conducted experiments on, for example, reaction times. A subject, sometimes in a room isolated from the scientist, would receive a stimulus such as light, image, or sound. The subject’s reaction to the stimulus would be to push a button, and an apparatus would record the time to reaction. Wundt could measure reaction time to one-thousandth of a second (Nicolas & Ferrand, 1999).



(a)



(b)

(a) Wilhelm Wundt is credited as one of the founders of psychology. He created the first laboratory for psychological research. (b) This photo shows him seated and surrounded by fellow researchers and equipment in his laboratory in Germany.

However, despite his efforts to train individuals in the process of introspection, this process remained highly subjective, and there was very little agreement between individuals. As a result, structuralism fell out of favor with the passing of Wundt’s student, Edward Titchener, in 1927 (Gordon, 1995).

## James and Functionalism

William James (1842–1910) was the first American psychologist who espoused a different perspective on how psychology should operate. James was introduced to Darwin's theory of evolution by natural selection and accepted it as an explanation of an organism's characteristics. Key to that theory is the idea that natural selection leads to organisms that are adapted to their environment, including their behavior. Adaptation means that a trait of an organism has a function for the survival and reproduction of the individual, because it has been naturally selected. As James saw it, psychology's purpose was to study the function of behavior in the world, and as such, his perspective was known as functionalism. **Functionalism** *focuses on how mental activities help an organism fit into its environment.* Functionalism has a second, more subtle meaning in that functionalists were more interested in the operation of the whole mind rather than of its individual parts, which were the focus of structuralism. Like Wundt, James believed that introspection could serve as one means by which someone might study mental activities, but James also relied on more objective measures, including the use of various recording devices, and examinations of concrete products of mental activities and of anatomy and physiology (Gordon, 1995).

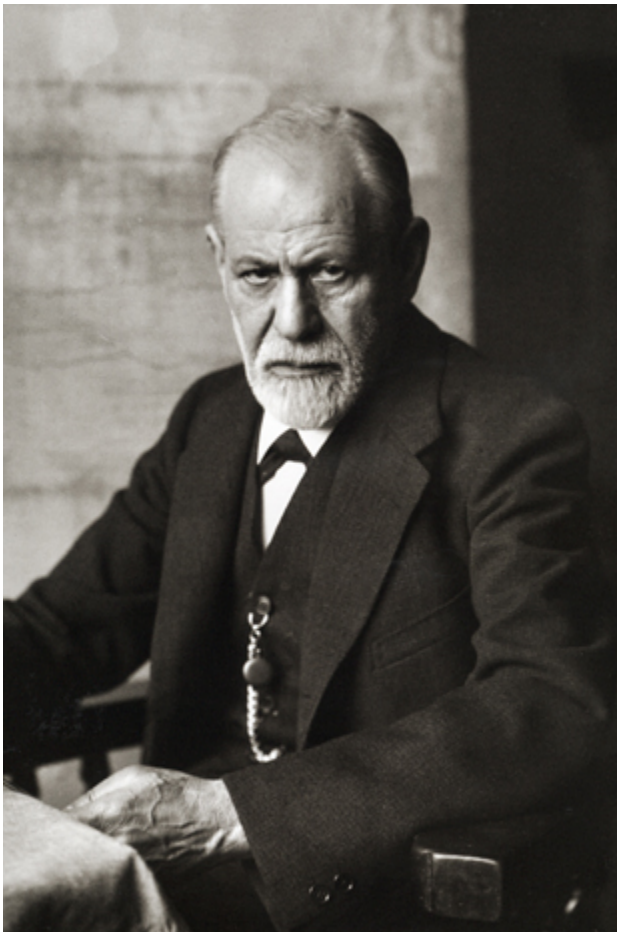


William James, shown here in a self-portrait, was the first American psychologist.

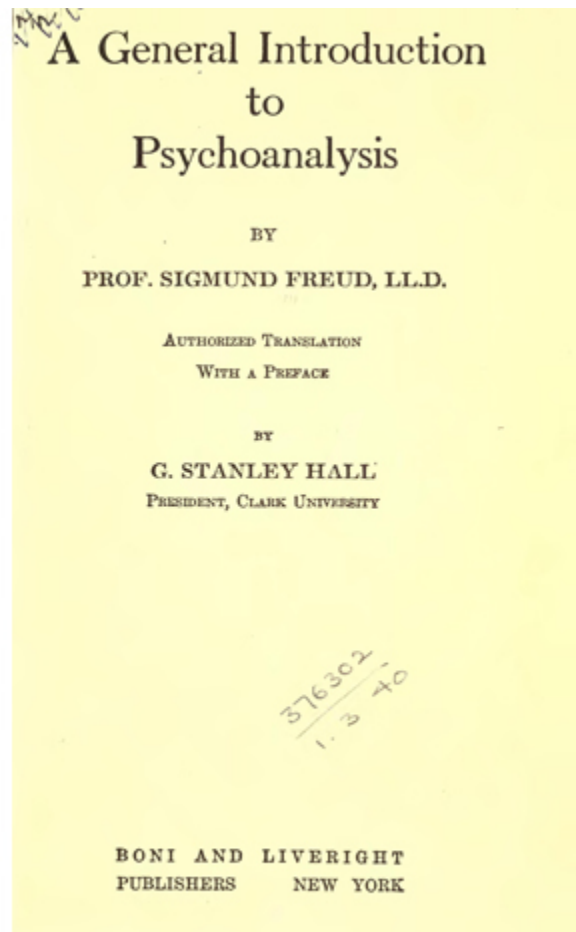
## Freud and Psychoanalytic Theory

Perhaps one of the most influential and well-known figures in psychology's history was Sigmund Freud.

Freud (1856–1939) was an Austrian neurologist who was fascinated by patients suffering from “hysteria” and neurosis. Hysteria was an ancient diagnosis for disorders, primarily of women with a wide variety of symptoms, including physical symptoms and emotional disturbances, none of which had an apparent physical cause. Freud theorized that many of his patients’ problems arose from the unconscious mind. In Freud’s view, the unconscious mind was a repository of feelings and urges of which we have no awareness. Gaining access to the unconscious, then, was crucial to the successful resolution of the patient’s problems. According to Freud, the unconscious mind could be accessed through dream analysis, by examinations of the first words that came to people’s minds, and through seemingly innocent slips of the tongue. **Psychoanalytic theory** focuses on the role of a person’s unconscious, as well as early childhood experiences, and this particular perspective dominated clinical psychology for several decades (Thorne & Henley, 2005).



(a)



(b)

(a) Sigmund Freud was a highly influential figure in the history of psychology. (b) One of his many books, *A General Introduction to Psychoanalysis*, shared his ideas about psychoanalytical therapy; it was published in 1922.

Freud’s ideas were influential, and you will learn more about them when you study lifespan development, personality, and therapy. For instance, many therapists believe strongly in the unconscious and the impact of

early childhood experiences on the rest of a person's life. The method of psychoanalysis, which involves the patient talking about their experiences and selves, while not invented by Freud, was certainly popularized by him and is still used today. Many of Freud's other ideas, however, are controversial. Drew Westen (1998) argues that many of the criticisms of Freud's ideas are misplaced, in that they attack his older ideas without taking into account later writings. Westen also argues that critics fail to consider the success of the broad ideas that Freud introduced or developed, such as the importance of childhood experiences in adult motivations, the role of unconscious versus conscious motivations in driving our behavior, the fact that motivations can cause conflicts that affect behavior, the effects of mental representations of ourselves and others in guiding our interactions, and the development of personality over time. Westen identifies subsequent research support for all of these ideas.

More modern iterations of Freud's clinical approach have been empirically demonstrated to be effective (Knekt et al., 2008; Shedler, 2010). Some current practices in psychotherapy involve examining unconscious aspects of the self and relationships, often through the relationship between the therapist and the client. Freud's historical significance and contributions to clinical practice merit his inclusion in a discussion of the historical movements within psychology.

## Wertheimer, Koffka, Köhler, and Gestalt Psychology

Max Wertheimer (1880–1943), Kurt Koffka (1886–1941), and Wolfgang Köhler (1887–1967) were three German psychologists who immigrated to the United States in the early 20th century to escape Nazi Germany. These men are credited with introducing psychologists in the United States to various Gestalt principles. The word *Gestalt* roughly translates to “whole”; a major emphasis of Gestalt psychology deals with the fact that although a sensory experience can be broken down into individual parts, how those parts relate to each other as a whole is often what the individual responds to in perception. For example, a song may be made up of individual notes played by different instruments, but the real nature of the song is perceived in the combinations of these notes as they form the melody, rhythm, and harmony. In many ways, this particular perspective would have directly contradicted Wundt's ideas of structuralism (Thorne & Henley, 2005).

Unfortunately, in moving to the United States, these men were forced to abandon much of their work and were unable to continue to conduct research on a large scale. These factors along with the rise of behaviorism (described next) in the United States prevented principles of Gestalt psychology from being as influential in the United States as they had been in their native Germany (Thorne & Henley, 2005). Despite these issues, several Gestalt principles are still very influential today. Considering the human individual as a whole rather than as a sum of individually measured parts became an important foundation in humanistic theory late in the century. The ideas of Gestalt have continued to influence research on sensation and perception.

Structuralism, Freud, and the Gestalt psychologists were all concerned in one way or another with describing and understanding inner experience. But other researchers had concerns that inner experience could

be a legitimate subject of scientific inquiry and chose instead to exclusively study behavior, the objectively observable outcome of mental processes.

## Pavlov, Watson, Skinner, and Behaviorism

Early work in the field of behavior was conducted by the Russian physiologist Ivan Pavlov (1849–1936). Pavlov studied a form of learning behavior called a conditioned reflex, in which an animal or human produced a reflex (unconscious) response to a stimulus and, over time, was conditioned to produce the response to a different stimulus that the experimenter associated with the original stimulus. The reflex Pavlov worked with was salivation in response to the presence of food. The salivation reflex could be elicited using a second stimulus, such as a specific sound, that was presented in association with the initial food stimulus several times. Once the response to the second stimulus was “learned,” the food stimulus could be omitted. Pavlov’s “classical conditioning” is only one form of learning behavior studied by behaviorists.

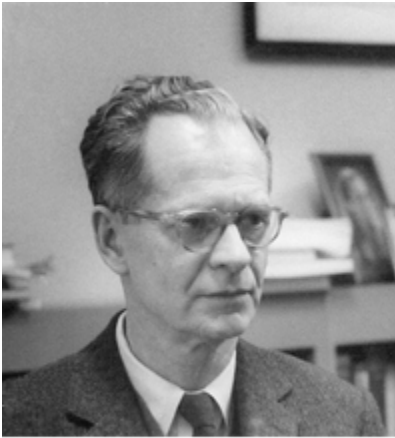
John B. Watson (1878–1958) was an influential American psychologist whose most famous work occurred during the early 20th century at Johns Hopkins University. While Wundt and James were concerned with understanding conscious experience, Watson thought that the study of consciousness was flawed. Because he believed that objective analysis of the mind was impossible, Watson preferred to focus directly on observable behavior and try to bring that behavior under control. Watson was a major proponent of shifting the focus of psychology from the mind to behavior, and *this approach of observing and controlling behavior came to be known as behaviorism*. A major object of study by behaviorists was learned behavior and its interaction with the inborn qualities of the organism. Behaviorism commonly used animals in experiments under the assumption that what was learned using animal models could, to some degree, be applied to human behavior. Indeed, Tolman (1938) stated, “I believe that everything important in psychology (except ... such matters as involve society and words) can be investigated in essence through the continued experimental and theoretical analysis of the determiners of rat behavior at a choice-point in a maze.”



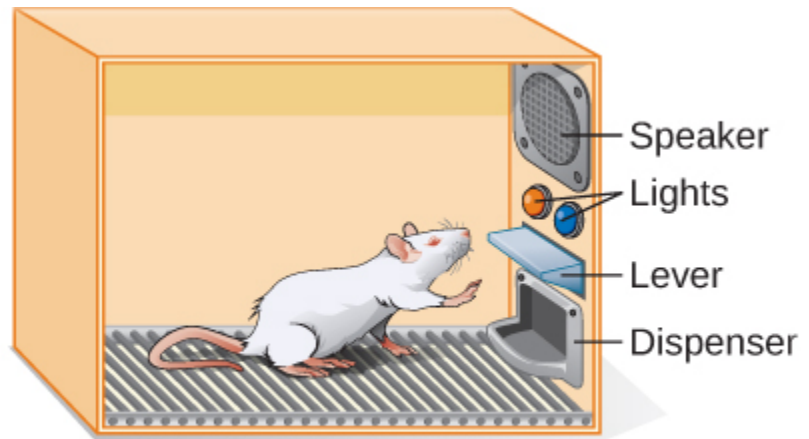
John B. Watson is known as the father of behaviorism within psychology.

Behaviorism dominated experimental psychology for several decades, and its influence can still be felt today (Thorne & Henley, 2005). Behaviorism is largely responsible for establishing psychology as a scientific discipline through its objective methods and especially experimentation. In addition, it is used in behavioral and cognitive-behavioral therapy. Behavior modification is commonly used in classroom settings. Behaviorism has also led to research on environmental influences on human behavior.

B. F. Skinner (1904–1990) was an American psychologist. Like Watson, Skinner was a behaviorist, and he concentrated on how behavior was affected by its consequences. Therefore, Skinner spoke of reinforcement and punishment as major factors in driving behavior. As a part of his research, Skinner developed a chamber that allowed the careful study of the principles of modifying behavior through reinforcement and punishment. This device, known as an operant conditioning chamber (or more familiarly, a Skinner box), has remained a crucial resource for researchers studying behavior (Thorne & Henley, 2005).



(a)



(b)

(a) B. F. Skinner is famous for his research on operant conditioning. (b) Modified versions of the operant conditioning chamber, or Skinner box, are still widely used in research settings today. (credit a: modification of work by “Silly rabbit”/Wikimedia Commons)

The Skinner box is a chamber that isolates the subject from the external environment and has a behavior indicator such as a lever or a button. When the animal pushes the button or lever, the box is able to deliver a positive reinforcement of the behavior (such as food) or a punishment (such as a noise) or a token conditioner (such as a light) that is correlated with either the positive reinforcement or punishment.

Skinner’s focus on positive and negative reinforcement of learned behaviors had a lasting influence in psychology that has waned somewhat since the growth of research in cognitive psychology. Despite this, conditioned learning is still used in human behavioral modification. Skinner’s two widely read and controversial popular science books about the value of operant conditioning for creating happier lives remain as thought-provoking arguments for his approach (Greengrass, 2004).

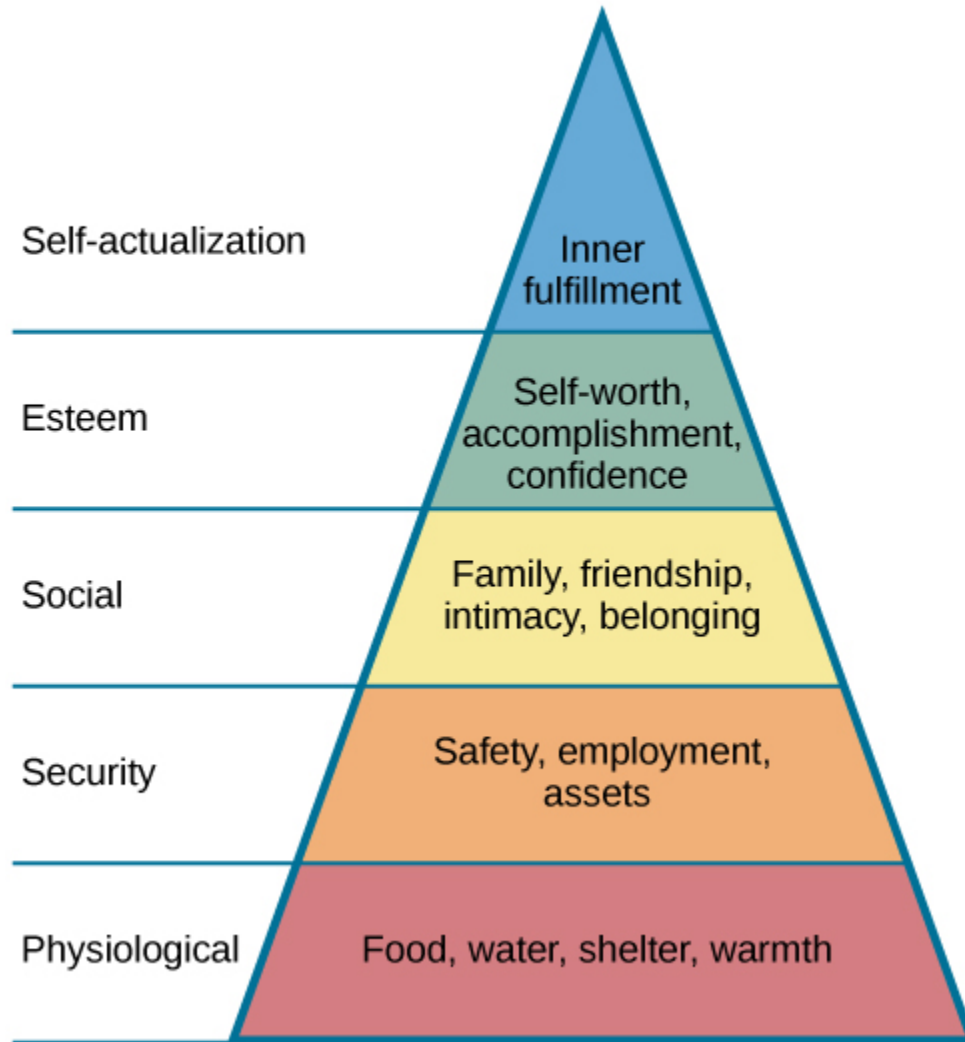
## Maslow, Rogers, And Humanism

During the early 20th century, American psychology was dominated by behaviorism and psychoanalysis. However, some psychologists were uncomfortable with what they viewed as limited perspectives being so influential to the field. They objected to the pessimism and determinism (all actions driven by the unconscious) of Freud. They also disliked the reductionism, or simplifying nature, of behaviorism. Behaviorism is also deterministic at its core, because it sees human behavior as entirely determined by a combination of genetics and environment. Some psychologists began to form ideas that emphasized personal control, intentionality, and a true predisposition for “good” as important for our self-concept and our behavior. Thus, humanism emerged. **Humanism** is a perspective within psychology that emphasizes the potential for good that is innate to all

*humans*. Two of the most well-known proponents of humanistic psychology are Abraham Maslow and Carl Rogers (O'Hara, n.d.).

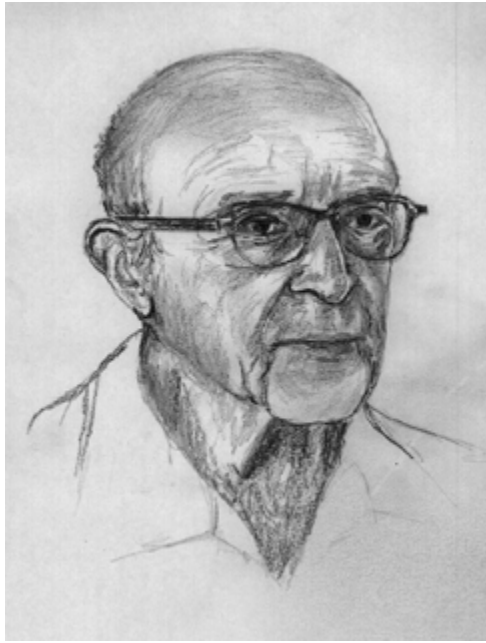
Abraham Maslow (1908–1970) was an American psychologist who is best known for proposing a hierarchy of human needs in motivating behavior. Although this concept will be discussed in more detail in a later chapter, a brief overview will be provided here. Maslow asserted that so long as basic needs necessary for survival were met (e.g., food, water, shelter), higher-level needs (e.g., social needs) would begin to motivate behavior. According to Maslow, the highest-level needs relate to self-actualization, a process by which we achieve our full potential. Obviously, the focus on the positive aspects of human nature that are characteristic of the humanistic perspective is evident (Thorne & Henley, 2005). Humanistic psychologists rejected, on principle, the research approach based on reductionist experimentation in the tradition of the physical and biological sciences, because it missed the “whole” human being. Beginning with Maslow and Rogers, there was an insistence on a humanistic research program. This program has been largely qualitative (not measurement-based), but there exist a number of quantitative research strains within humanistic psychology, including research on happiness, self-concept, meditation, and the outcomes of humanistic psychotherapy (Friedman, 2008).

## Maslow's Hierarchy of Needs



[\[Maslow's Hierarchy of Needs Image description\]](#)

Carl Rogers (1902–1987) was also an American psychologist who, like Maslow, emphasized the potential for good that exists within all people. Rogers used a therapeutic technique known as client-centered therapy in helping his clients deal with problematic issues that resulted in their seeking psychotherapy. Unlike a psychoanalytic approach in which the therapist plays an important role in interpreting what conscious behavior reveals about the unconscious mind, client-centered therapy involves the patient taking a lead role in the therapy session. Rogers believed that a therapist needed to display three features to maximize the effectiveness of this particular approach: unconditional positive regard, genuineness, and empathy. Unconditional positive regard refers to the fact that the therapist accepts their client for who they are, no matter what he or she might say. Provided these factors, Rogers believed that people were more than capable of dealing with and working through their own issues (Thorne & Henley, 2005).



Carl Rogers, shown in this portrait, developed a client-centered therapy method that has been influential in clinical settings. (credit: "Didius"/Wikimedia Commons)

Humanism has been influential to psychology. Both Maslow and Rogers are well-known names among students of psychology (you will read more about both men later in this text), and their ideas have influenced many scholars. Furthermore, Rogers' client-centered approach to therapy is still commonly used in psychotherapeutic settings today (O'Hara, n.d.)

View a brief video of Carl Rogers describing his therapeutic approach: [Carl Rogers on Person-Centered Therapy Video](#).



*One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://louis.pressbooks.pub/intropsychology/?p=138#oembed-1>*

# The Cognitive Revolution

Behaviorism's emphasis on objectivity and focus on external behavior had pulled psychologists' attention away from the mind for a prolonged period of time. The early work of humanistic psychologists redirected attention to the individual human as a whole, and as a conscious and self-aware being. By the 1950s, new disciplinary perspectives in linguistics, neuroscience, and computer science were emerging, and these areas revived interest in the mind as a focus of scientific inquiry. This particular perspective has come to be known as the cognitive revolution (Miller, 2003). By 1967, Ulric Neisser published the first textbook entitled *Cognitive Psychology*, which served as a core text in cognitive psychology courses around the country (Thorne & Henley, 2005).

Although no one person is entirely responsible for starting the cognitive revolution, Noam Chomsky was very influential in the early days of this movement. Chomsky (1928–), an American linguist, was dissatisfied with the influence that behaviorism had had on psychology. He believed that psychology's focus on behavior was short-sighted and that the field had to re-incorporate mental functioning into its purview if it were to offer any meaningful contributions to understanding behavior (Miller, 2003).



Noam Chomsky was very influential in beginning the cognitive revolution. In 2010, this mural honoring him was put up in Philadelphia, Pennsylvania. (credit: Robert Moran)

European psychology had never really been as influenced by behaviorism as had American psychology; and thus, the cognitive revolution helped reestablish lines of communication between European psychologists and their American counterparts. Furthermore, psychologists began to cooperate with scientists in other fields, like anthropology, linguistics, computer science, and neuroscience, among others. This interdisciplinary approach often was referred to as the cognitive sciences, and the influence and prominence of this particular perspective resonates in modern-day psychology (Miller, 2003).

# FEMINIST PSYCHOLOGY

The science of psychology has had an impact on human well-being, both positive and negative. The dominant influence of Western, white, and male academics in the early history of psychology meant that psychology developed with the biases inherent in those individuals, which often had negative consequences for members of society who were not white or male. Women, members of ethnic minorities in both the United States and other countries, and individuals with sexual orientations other than heterosexual had difficulties entering the field of psychology and therefore influencing its development. They also suffered from the attitudes of white, male psychologists, who were not immune to the nonscientific attitudes prevalent in the society in which they developed and worked. Until the 1960s, the science of psychology was largely a “womanless” psychology (Crawford & Marecek, 1989), meaning that few women were able to practice psychology, so they had little influence on what was studied. In addition, the experimental subjects of psychology were mostly men, which resulted from underlying assumptions that gender had no influence on psychology and that women were not of sufficient interest to study.

An article by Naomi Weisstein, first published in 1968 (Weisstein, 1993), stimulated a feminist revolution in psychology by presenting a critique of psychology as a science. She also specifically criticized male psychologists for constructing the psychology of women entirely out of their own cultural biases and without careful experimental tests to verify any of their characterizations of women. Weisstein used, as examples, statements by prominent psychologists in the 1960s, such as this quote by Bruno Bettelheim: “. . . we must start with the realization that, as much as women want to be good scientists or engineers, they want first and foremost to be womanly companions of men and to be mothers.” Weisstein’s critique formed the foundation for the subsequent development of feminist psychology that attempted to be free of the influence of male cultural biases on our knowledge of the psychology of women and, indeed, of both genders.

Crawford & Marecek (1989) identify several feminist approaches to psychology that can be described as feminist psychology. These include re-evaluating and discovering the contributions of women to the history of psychology, studying psychological gender differences, and questioning the male bias present across the practice of the scientific approach to knowledge.

## Multicultural Psychology

Culture has important impacts on individuals and social psychology, yet the effects of culture on psychology are under-studied. There is a risk that psychological theories and data derived from white, American settings could be assumed to apply to individuals and social groups from other cultures, but this is unlikely to be true (Betancourt & López, 1993). One weakness in the field of cross-cultural psychology is that in looking for differences in psychological attributes across cultures, there remains a need to go beyond simple descriptive

statistics (Betancourt & López, 1993). In this sense, it has remained a descriptive science, rather than one seeking to determine cause and effect. For example, a study of characteristics of individuals seeking treatment for a binge eating disorder in Hispanic American, African American, and Caucasian American individuals found significant differences between groups (Franko et al., 2012). The study concluded that results from studying any one of the groups could not be extended to the other groups, and yet potential causes of the differences were not measured.

The history of multicultural psychology in the United States is a long one. The role of African American psychologists in researching the cultural differences between African American individuals and social psychology is but one example. In 1920, Cecil Sumner was the first African American to receive a Ph.D. in psychology in the United States. Sumner established a psychology degree program at Howard University, leading to the education of a new generation of African American psychologists (Black, Spence, and Omari, 2004). Much of the work of early African American psychologists (and a general focus of much work in the first half of the 20th century in psychology in the United States) was dedicated to testing, and intelligence testing in particular (Black et al., 2004). That emphasis has continued, particularly because of the importance of testing in determining opportunities for children, but other areas of exploration in African-American psychology research include learning style, sense of community and belonging, and spiritualism (Black et al., 2004).

The American Psychological Association has several ethnically based organizations for professional psychologists that facilitate interactions among members. Since psychologists belonging to specific ethnic groups or cultures have the most interest in studying the psychology of their communities, these organizations provide an opportunity for the growth of research on the impact of culture on individual and social psychology.

Read a news story about the influence of an African American's psychology research on the historic *Brown v. Board of Education* civil rights case: [Doll Cultural Study Had Impact on "Brown v. Board."](#)

## Summary

Before the time of Wundt and James, questions about the mind were considered by philosophers. However, both Wundt and James helped create psychology as a distinct scientific discipline. Wundt was a structuralist, which meant he believed that our cognitive experience was best understood by breaking that experience into its component parts. He thought this was best accomplished by introspection.

William James was the first American psychologist, and he was a proponent of functionalism. This

particular perspective focused on how mental activities served as adaptive responses to an organism's environment. Like Wundt, James also relied on introspection; however, his research approach also incorporated more objective measures as well.

Sigmund Freud believed that understanding the unconscious mind was absolutely critical to understanding conscious behavior. This was especially true for individuals that he saw who suffered from various hysterias and neuroses. Freud relied on dream analysis, slips of the tongue, and free association as means to access the unconscious. The psychoanalytic theory remained a dominant force in clinical psychology for several decades.

Gestalt psychology was very influential in Europe. Gestalt psychology takes a holistic view of an individual and his experiences. As the Nazis came to power in Germany, Wertheimer, Koffka, and Köhler immigrated to the United States. Although they left their laboratories and their research behind, they did introduce America to Gestalt ideas. Some of the principles of Gestalt psychology are still very influential in the study of sensation and perception.

One of the most influential schools of thought in psychology's history was behaviorism. Behaviorism focuses on making psychology an objective science by studying overt behavior and deemphasizing the importance of unobservable mental processes. John Watson is often considered the father of behaviorism, and B. F. Skinner's contributions to our understanding of the principles of operant conditioning cannot be underestimated.

As behaviorism and psychoanalytic theory took hold of so many aspects of psychology, some began to become dissatisfied with psychology's picture of human nature. Thus, a humanistic movement within psychology began to take hold. Humanism focuses on the potential of all people for good. Both Maslow and Rogers were influential in shaping humanistic psychology.

During the 1950s, the landscape of psychology began to change. The science of behavior began to shift back to its roots of focus on mental processes. The emergence of neuroscience and computer science aided this transition. Ultimately, the cognitive revolution took hold, and people came to realize that cognition was crucial to a true appreciation and understanding of behavior.

## Review Questions



*An interactive H5P element has been excluded from this version of the text. You can view it*

online here:

<https://louis.pressbooks.pub/intropsychology/?p=138#h5p-28>

## Critical Thinking Questions

How did the object of study in psychology change over the history of the field since the 19th century?

In its early days, psychology could be defined as the scientific study of mind or mental processes. Over time, psychology began to shift more towards the scientific study of behavior. However, as the cognitive revolution took hold, psychology once again began to focus on mental processes as necessary to the understanding of behavior.

In part, what aspect of psychology was the behaviorist approach to psychology a reaction to? Behaviorists studied objectively observable behavior partly in reaction to the psychologists of the mind who were studying things that were not directly observable.

## Personal Application Questions

Freud is probably one of the most well-known historical figures in psychology. Where have you encountered references to Freud or his ideas about the role that the unconscious mind plays in determining conscious behavior?

# Glossary



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://louis.pressbooks.pub/intropsychology/?p=138#h5p-29>

## Image Descriptions

**Maslow’s Hierarchy of Needs Image Description:** A pyramid shape divided into five horizontal sections that are labelled. From top to bottom, the triangle’s sections are labeled as follows:

- Self-actualization corresponds to “Inner fulfillment”;
- Esteem corresponds to “Self-worth, accomplishment, confidence”;
- Social corresponds to “Family, friendship, intimacy, belonging”;
- Security corresponds to “Safety, employment, assets”;
- Physiological corresponds to “Food, water, shelter, warmth.”

[\[Return to Maslow’s Hierarchy of Needs image\]](#)

## Media Attributions

- “[Carl Rogers on Person-Centered Therapy Video](#)” by [PsychotherapyNet](#). Standard YouTube License.

## 3.

# CONTEMPORARY PSYCHOLOGY

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## Learning Objectives

By the end of this section, you will be able to:

- Appreciate the diversity of interests and foci within psychology
- Understand basic interests and applications in each of the described areas of psychology
- Demonstrate familiarity with some of the major concepts or important figures in each of the described areas of psychology

Contemporary psychology is a diverse field that is influenced by all of the historical perspectives described in the preceding section. Reflective of the discipline's diversity is the diversity seen within the **American Psychological Association (APA)**. The APA *is a professional organization representing psychologists in the United States*. The APA is the largest organization of psychologists in the world, and its mission is to advance and disseminate psychological knowledge for the betterment of people. There are 56 divisions within the APA, representing a wide variety of specialties that range from Societies for the Psychology of Religion and Spirituality to Exercise and Sport Psychology to Behavioral Neuroscience and Comparative Psychology. Reflecting the diversity of the field of psychology itself, members, affiliate members, and associate members span the spectrum from students to doctoral-level psychologists and come from a variety of places, including educational settings, criminal justice, hospitals, the armed forces, and industry (American Psychological Association, 2014). The Association for Psychological Science (APS) was founded in 1988 and seeks to advance the scientific orientation of psychology. Its founding resulted from disagreements between members of the scientific and clinical branches of psychology within the APA. The APS publishes five research journals and engages in education and advocacy with funding agencies. A significant proportion of its members are international, although the majority is located in the United States. Other organizations provide networking and collaboration opportunities for professionals of several ethnic or racial groups working in psychology, such as the National Latina/o Psychological Association (NLPA), the Asian American Psychological Association

(AAPA), the Association of Black Psychologists (ABPsi), and the Society of Indian Psychologists (SIP). Most of these groups are also dedicated to studying psychological and social issues within their specific communities.

This section will provide an overview of the major subdivisions within psychology today in the order in which they are introduced throughout the remainder of this textbook. This is not meant to be an exhaustive listing, but it will provide insight into the major areas of research and practice of modern-day psychologists.

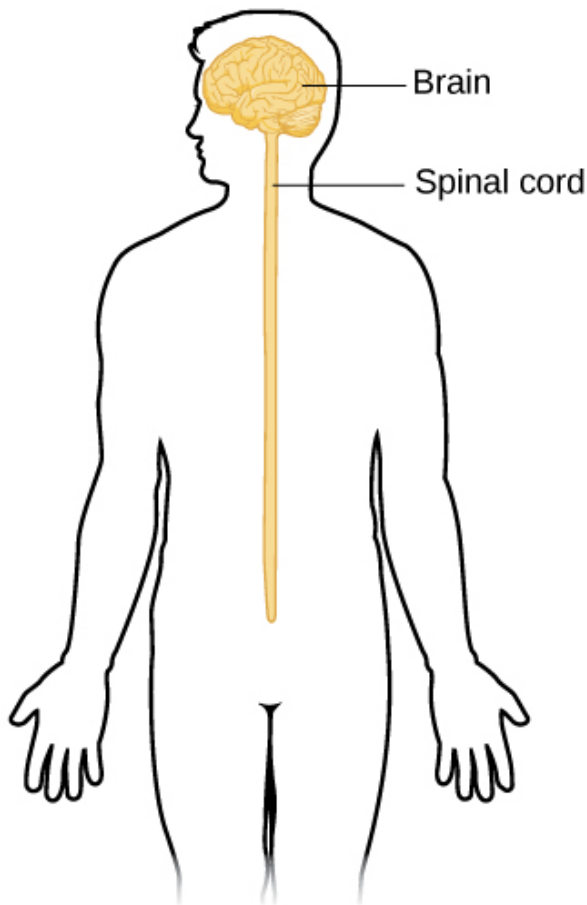
Please visit this website to learn about the divisions within the APA: [Divisions of APA](#).

Student resources are also provided by the APA: [Especially for Students](#).

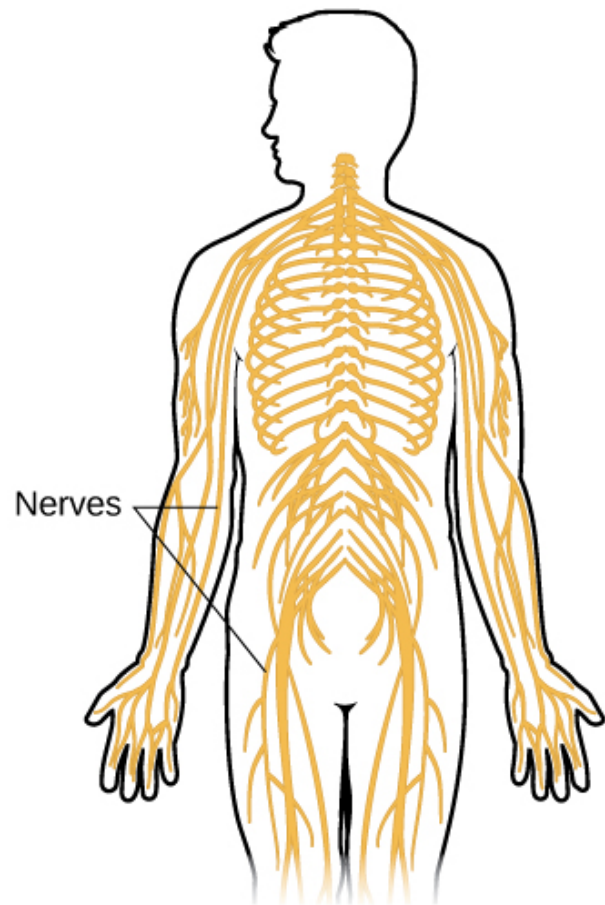
## Biopsychology and Evolutionary Psychology

As the name suggests, **biopsychology** *explores how our biology influences our behavior*. While biological psychology is a broad field, many biological psychologists want to understand how the structure and function of the nervous system is related to behavior. As such, they often combine the research strategies of both psychologists and physiologists to accomplish this goal (as discussed in Carlson, 2013).

## Central Nervous System



## Peripheral Nervous System



Biological psychologists study how the structure and function of the nervous system generate behavior.

The research interests of biological psychologists span a number of domains, including but not limited to, sensory and motor systems, sleep, drug use and abuse, ingestive behavior, reproductive behavior, neurodevelopment, plasticity of the nervous system, and biological correlates of psychological disorders. Given the broad areas of interest falling under the purview of biological psychology, it will probably come as no surprise that individuals from all sorts of backgrounds are involved in this research, including biologists, medical professionals, physiologists, and chemists. This interdisciplinary approach is often referred to as neuroscience, of which biological psychology is a component (Carlson, 2013).

While biopsychology typically focuses on the immediate causes of behavior based in the physiology of a human or other animal, evolutionary psychology seeks to study the ultimate biological causes of behavior. To the extent that a behavior is impacted by genetics, a behavior, like any anatomical characteristic of a human or animal, will demonstrate adaptation to its surroundings. These surroundings include the physical environment and, since interactions between organisms can be important to survival and reproduction, the social environment. The study of behavior in the context of evolution has its origins with Charles Darwin, the co-discoverer of the theory of evolution by natural selection. Darwin was well aware that behaviors should be

adaptive and wrote books titled *The Descent of Man* (1871) and *The Expression of the Emotions in Man and Animals* (1872) to explore this field.

Evolutionary psychology, and specifically the evolutionary psychology of humans, has enjoyed a resurgence in recent decades. To be subject to evolution by natural selection, a behavior must have a significant genetic cause. In general, we expect all human cultures to express a behavior if it is caused genetically, since the genetic differences among human groups are small. The approach taken by most evolutionary psychologists is to predict the outcome of a behavior in a particular situation based on evolutionary theory and then to make observations, or conduct experiments, to determine whether the results match the theory. It is important to recognize that these types of studies are not strong evidence that a behavior is adaptive, since they lack information that the behavior is in some part genetic and not entirely cultural (Endler, 1986). Demonstrating that a trait, especially in humans, is naturally selected is extraordinarily difficult; perhaps for this reason, some evolutionary psychologists are content to assume the behaviors they study have genetic determinants (Confer et al., 2010).

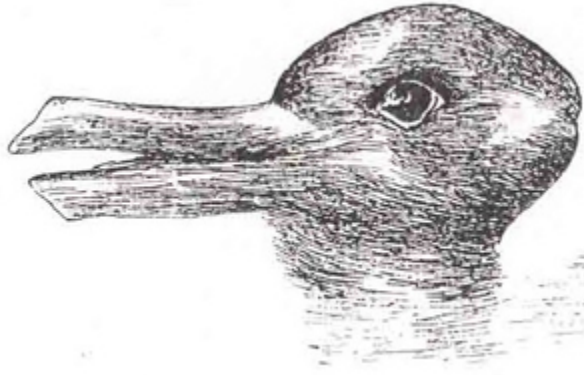
One other drawback of evolutionary psychology is that the traits that we possess now evolved under environmental and social conditions far back in human history, and we have a poor understanding of what these conditions were. This makes predictions about what is adaptive for a behavior difficult. Behavioral traits need not be adaptive under current conditions, only under the conditions of the past when they evolved, about which we can only hypothesize.

There are many areas of human behavior for which evolution can make predictions. Examples include memory, mate choice, relationships between kin, friendship and cooperation, parenting, social organization, and status (Confer et al., 2010).

Evolutionary psychologists have had success in finding experimental correspondence between observations and expectations. In one example, in a study of mate preference differences between men and women that spanned 37 cultures, Buss (1989) found that women valued earning potential factors greater than men, and men valued potential reproductive factors (youth and attractiveness) greater than women in their prospective mates. In general, the predictions were in line with the predictions of evolution, although there were deviations in some cultures.

## Sensation And Perception

Scientists interested in both physiological aspects of sensory systems as well as in the psychological experience of sensory information work within the area of sensation and perception. As such, sensation and perception research is also quite interdisciplinary. Imagine walking between buildings as you move from one class to another. You are inundated with sights, sounds, touch sensations, and smells. You also experience the temperature of the air around you and maintain your balance as you make your way. These are all factors of interest to someone working in the domain of sensation and perception.



When you look at this image, you may see a duck or a rabbit. The sensory information remains the same, but your perception can vary dramatically.

As described in a later chapter that focuses on the results of studies in sensation and perception, our experience of our world is not as simple as the sum total of all of the sensory information (or sensations) together. Rather, our experience (or perception) is complex and is influenced by where we focus our attention, our previous experiences, and even our cultural backgrounds.

## Cognitive Psychology

As mentioned in the previous section, the cognitive revolution created an impetus for psychologists to focus their attention on better understanding the mind and mental processes that underlie behavior. Thus, cognitive psychology is the area of psychology that focuses on studying cognitions, or thoughts, and their relationship to our experiences and our actions. Like biological psychology, cognitive psychology is broad in its scope and often involves collaborations among people from a diverse range of disciplinary backgrounds. This has led some to coin the term cognitive science to describe the interdisciplinary nature of this area of research (Miller, 2003).

Cognitive psychologists have research interests that span a spectrum of topics, ranging from attention to problem-solving to language to memory. The approaches used in studying these topics are equally diverse. Given such diversity, cognitive psychology is not captured in one chapter of this text per se; rather, various concepts related to cognitive psychology will be covered in relevant portions of the chapters in this text on sensation and perception, thinking and intelligence, memory, lifespan development, social psychology, and therapy.

View a brief video recapping some of the major concepts explored by cognitive psychologists:  
[1.2 – Lesson 1 – introduction to cognitive psychology.](#)



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://louis.pressbooks.pub/intropsychology/?p=140#oembed-1>

## Developmental Psychology

**Developmental psychology** is the scientific study of development across a lifespan. Developmental psychologists are interested in processes related to physical maturation. However, their focus is not limited to the physical changes associated with aging, as they also focus on changes in cognitive skills, moral reasoning, social behavior, and other psychological attributes.

Early developmental psychologists focused primarily on changes that occurred through reaching adulthood, providing enormous insight into the differences in physical, cognitive, and social capacities that exist between very young children and adults. For instance, research by Jean Piaget demonstrated that very young children do not demonstrate object permanence. Object permanence refers to the understanding that physical things continue to exist, even if they are hidden from us. If you were to show an adult a toy, and then hide it behind a curtain, the adult knows that the toy still exists. However, very young infants act as if a hidden object no longer exists. The age at which object permanence is achieved is somewhat controversial (Munakata, McClelland, Johnson, and Siegler, 1997).



Jean Piaget is famous for his theories regarding changes in cognitive ability that occur as we move from infancy to adulthood.

While Piaget focused on cognitive changes during infancy and childhood as we move to adulthood, there is an increasing interest in extending research into the changes that occur much later in life. This may be reflective of changing population demographics of developed nations as a whole. As more and more people live longer lives, the number of people of advanced age will continue to increase. Indeed, it is estimated that there were just over 40 million people aged 65 or older living in the United States in 2010. However, by 2020, this number was expected to increase to about 55 million. By the year 2050, it is estimated that nearly 90 million people in this country will be 65 or older (Department of Health and Human Services, n.d.).

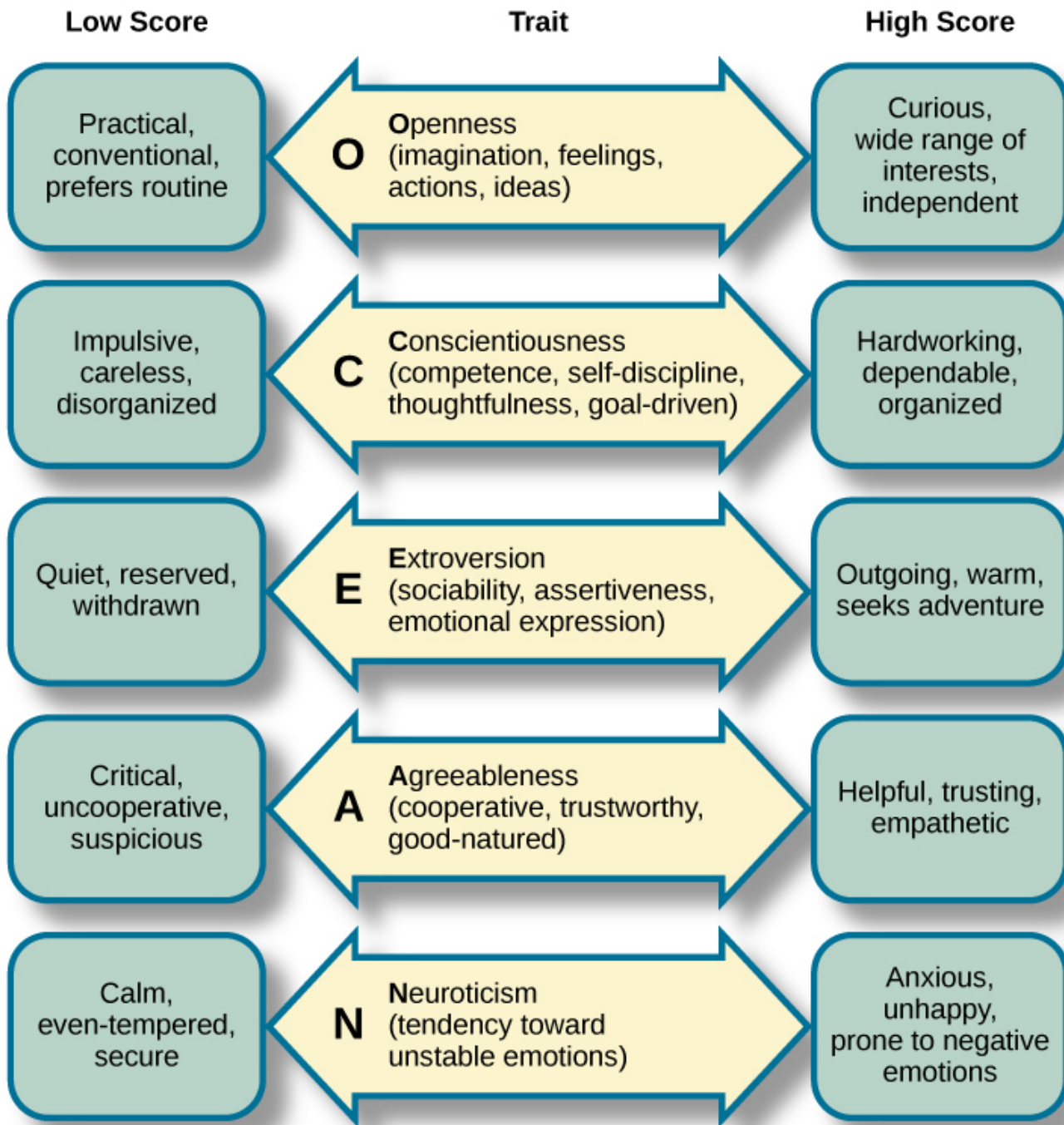
## Personality Psychology

**Personality psychology** *focuses on patterns of thoughts and behaviors that make each individual unique.* Several individuals (e.g., Freud and Maslow) that we have already discussed in our historical overview of psychology, and the American psychologist Gordon Allport, contributed to early theories of personality. These early theorists attempted to explain how an individual's personality develops from his or her given perspective. For

example, Freud proposed that personality arose as conflicts between the conscious and unconscious parts of the mind were carried out over the lifespan. Specifically, Freud theorized that an individual went through various psychosexual stages of development. According to Freud, adult personality would result from the resolution of various conflicts that centered on the migration of erogenous (or sexual pleasure-producing) zones from the oral (mouth) to the anus to the phallus to the genitals. Like many of Freud's theories, this particular idea was controversial and did not lend itself to experimental tests (Person, 1980).

More recently, the study of personality has taken on a more quantitative approach. Rather than explaining how personality arises, research is focused on identifying personality traits, measuring these traits, and determining how these traits interact in a particular context to determine how a person will behave in any given situation. **Personality traits** *are relatively consistent patterns of thought and behavior*, and many have proposed that five trait dimensions are sufficient to capture the variations in personality seen across individuals. These five dimensions are known as the "Big Five" or the Five Factor model and include dimensions of conscientiousness, agreeableness, neuroticism, openness, and extroversion. Each of these traits has been demonstrated to be relatively stable over the lifespan (e.g., Rantanen, Metsäpelto, Feldt, Pulkkinen, and Kokko, 2007; Soldz & Vaillant, 1999; McCrae & Costa, 2008) and is influenced by genetics (e.g., Jang, Livesly, and Vernon, 1996).

Each of the dimensions of the Five Factor model is shown in this figure. The provided description would describe someone who scored highly on that given dimension. Someone with a lower score on a given dimension could be described in opposite terms.



[Five Factor Model image description]

## Social Psychology

Social psychology focuses on how we interact with and relate to others. Social psychologists conduct research on a wide variety of topics that include differences in how we explain our own behavior versus how we explain the behaviors of others, prejudice, attraction, and how we resolve interpersonal conflicts. Social psychologists

have also sought to determine how being among other people changes our own behavior and patterns of thinking.

There are many interesting examples of social psychological research, and you will read about many of these in a later chapter of this textbook. Until then, you will be introduced to one of the most controversial psychological studies ever conducted. Stanley Milgram was an American social psychologist who is most famous for research that he conducted on obedience. After the Holocaust, in 1961, a Nazi war criminal, Adolf Eichmann, who was accused of committing mass atrocities, was put on trial. Many people wondered how German soldiers were capable of torturing prisoners in concentration camps, and they were unsatisfied with the excuses given by soldiers that they were simply following orders. At the time, most psychologists agreed that few people would be willing to inflict such extraordinary pain and suffering simply because they were obeying orders. Milgram decided to conduct research to determine whether or not this was true. As you will read later in the text, Milgram found that nearly two-thirds of his participants were willing to deliver what they believed to be lethal shocks to another person simply because they were instructed to do so by an authority figure (in this case, a man dressed in a lab coat). This was in spite of the fact that participants received payment just for showing up for the research study and could have chosen not to inflict pain or more serious consequences on another person by withdrawing from the study. No one was actually hurt or harmed in any way; Milgram's experiment was a clever ruse that took advantage of research confederates, those who pretend to be participants in a research study who are actually working for the researcher and have clear, specific directions on how to behave during the research study (Hock, 2009). Milgram's and others' studies that involved deception and potential emotional harm to study participants catalyzed the development of ethical guidelines for conducting psychological research that discourage the use of deception of research subjects, unless it can be argued not to cause harm and, in general, requires informed consent of participants.

**Public Announcement**

**WE WILL PAY YOU \$4.00 FOR  
ONE HOUR OF YOUR TIME**

**Persons Needed for a Study of Memory**

\*We will pay five hundred New Haven men to help us complete a scientific study of memory and learning. The study is being done at Yale University.

\*Each person who participates will be paid \$4.00 (plus 50c carfare) for approximately 1 hour's time. We need you for only one hour: there are no further obligations. You may choose the time you would like to come (evenings, weekdays, or weekends).

\*No special training, education, or experience is needed. We want:

- |                 |                     |                      |
|-----------------|---------------------|----------------------|
| Factory workers | Businessmen         | Construction workers |
| City employees  | Clerks              | Salespeople          |
| Laborers        | Professional people | White-collar workers |
| Barbers         | Telephone workers   | Others               |

All persons must be between the ages of 20 and 50. High school and college students cannot be used.

\*If you meet these qualifications, fill out the coupon below and mail it now to Professor Stanley Milgram, Department of Psychology, Yale University, New Haven. You will be notified later of the specific time and place of the study. We reserve the right to decline any application.

\*You will be paid \$4.00 (plus 50c carfare) as soon as you arrive at the laboratory.

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TO:  
 PROF. STANLEY MILGRAM, DEPARTMENT OF PSYCHOLOGY,  
 YALE UNIVERSITY, NEW HAVEN, CONN. I want to take part in  
 this study of memory and learning. I am between the ages of 20 and  
 50. I will be paid \$4.00 (plus 50c carfare) if I participate.

NAME: (Please Print) . . . . .

ADDRESS . . . . .

TELEPHONE NO. . . . . Best time to call you . . . . .

AGE . . . . . OCCUPATION . . . . . SEX . . . . .

CAN YOU COME:

WEEKDAYS . . . . . EVENINGS . . . . . WEEKENDS . . . . .

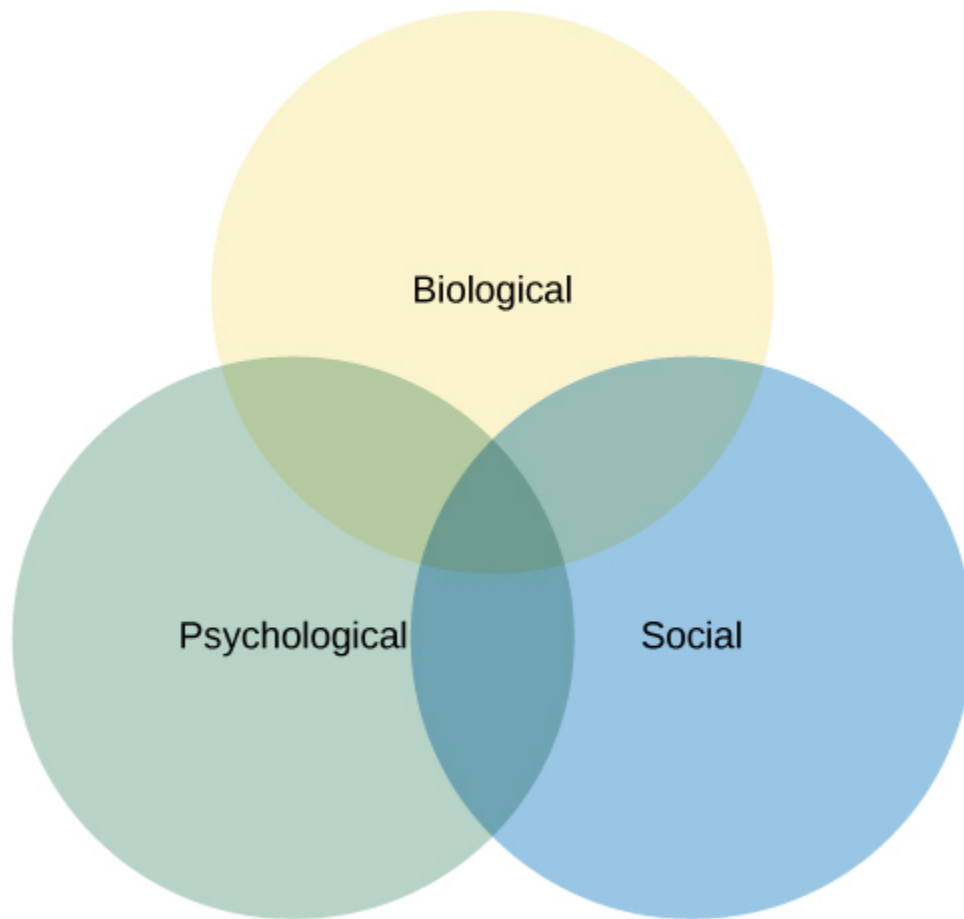
Stanley Milgram's research demonstrated just how far people will go in obeying orders from an authority figure. This advertisement was used to recruit subjects for his research.

## Industrial-Organizational Psychology

Industrial-Organizational psychology (I-O psychology) is a subfield of psychology that applies psychological theories, principles, and research findings in industrial and organizational settings. I-O psychologists are often involved in issues related to personnel management, organizational structure, and workplace environment. Businesses often seek the aid of I-O psychologists to make the best hiring decisions as well as to create an environment that results in high levels of employee productivity and efficiency. In addition to its applied nature, I-O psychology also involves conducting scientific research on behavior within I-O settings (Riggio, 2013).

## Health Psychology

Health psychology *focuses on how health is affected by the interaction of biological, psychological, and sociocultural factors*. This particular approach is known as the **biopsychosocial model**. Health psychologists are interested in helping individuals achieve better health through public policy, education, intervention, and research. Health psychologists might conduct research that explores the relationship between one's genetic makeup, patterns of behavior, relationships, psychological stress, and health. They may research effective ways to motivate people to address patterns of behavior that contribute to poorer health (MacDonald, 2013).



The biopsychosocial model suggests that health/illness is determined by an interaction of these three factors.

## Sport and Exercise Psychology

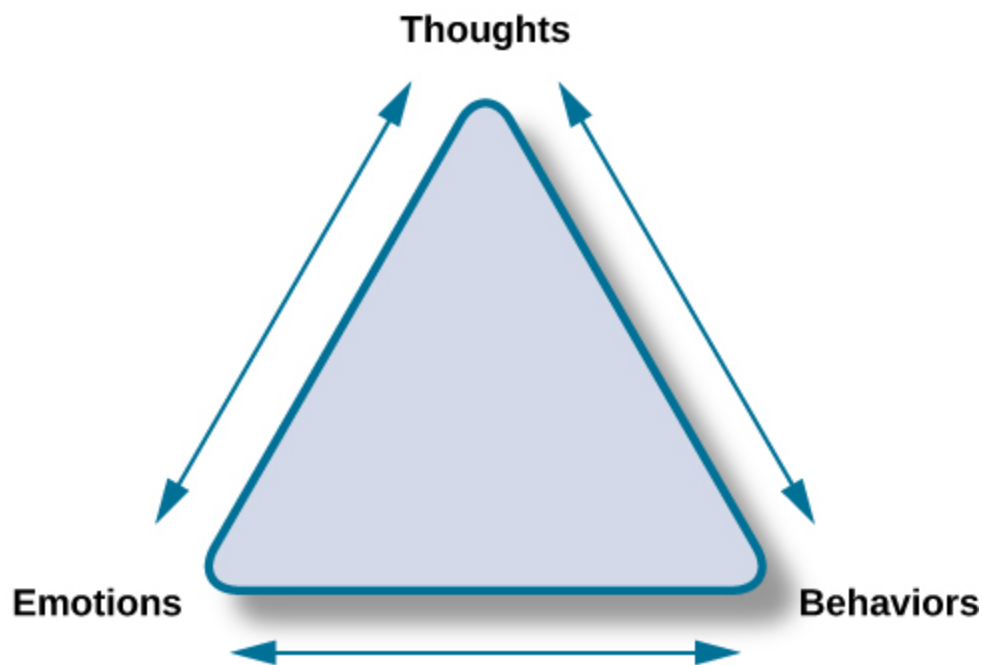
Researchers in **sport and exercise psychology** *study the psychological aspects of sport performance, including motivation and performance anxiety, and the effects of sport on mental and emotional wellbeing.* Research is also conducted on similar topics as they relate to physical exercise in general. The discipline also includes topics that are broader than sport and exercise but that are related to interactions between mental and physical performance under demanding conditions, such as firefighting, military operations, artistic performance, and surgery.

## Clinical Psychology

**Clinical psychology** *is the area of psychology that focuses on the diagnosis and treatment of psychological disorders and other problematic patterns of behavior.* As such, it is generally considered to be a more applied

area within psychology; however, some clinicians are also actively engaged in scientific research. **Counseling psychology** is a similar discipline that focuses on emotional, social, vocational, and health-related outcomes in individuals who are considered psychologically healthy.

As mentioned earlier, both Freud and Rogers provided perspectives that have been influential in shaping how clinicians interact with people seeking psychotherapy. While aspects of the psychoanalytic theory are still found among some of today's therapists who are trained from a psychodynamic perspective, Roger's ideas about client-centered therapy have been especially influential in shaping how many clinicians operate. Furthermore, both behaviorism and the cognitive revolution have shaped clinical practice in the forms of behavioral therapy, cognitive therapy, and cognitive-behavioral therapy. Issues related to the diagnosis and treatment of psychological disorders and problematic patterns of behavior will be discussed in detail in later chapters of this textbook.



Cognitive-behavioral therapists take cognitive processes and behaviors into account when providing psychotherapy. This is one of several strategies that may be used by practicing clinical psychologists.

By far, this is the area of psychology that receives the most attention in popular media, and many people mistakenly assume that all psychology is clinical psychology.

## Forensic Psychology

**Forensic psychology** is a branch of psychology that deals with questions of psychology as they arise in the context of the justice system. For example, forensic psychologists (and forensic psychiatrists) will assess a person's

competency to stand trial, assess the state of mind of a defendant, act as consultants on child custody cases, consult on sentencing and treatment recommendations, and advise on issues such as eyewitness testimony and children's testimony (American Board of Forensic Psychology, 2014). In these capacities, they will typically act as expert witnesses, called by either side in a court case to provide their research- or experience-based opinions. As expert witnesses, forensic psychologists must have a good understanding of the law and provide information in the context of the legal system rather than just within the realm of psychology. Forensic psychologists are also used in the jury selection process and witness preparation. They may also be involved in providing psychological treatment within the criminal justice system. Criminal profilers are a relatively small proportion of psychologists who act as consultants to law enforcement.

The APA provides career information about various areas of psychology: [Careers in Psychology](#).

## Summary

Psychology is a diverse discipline that is made up of several major subdivisions with unique perspectives. Biological psychology involves the study of the biological bases of behavior. Sensation and perception refer to the area of psychology that is focused on how information from our sensory modalities is received and how this information is transformed into our perceptual experiences of the world around us. **Cognitive psychology** *is concerned with the relationship that exists between thought and behavior, and developmental psychologists study the physical and cognitive changes that occur throughout one's lifespan.* Personality psychology focuses on individuals' unique patterns of behavior, thought, and emotion. Industrial and organizational psychology, health psychology, sport and exercise psychology, forensic psychology, and clinical psychology are all considered applied areas of psychology. Industrial and organizational psychologists apply psychological concepts to I-O settings. Health psychologists look for ways to help people live healthier lives, and clinical psychology involves the diagnosis and treatment of psychological disorders and other problematic behavioral patterns. Sport and exercise psychologists study the interactions between thoughts, emotions, and physical performance in sports, exercise, and other activities. Forensic psychologists carry out activities related to psychology in association with the justice system.

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## Review Questions



*An interactive H5P element has been excluded from this version of the text. You can view it online here:*

<https://louis.pressbooks.pub/intropsychology/?p=140#h5p-30>

## Critical Thinking Questions

Given the incredible diversity among the various areas of psychology that were described in this section, how do they all fit together?

Although the different perspectives all operate on different levels of analyses, have different foci of interests, and different methodological approaches, all of these areas share a focus on understanding and/or correcting patterns of thought and/or behavior.

What are the potential ethical concerns associated with Milgram's research on obedience? Many people have questioned how ethical this particular research was. Although no one was actually harmed in Milgram's study, many people have questioned how the knowledge that you would be willing to inflict incredible pain and/or death to another person, simply because someone in authority told you to do so, would affect someone's self-concept and psychological health. Furthermore, the degree to which deception was used in this particular study raises a few eyebrows.

## Personal Application Question

Now that you've been briefly introduced to some of the major areas within psychology, which are you most interested in learning more about? Why?

## Image Descriptions

Five Factor Model image description: A diagram describing what a low and high score in each of the traits in the five factor model looks like:

<b>Five Factor Model</b>		
<b>Trait</b>	<b>Low score</b>	<b>High score</b>
O – Openness (imagination, feelings, actions, ideas)	Practical, conventional, prefers routine	Curious, wide range of interests, independent
C – Conscientiousness (competence, self-discipline, thoughtfulness, goal-driven)	Impulsive, careless, disorganized	Hardworking, dependable, organized
E – Extroversion (sociability, assertiveness, emotional expression)	Quiet, reserved, withdrawn	Outgoing, warm, seek adventure
A – Agreeableness (cooperative, trustworthy, good-natured)	Critical, uncooperative, suspicious	Helpful, trusting, empathetic
N – Neuroticism (tendency toward unstable emotions)	Calm, even-tempered, secure	Anxious, unhappy, prone to negative emotions

[\[Return to Five Factor Model image\]](#)

## Media Attributions

- “[1.2 – Lesson 1 – introduction to cognitive psychology](#)” by [Abbey SocialScience](#). Standard YouTube License.

## 4.

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## PART II

# THE SCIENCE OF PSYCHOLOGY

### Chapter Learning Objective

By the end of this chapter, you will be able to:

- Describe what scientific principles, laws and theories, and research hypotheses are.
- Explain how various scientific research methods can be used to address psychological research questions.
- Discuss general ethical guidelines for conducting psychological research in humans and animals.



How does television content impact children's behavior? (credit: modification of work by "antisocialtory"/Flickr)

Have you ever wondered whether the violence you see on television affects your behavior? Are you more likely to behave aggressively in real life after watching people behave violently in dramatic situations on the screen? Or, could seeing fictional violence actually get aggression out of your system, causing you to be more peaceful? How are children influenced by the media they are exposed to? A psychologist interested in the relationship between behavior and exposure to violent images might ask these very questions.

The topic of violence in the media today is contentious. Since ancient times, humans have been concerned about the effects of new technologies on our behaviors and thinking processes. The Greek philosopher Socrates, for example, worried that writing—a new technology at that time—would diminish people’s ability to remember because they could rely on written records rather than committing information to memory. In our world of quickly changing technologies, questions about the effects of media continue to emerge. Many of us find ourselves with a strong opinion on these issues, only to find the person next to us bristling with the opposite view.

How can we go about finding answers that are supported not by mere opinion but by evidence that we can all agree on? The findings of psychological research can help us navigate issues like this.

## 5.

## SCIENTIFIC THINKING

## Learning Objectives

- Describe the principles of the scientific method and explain its importance in conducting and interpreting research.
- Differentiate laws from theories and explain how research hypotheses are developed and tested.
- Identify the role of the research hypothesis in psychological research.

Psychologists aren't the only people who seek to understand human behavior and solve social problems. Philosophers, religious leaders, and politicians, among others, also strive to provide explanations for human behavior. But psychologists believe that research is the best tool for understanding human beings and their relationships with others. Rather than accepting the claim of a philosopher that people do (or do not) have free will, a psychologist would collect data to empirically test whether or not people are able to actively control their own behavior. Rather than accepting a politician's contention that creating (or abandoning) a new center for mental health will improve the lives of individuals in the inner city, a psychologist would empirically assess the effects of receiving mental health treatment on the quality of life of the recipients. The statements made by psychologists are empirical, which means they are *based on systematic collection and analysis of data*.

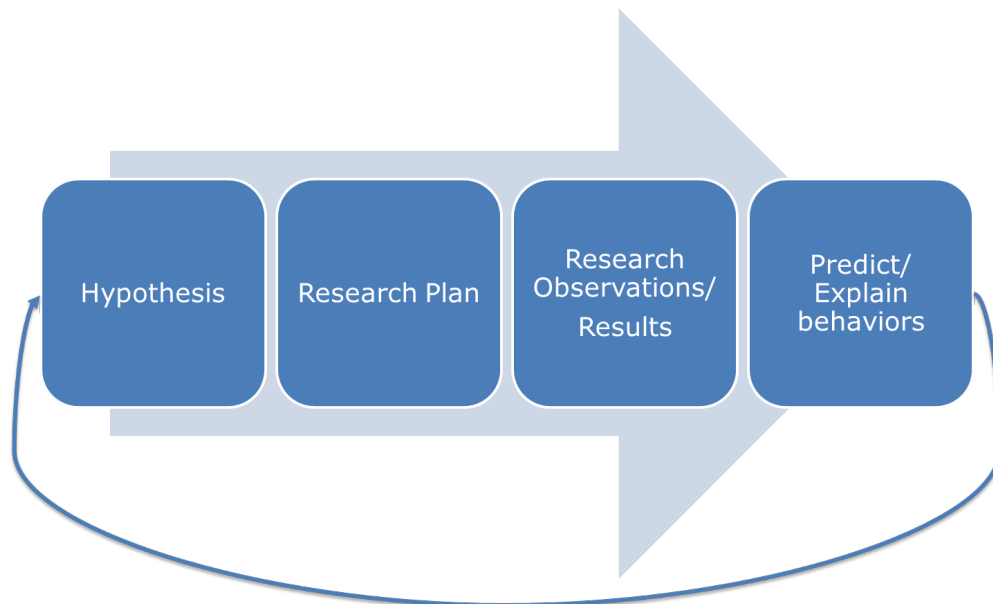
## The Scientific Method

All scientists (whether they are physicists, chemists, biologists, sociologists, or psychologists) are engaged in the basic processes of collecting data and drawing conclusions about those data. The methods used by scientists have developed over many years and provide a common framework for developing, organizing, and sharing information. The **scientific method** is *the set of assumptions, rules, and procedures scientists use to conduct research*.

In addition to requiring that science be empirical, the scientific method demands that the procedures used be **objective**, or *free from the personal bias or emotions of the scientist*. The scientific method describes how scientists collect and analyze data, how they draw conclusions from data, and how they share data with others. These rules increase objectivity by placing data under the scrutiny of other scientists and even the public at large. Because data are reported objectively, other scientists know exactly how the scientist collected and analyzed the data. This means that they do not have to rely only on the scientist's own interpretation of the data; they may draw their own, potentially different, conclusions.

The scientific method is an iterative process. The scientific process often starts with making a hypothesis (which is also an educated guess). Then, research studies are designed to test the hypothesis. The results obtained from experiments then inform the researchers how behaviors may be predicted or explained. This is a recurring process in which the results then loop back to modify the hypothesis if necessary. With an updated hypothesis, researchers then continue to employ the scientific process to conduct experiments.

Figure 2.1 The scientific process employed by psychologists



The scientific process employed by psychologists

Most new research is designed to *replicate*—that is, to repeat, add to, or modify—previous research findings. The scientific method therefore results in an accumulation of scientific knowledge through the reporting of research and the addition to and modifications of these reported findings by other scientists.

## Laws and Theories as Organizing Principles

One goal of research is to organize information into meaningful statements that can be applied in many situations. *Principles that are so general as to apply to all situations in a given domain of inquiry* are known

as laws. There are well-known laws in the physical sciences, such as the law of gravity and the laws of thermodynamics, and there are some universally accepted laws in psychology, such as the law of effect and Weber's law. But because laws are very general principles and their validity has already been well established, they are themselves rarely directly subjected to scientific testing.

The next step down from laws in the hierarchy of organizing principles is theory. A theory is *an integrated set of principles that explains and predicts many, but not all, observed relationships within a given domain of inquiry*. One example of an important theory in psychology is the stage theory of cognitive development proposed by the Swiss psychologist Jean Piaget. The theory states that children pass through a series of cognitive stages as they grow, each of which must be mastered in succession before movement to the next cognitive stage can occur. This is an extremely useful theory in human development because it can be applied to many different content areas and can be tested in many different ways.

Good theories have four important characteristics. First, good theories are *general*, meaning they summarize many different outcomes. Second, they are *parsimonious*, meaning they provide the simplest possible account of those outcomes. The stage theory of cognitive development meets both of these requirements. It can account for developmental changes in behavior across a wide variety of domains, and yet it does so parsimoniously—by hypothesizing a simple set of cognitive stages. Third, good theories *provide ideas for future research*. The stage theory of cognitive development has been applied not only to learning about cognitive skills but also to the study of children's moral (Kohlberg, 1966) and gender (Ruble & Martin, 1998) development.

Finally, good theories are falsifiable (Popper, 1959), which means *the variables of interest can be adequately measured and the relationships between the variables that are predicted by the theory can be shown through research to be incorrect*. The stage theory of cognitive development is falsifiable because the stages of cognitive reasoning can be measured and because if research discovers, for instance, that children learn new tasks before they have reached the cognitive stage hypothesized to be required for that task, then the theory will be shown to be incorrect.

No single theory is able to account for all behavior in all cases. Rather, theories are each limited in that they make accurate predictions in some situations or for some people but not in other situations or for other people. As a result, there is a constant exchange between theory and data: Existing theories are modified on the basis of collected data, and the newly modified theories then make new predictions that are tested by new data, and so forth. When a better theory is found, it will replace the old one. This is part of the accumulation of scientific knowledge.

## The Research Hypothesis

Theories are usually framed too broadly to be tested in a single experiment. Therefore, scientists use a more precise statement of the presumed relationship among specific parts of a theory—a research hypothesis—as the basis for their research. A research hypothesis is a specific and falsifiable prediction about the relationship between or among two or more variables, where a variable is any attribute that can assume different values

among different people or across different times or places. The research hypothesis states the existence of a relationship between the variables of interest and the specific direction of that relationship. For instance, the research hypothesis “Using marijuana will reduce learning” predicts that there is a relationship between a variable “using marijuana” and another variable called “learning.” Similarly, in the research hypothesis “participating in psychotherapy will reduce anxiety,” the variables that are expected to be related are “participating in psychotherapy” and “level of anxiety.”

When stated in an abstract manner, the ideas that form the basis of a research hypothesis are known as conceptual variables. Conceptual variables are abstract ideas that form the basis of research hypotheses. Sometimes the conceptual variables are rather simple—for instance, “age,” “gender,” or “weight.” In other cases, the conceptual variables represent more complex ideas, such as “anxiety,” “cognitive development,” “learning,” “self-esteem,” or “sexism.”

The first step in testing a research hypothesis involves turning the conceptual variables into measured variables, which are variables consisting of numbers that represent the conceptual variables. For instance, the conceptual variable “participating in psychotherapy” could be represented as the measured variable “number of psychotherapy hours the patient has accrued,” and the conceptual variable “using marijuana” could be assessed by having the research participants rate, on a scale from 1 to 10, how often they use marijuana or by administering a blood test that measures the presence of the chemicals in marijuana.

Psychologists use the term operational definition to refer to a precise statement of how a conceptual variable is turned into a measured variable. The relationship between conceptual and measured variables in a research hypothesis is diagrammed in Figure 2.2 “Diagram of a Research Hypothesis.” The conceptual variables are represented within circles at the top of the figure, and the measured variables are represented within squares at the bottom. The two vertical arrows, which lead from the conceptual variables to the measured variables, represent the operational definitions of the two variables. The arrows indicate the expectation that changes in the conceptual variables (psychotherapy and anxiety in this example) will cause changes in the corresponding measured variables. The measured variables are then used to draw inferences about the conceptual variables.

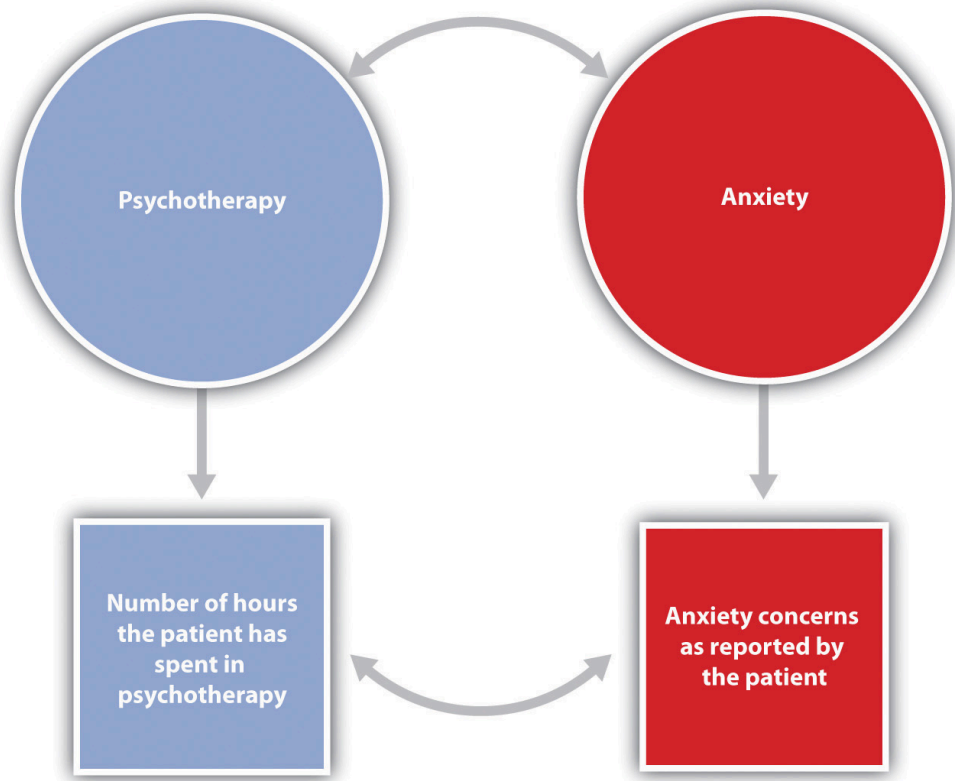


Figure 2.2 Diagram of a Research Hypothesis. In this research hypothesis, the conceptual variable of attending psychotherapy is operationalized using the number of hours of psychotherapy the client has completed, and the conceptual variable of anxiety is operationalized using self-reported levels of anxiety. The research hypothesis is that more psychotherapy will be related to less reported anxiety.

[Table 2.1, “Examples of the Operational Definitions of Conceptual Variables That Have Been Used in Psychological Research,”](#) lists some potential operational definitions of conceptual variables that have been used in psychological research. As you read through this list, note that in contrast to the abstract conceptual variables, the measured variables are very specific. This specificity is important for two reasons. First, more specific definitions mean that there is less danger that the collected data will be misunderstood by others. Second, specific definitions will enable future researchers to replicate the research.

Table 2.1 Examples of the Operational Definitions of Conceptual Variables That Have Been Used in Psychological Research

<b>Conceptual variable</b>	<b>Operational definitions</b>
Aggression	<ul style="list-style-type: none"><li>• Number of presses of a button that administers shock to another student</li><li>• Number of seconds taken to honk the horn at the car ahead after a stoplight turns green</li></ul>
Interpersonal attraction	<ul style="list-style-type: none"><li>• Number of inches that an individual places his or her chair away from another person</li><li>• Number of millimeters of pupil dilation when one person looks at another</li></ul>
Employee satisfaction	<ul style="list-style-type: none"><li>• Number of days per month an employee shows up to work on time</li><li>• Rating of job satisfaction from 1 (<i>not at all satisfied</i>) to 9 (<i>extremely satisfied</i>)</li></ul>
Decision-making skills	<ul style="list-style-type: none"><li>• Number of groups able to correctly solve a group performance task</li><li>• Number of seconds in which a person solves a problem</li></ul>
Depression	<ul style="list-style-type: none"><li>• Number of negative words used in a creative story</li><li>• Number of appointments made with a psychotherapist</li></ul>

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## 6.

# RESEARCH METHODS

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## Learning Objectives

By the end of this section, you will be able to:

- Describe the different research methods used by psychologists
- Discuss the strengths and weaknesses of case studies, naturalistic observation, surveys, and archival research
- Compare longitudinal and cross-sectional approaches to research

There are many research methods available to psychologists in their efforts to understand, describe, and explain behavior and the cognitive and biological processes that underlie it. Some methods rely on observational techniques. Other approaches involve interactions between the researcher and the individuals who are being studied—ranging from a series of simple questions to extensive, in-depth interviews—to well-controlled experiments.

Each of these research methods has unique strengths and weaknesses, and each method may only be appropriate for certain types of research questions. For example, studies that rely primarily on observation produce incredible amounts of information, but the ability to apply this information to the larger population is somewhat limited because of small sample sizes. Survey research, on the other hand, allows researchers to easily collect data from relatively large samples. While this allows for results to be generalized to the larger population more easily, the information that can be collected on any given survey is somewhat limited and subject to problems associated with any type of self-reported data. Some researchers conduct archival research by using existing records. While this can be a fairly inexpensive way to collect data that can provide insight into a number of research questions, researchers using this approach have no control over how or what kind of data was collected. All of the methods described thus far are correlational in nature. This means that researchers can speak to important relationships that might exist between two or more variables of interest. However, correlational data cannot be used to make claims about cause-and-effect relationships.

Correlational research can find a relationship between two variables, but the only way a researcher can claim that the relationship between the variables is cause and effect is to perform an experiment. In experimental research, there is a tremendous amount of control over variables of interest. While this is a powerful approach, experiments are often conducted in very artificial settings. This calls into question the validity of experimental findings with regard to how they would apply in real-world settings. In addition, many of the questions that psychologists would like to answer cannot be pursued through experimental research because of ethical concerns.

## Clinical or Case Studies

In 2011, the *New York Times* published a feature story on Krista and Tatiana Hogan, Canadian twin girls. These particular twins are unique because Krista and Tatiana are conjoined twins, connected at the head. There is evidence that the two girls are connected in a part of the brain called the thalamus, which is a major sensory relay center. Most incoming sensory information is sent through the thalamus before reaching higher regions of the cerebral cortex for processing.

To learn more about Krista and Tatiana, watch this *CBC* video about their lives: [Inseparable – See Through Each Other’s Eyes](#).

The implications of this potential connection mean that it might be possible for one twin to experience the sensations of the other twin. For instance, if Krista is watching a particularly funny television program, Tatiana might smile or laugh even if she is not watching the program. This particular possibility has piqued the interest of many neuroscientists who seek to understand how the brain uses sensory information.

These twins represent an enormous resource in the study of the brain, and since their condition is very rare, it is likely that as long as their family agrees, scientists will follow these girls very closely throughout their lives to gain as much information as possible (Dominus, 2011).

In observational research, scientists are conducting a clinical or case study when they focus on one person or just a few individuals. Indeed, some scientists spend their entire careers studying just 10–20 individuals. Why would they do this? Obviously, when they focus their attention on a very small number of people, they can gain a tremendous amount of insight into those cases. The richness of information that is collected in clinical or case studies is unmatched by any other single research method. This allows the researcher to have a very deep understanding of the individuals and the particular phenomenon being studied.

If clinical or case studies provide so much information, why are they not more frequent among researchers? As it turns out, the major benefit of this particular approach is also a weakness. As mentioned earlier, this

approach is often used when studying individuals who are interesting to researchers because they have a rare characteristic. Therefore, the individuals who serve as the focus of case studies are not like most other people. If scientists ultimately want to explain all behavior, focusing attention on such a special group of people can make it difficult to generalize any observations to the larger population as a whole. Generalizing refers to the ability to apply the findings of a particular research project to larger segments of society. Again, case studies provide enormous amounts of information, but since the cases are so specific, the potential to apply what's learned to the average person may be very limited.

## Naturalistic Observation

If you want to understand how behavior occurs, one of the best ways to gain information is to simply observe the behavior in its natural context. However, people might change their behavior in unexpected ways if they know they are being observed. How do researchers obtain accurate information when people tend to hide their natural behavior? As an example, imagine that your professor asks everyone in your class to raise their hand if they always wash their hands after using the restroom. Chances are that almost everyone in the classroom will raise their hand, but do you think hand washing after every trip to the restroom is really that universal?

This is very similar to the phenomenon mentioned earlier in this chapter: many individuals do not feel comfortable answering a question honestly. But if we are committed to finding out the facts about hand washing, we have other options available to us.

Suppose we send a classmate into the restroom to actually watch whether everyone washes their hands after using the restroom. Will our observer blend into the restroom environment by wearing a white lab coat, sitting with a clipboard, and staring at the sinks? We want our researcher to be inconspicuous—perhaps standing at one of the sinks pretending to put in contact lenses while secretly recording the relevant information. This type of observational study is called naturalistic observation: observing behavior in its natural setting. To better understand peer exclusion, Suzanne Fanger collaborated with colleagues at the University of Texas to observe the behavior of preschool children on a playground. How did the observers remain inconspicuous over the duration of the study? They equipped a few of the children with wireless microphones (which the children quickly forgot about) and observed while taking notes from a distance. Also, the children in that particular preschool (a “laboratory preschool”) were accustomed to having observers on the playground (Fanger, Frankel, & Hazen, 2012).

It is critical that the observer be as unobtrusive and as inconspicuous as possible: when people know they are being watched, they are less likely to behave naturally. If you have any doubt about this, ask yourself how your driving behavior might differ in two situations: In the first situation, you are driving down a deserted highway during the middle of the day; in the second situation, you are being followed by a police car down the same deserted highway.



Seeing a police car behind you would probably affect your driving behavior. (credit: Michael Gil)

It should be pointed out that naturalistic observation is not limited to research involving humans. Indeed, some of the best-known examples of naturalistic observation involve researchers going into the field to observe various kinds of animals in their own environments. As with human studies, the researchers maintain their distance and avoid interfering with the animal subjects so as not to influence their natural behaviors. Scientists have used this technique to study social hierarchies and interactions among animals ranging from ground squirrels to gorillas. The information provided by these studies is invaluable in understanding how those animals organize socially and communicate with one another. The anthropologist Jane Goodall, for example, spent nearly five decades observing the behavior of chimpanzees in Africa. As an illustration of the types of concerns that a researcher might encounter in naturalistic observation, some scientists criticized Goodall for giving the chimps names instead of referring to them by numbers—using names was thought to undermine the emotional detachment required for the objectivity of the study (McKie, 2010).



(a)



(b)

(a) Jane Goodall made a career of conducting naturalistic observations of (b) chimpanzee behavior. (credit “Jane Goodall”: modification of work by Erik Hersman; “chimpanzee”: modification of work by “Afrika Force”/Flickr.com)

The greatest benefit of naturalistic observation is the validity, or accuracy, of information collected unobtrusively in a natural setting. Having individuals behave as they normally would in a given situation means that we have a higher degree of ecological validity, or realism, than we might achieve with other research approaches. Therefore, our ability to generalize the findings of the research to real-world situations is enhanced. If done correctly, we need not worry about people or animals modifying their behavior simply because they are being observed. Sometimes, people may assume that reality programs give us a glimpse into authentic human behavior. However, the principle of inconspicuous observation is violated as reality stars are followed by camera crews and are interviewed on camera for personal confessionals. Given that environment, we must doubt how natural and realistic their behaviors are.

The major downside of naturalistic observation is that they are often difficult to set up and control. In our restroom study, what if you stood in the restroom all day prepared to record people’s hand-washing behavior and no one came in? Or, what if you have been closely observing a troop of gorillas for weeks only to find that they migrated to a new place while you were sleeping in your tent? The benefit of realistic data comes at a cost. As a researcher, you have no control over when (or if) you have behavior to observe. In addition, this type of observational research often requires significant investments of time, money, and a good dose of luck.

Sometimes studies involve structured observation. In these cases, people are observed while engaging in set, specific tasks. An excellent example of structured observation comes from Strange Situation by Mary Ainsworth (you will read more about this in the chapter on lifespan development). The Strange Situation is a procedure used to evaluate attachment styles that exist between an infant and caregiver. In this scenario, caregivers bring their infants into a room filled with toys. The Strange Situation involves a number of phases, including a stranger coming into the room, the caregiver leaving the room, and the caregiver’s return to the room. The infant’s behavior is closely monitored at each phase, but it is the behavior of the infant upon being

reunited with the caregiver that is most telling in terms of characterizing the infant's attachment style with the caregiver.

Another potential problem in observational research is observer bias. Generally, people who act as observers are closely involved in the research project and may unconsciously skew their observations to fit their research goals or expectations. To protect against this type of bias, researchers should have clear criteria established for the types of behaviors recorded and how those behaviors should be classified. In addition, researchers often compare observations of the same event by multiple observers, in order to test inter-rater reliability: a measure of reliability that assesses the consistency of observations by different observers.

## Surveys

Often, psychologists develop surveys as a means of gathering data. Surveys are lists of questions to be answered by research participants and can be delivered as paper-and-pencil questionnaires, administered electronically, or conducted verbally. Generally, the survey itself can be completed in a short time, and the ease of administering a survey makes it easy to collect data from a large number of people.

Surveys allow researchers to gather data from larger samples than may be afforded by other research methods. A sample is a subset of individuals selected from a population, which is the overall group of individuals that the researchers are interested in. Researchers study the sample and seek to generalize their findings to the population.

**Dear Visitor,**

**Your opinion is important to us.**

We would like to invite you to participate in a short survey to gather your opinions and feedback on your news consumption habits.

The survey will take approximately 10-15 minutes.  
Simply click the "Yes" button below to launch the survey.

**Would you like to participate?**

**YES**

**NO**

Surveys can be administered in a number of ways, including electronically administered research, like the survey shown here. (credit: Robert Nyman)

There are both strengths and weaknesses to using surveys in comparison to case studies. By using surveys, we can collect information from a larger sample of people. A larger sample is better able to reflect the actual diversity of the population, thus allowing better generalizability. Therefore, if our sample is sufficiently large and diverse, we can assume that the data we collect from the survey can be generalized to the larger population with more certainty than the information collected through a case study. However, given the greater number of people involved, we are not able to collect the same depth of information on each person that would be collected in a case study.

Another potential weakness of surveys is something we touched on earlier in this chapter: People don't always give accurate responses. They may lie, misremember, or answer questions in a way that they think makes them look good. For example, people may report drinking less alcohol than is actually the case.

Any number of research questions can be answered through the use of surveys. One real-world example is the research conducted by Jenkins, Ruppel, Kizer, Yehl, and Griffin (2012) about the backlash against the US Arab-American community following the terrorist attacks of September 11, 2001. Jenkins and colleagues wanted to determine to what extent these negative attitudes toward Arab Americans still existed nearly a decade after the attacks occurred. In one study, 140 research participants filled out a survey with 10 questions, including questions asking directly about the participant's overt prejudicial attitudes toward people of various ethnicities. The survey also asked indirect questions about how likely the participant would be to interact with a person of a given ethnicity in a variety of settings (such as, "How likely do you think it is that you would introduce yourself to a person of Arab-American descent?"). The results of the research suggested that participants were unwilling to report prejudicial attitudes toward any ethnic group. However, there were significant differences between their pattern of responses to questions about social interaction with Arab-Americans compared to other ethnic groups: they indicated less willingness for social interaction with Arab-Americans compared to the other ethnic groups. This suggested that the participants harbored subtle forms of prejudice against Arab-Americans, despite their assertions that this was not the case (Jenkins et al., 2012).

## Archival Research

Some researchers gain access to large amounts of data without interacting with a single research participant. Instead, they use existing records to answer various research questions. This type of research approach is known as [\[pb\\_glossary id="132"\]archival research\[/pb\\_glossary\]](#). Archival research relies on looking at past records or data sets to look for interesting patterns or relationships.

For example, a researcher might access the academic records of all individuals who enrolled in college within the past ten years and calculate how long it took them to complete their degrees, as well as course loads, grades, and extracurricular involvement. Archival research could provide important information about who is most likely to complete their education, and it could help identify important risk factors for struggling students.



(a)



(b)

A researcher doing archival research examines records, whether archived as a (a) hardcopy or (b) electronically. (credit “paper files”: modification of work by “Newtown graffiti”/Flickr; “computer”: modification of work by INPVIC Family/Flickr)

In comparing archival research to other research methods, there are several important distinctions. For one, the researcher employing archival research never directly interacts with research participants. Therefore, the investment of time and money to collect data is considerably less with archival research. Additionally, researchers have no control over what information was originally collected. Therefore, research questions have to be tailored so they can be answered within the structure of the existing data sets. There is also no guarantee of consistency between the records from one source to another, which might make comparing and contrasting different data sets problematic.

## Longitudinal and Cross-Sectional Research

Sometimes we want to see how people change over time, as in studies of human development and lifespan. When we test the same group of individuals repeatedly over an extended period of time, we are conducting longitudinal research. Longitudinal research is a research design in which data-gathering is administered repeatedly over an extended period of time. For example, we may survey a group of individuals about their dietary habits at age 20, retest them a decade later at age 30, and then again at age 40.

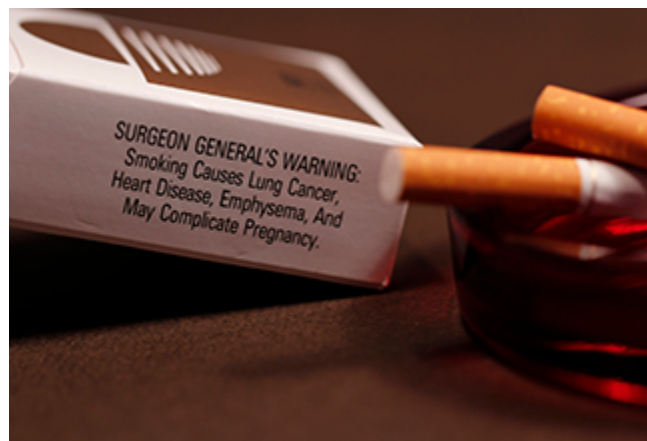
Another approach is cross-sectional research. In cross-sectional research, a researcher compares multiple segments of the population at the same time. Using the dietary habits example above, the researcher might directly compare different groups of people by age. Instead of following a group of people for 20 years to see how their dietary habits changed from decade to decade, the researcher would study a group of 20-year-old individuals and compare them to a group of 30-year-old individuals and a group of 40-year-old individuals. While cross-sectional research requires a shorter-term investment, it is also limited by differences that exist between the different generations (or cohorts) that have nothing to do with age, per se, but rather reflect

the social and cultural experiences of different generations of individuals that make them different from one another.

To illustrate this concept, consider the following survey findings. In recent years there has been significant growth in the popular support of same-sex marriage. Many studies on this topic break down survey participants into different age groups. In general, younger people are more supportive of same-sex marriage than those who are older (Jones, 2013). Does this mean that as we age we become less open to the idea of same-sex marriage, or does this mean that older individuals have different perspectives because of the social climates in which they grew up? Longitudinal research is a powerful approach because the same individuals are involved in the research project over time, which means that the researchers need to be less concerned with differences among cohorts affecting the results of their study.

Often longitudinal studies are employed when researching various diseases in an effort to understand particular risk factors. Such studies often involve tens of thousands of individuals who are followed for several decades. Given the enormous number of people involved in these studies, researchers can feel confident that their findings can be generalized to the larger population. The Cancer Prevention Study-3 (CPS-3) is one of a series of longitudinal studies sponsored by the American Cancer Society aimed at determining predictive risk factors associated with cancer. When participants enter the study, they complete a survey about their lives and family histories, providing information on factors that might cause or prevent the development of cancer. Then every few years the participants receive additional surveys to complete. In the end, hundreds of thousands of participants will be tracked over 20 years to determine which of them develop cancer and which do not.

Clearly, this type of research is important and potentially very informative. For instance, earlier longitudinal studies sponsored by the American Cancer Society provided some of the first scientific demonstrations of the now well-established links between increased rates of cancer and smoking (American Cancer Society, n.d.).



Longitudinal research like the CPS-3 helps us to better understand how smoking is associated with cancer and other diseases. (credit: CDC/Debra Cartagena)

As with any research strategy, longitudinal research is not without limitations. For one, these studies require

an incredible time investment by the researcher and research participants. Given that some longitudinal studies take years, if not decades, to complete, the results will not be known for a considerable period of time. In addition to the time demands, these studies also require a substantial financial investment. Many researchers are unable to commit the resources necessary to see a longitudinal project through to the end.

Research participants must also be willing to continue their participation for an extended period of time, and this can be problematic. People move, get married and take new names, get ill, and eventually die. Even without significant life changes, some people may simply choose to discontinue their participation in the project. As a result, the attrition rates, or reduction in the number of research participants due to dropouts, in longitudinal studies are quite high and increase over the course of a project. For this reason, researchers using this approach typically recruit many participants fully expecting that a substantial number will drop out before the end. As the study progresses, they continually check whether the sample still represents the larger population and make adjustments as necessary.

## Test Your Understanding



*An interactive H5P element has been excluded from this version of the text. You can view it online here:*

<https://louis.pressbooks.pub/intropsychology/?p=59#h5p-3>

## Summary

The clinical or case study involves studying just a few individuals for an extended period of time. While this approach provides an incredible depth of information, the ability to generalize these observations to the larger population is problematic. Naturalistic observation involves observing behavior in a natural setting and allows for the collection of valid, true-to-life information from realistic situations. However, naturalistic observation does not allow for much control and often requires quite a bit of time and money to perform. Researchers strive to ensure that their tools for collecting data are both reliable (consistent and replicable) and valid (accurate).

Surveys can be administered in a number of ways and make it possible to collect large amounts of data

quickly. However, the depth of information that can be collected through surveys is somewhat limited compared to a clinical or case study.

Archival research involves studying existing data sets to answer research questions.

Longitudinal research has been incredibly helpful to researchers who need to collect data on how people change over time. Cross-sectional research compares multiple segments of a population at a single time.

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## Review Questions



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<https://louis.pressbooks.pub/intropsychology/?p=59#h5p-4>

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## Critical Thinking Questions

In this section, conjoined twins, Krista and Tatiana, were described as being potential participants in a case study. In what other circumstances would you think that this particular research approach would be especially helpful and why?

Case studies might prove especially helpful using individuals who have rare conditions. For instance, if one wanted to study multiple personality disorder then the case study approach with individuals diagnosed with multiple personality disorder would be helpful.

Presumably, reality television programs aim to provide a realistic portrayal of the behavior displayed by the characters featured in such programs. This section pointed out why this is not really the case. What changes could be made in the way that these programs are produced that would result in more honest portrayals of realistic behavior?

The behavior displayed on these programs would be more realistic if the cameras were mounted in hidden locations, or if the people who appear on these programs did not know when they were being recorded.

Which of the research methods discussed in this section would be best suited to research the effectiveness of the D.A.R.E. program in preventing the use of alcohol and other drugs? Why? Longitudinal research would be an excellent approach in studying the effectiveness of this program because it would follow students as they aged to determine if their choices regarding alcohol and drugs were affected by their participation in the program.

Aside from biomedical research, what other areas of research could greatly benefit from both longitudinal and archival research?

Answers will vary. Possibilities include research on hiring practices based on human resource records, and research that follows former prisoners to determine if the time that they were incarcerated provided any sort of positive influence on their likelihood of engaging in criminal behavior in the future.

## Personal Application Questions

A friend of yours is working part-time in a local pet store. Your friend has become increasingly interested in how dogs normally communicate and interact with each other, and is thinking of visiting a local veterinary clinic to see how dogs interact in the waiting room. After reading this section, do you think this is the best way to better understand such interactions? Do you have any suggestions that might result in more valid data?

As a college student, you are no doubt concerned about the grades that you earn while completing your coursework. If you wanted to know how overall GPA is related to success in life after college, how would you choose to approach this question and what kind of resources would you need to conduct this research?

## 7.

ETHICS

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## Learning Objectives

- Identify characteristics of an ethical research project using human participants and animals.
- Discuss the procedures that researchers use to ensure that their research with humans and with animals is ethical.

One of the questions that all scientists must address concerns the ethics of their research. Physicists are concerned about the potentially harmful outcomes of their experiments with nuclear materials. Biologists worry about the potential outcomes of creating genetically engineered human babies. Medical researchers agonize over the ethics of withholding potentially beneficial drugs from control groups in clinical trials. Likewise, psychologists are continually considering the ethics of their research.

Research in psychology may cause some stress, harm, or inconvenience for the people who participate in that research. For instance, researchers may require introductory psychology students to participate in research projects and then deceive these students, at least temporarily, about the nature of the research. Psychologists may induce stress, anxiety, or negative moods in their participants, expose them to weak electrical shocks, or convince them to behave in ways that violate their moral standards. And researchers may sometimes use animals in their research, potentially harming them in the process.

Decisions about whether research is ethical are made using established ethical codes developed by scientific organizations, such as the American Psychological Association, and federal governments. In the United States, the Department of Health and Human Services provides guidelines for ethical standards in research. Some research, such as the research conducted by the Nazis on prisoners during World War II, is perceived as immoral by almost everyone. Other procedures, such as the use of animals in research testing the effectiveness of drugs, are more controversial.

Scientific research has provided information that has improved the lives of many people. Therefore, it is unreasonable to argue that because scientific research has costs, no research should be conducted. This

argument fails to consider the fact that there are significant costs to *not* doing research and that these costs may be greater than the potential costs of conducting the research (Rosenthal, 1994). In each case, before beginning to conduct the research, scientists have attempted to determine the potential risks and benefits of the research and have come to the conclusion that the potential benefits of conducting the research outweigh the potential costs to the research participants.

## CHARACTERISTICS OF AN ETHICAL RESEARCH PROJECT USING HUMAN PARTICIPANTS

- Trust and positive rapport are created between the researcher and the participant.
- The rights of both the experimenter and participant are considered, and the relationship between them is mutually beneficial.
- The experimenter treats the participant with concern and respect and attempts to make the research experience a pleasant and informative one.
- Before the research begins, the participant is given all information relevant to his or her decision to participate, including any possibilities of physical danger or psychological stress.
- The participant is given a chance to have questions about the procedure answered, thus guaranteeing his or her free choice about participating.
- After the experiment is over, any deception that has been used is made public, and the necessity for it is explained.
- The experimenter carefully debriefs the participant, explaining the underlying research hypothesis and the purpose of the experimental procedure in detail and answering any questions.
- The experimenter provides information about how he or she can be contacted and offers to provide information about the results of the research if the participant is interested in receiving it. (Stangor, 2011)

This list presents some of the most important factors that psychologists take into consideration when designing their research. The most direct ethical concern of the scientist is to *prevent harm* to the research

participants. One example is the well-known research of Stanley Milgram (1974) investigating obedience to authority. In these studies, participants were induced by an experimenter to administer electric shocks to another person so that Milgram could study the extent to which they would obey the demands of an authority figure. Most participants evidenced high levels of stress resulting from the psychological conflict they experienced between engaging in aggressive and dangerous behavior and following the instructions of the experimenter. Studies such as those by Milgram are no longer conducted because the scientific community is now much more sensitized to the potential of such procedures to create emotional discomfort or harm.

Another goal of ethical research is to guarantee that participants have *free choice* regarding whether they wish to participate in research. Students in psychology classes may be allowed, or even required, to participate in research, but they are also always given an option to choose a different study to be in, or to perform other activities instead. And once an experiment begins, the research participant is always free to leave the experiment if he or she wishes to. Concerns with free choice also occur in institutional settings, such as in schools, hospitals, corporations, and prisons, when individuals are required by the institutions to take certain tests, or when employees are told or asked to participate in research.

Researchers must also protect the *privacy* of the research participants. In some cases data can be kept anonymous by not having the respondents put any identifying information on their questionnaires. In other cases the data cannot be anonymous because the researcher needs to keep track of which respondent contributed the data. In this case one technique is to have each participant use a unique code number to identify his or her data, such as the last four digits of the student ID number. In this way the researcher can keep track of which person completed which questionnaire, but no one will be able to connect the data with the individual who contributed them.

Perhaps the most widespread ethical concern to the participants in behavioral research is the extent to which researchers employ deception. *Deception occurs whenever research participants are not completely and fully informed about the nature of the research project before participating in it.* Deception may occur in an active way, such as when the researcher tells the participants that he or she is studying learning when in fact the experiment really concerns obedience to authority. In other cases the deception is more passive, such as when participants are not told about the hypothesis being studied or the potential use of the data being collected.

Some researchers have argued that no deception should ever be used in any research (Baumrind, 1985). They argue that participants should always be told the complete truth about the nature of the research they are in and that when participants are deceived there will be negative consequences, such as the possibility that participants may arrive at other studies already expecting to be deceived. Other psychologists defend the use of deception on the grounds that it is needed to get participants to act naturally and to enable the study of psychological phenomena that might not otherwise be investigated. They argue that it would be impossible to study topics such as altruism, aggression, obedience, and stereotyping without using deception because if participants were informed ahead of time what the study involved, this knowledge would certainly change their behavior. The codes of ethics of the American Psychological Association and other organizations allow

researchers to use deception, but these codes also require them to explicitly consider how their research might be conducted without the use of deception.

## ENSURING THAT RESEARCH IS ETHICAL

Making decisions about the ethics of research involves weighing the costs and benefits of conducting versus not conducting a given research project. The costs involve potential harm to the research participants and to the field, whereas the benefits include the potential for advancing knowledge about human behavior and offering various advantages, some educational, to the individual participants. Most generally, the ethics of a given research project are determined through a *cost-benefit analysis*, in which the costs are compared to the benefits. If the potential costs of the research appear to outweigh any potential benefits that might come from it, then the research should not proceed.

Arriving at a cost-benefit ratio is not simple. For one thing, there is no way to know ahead of time what the effects of a given procedure will be on every person or animal who participates or what benefit to society the research is likely to produce. In addition, what is ethical is defined by the current state of thinking within society, and thus perceived costs and benefits change over time. The U.S. Department of Health and Human Services regulations require that all universities receiving funds from the department set up an *Institutional Review Board (IRB)* to determine whether proposed research meets department regulations. The Institutional Review Board (IRB) is a committee of at least five members whose goal it is to determine the cost-benefit ratio of research conducted within an institution. The IRB approves the procedures of all the research conducted at the institution before the research can begin. The board may suggest modifications to the procedures, or (in rare cases) it may inform the scientist that the research violates Department of Health and Human Services guidelines and thus cannot be conducted at all.

One important tool for ensuring that research is ethical is the use of *informed consent*. A sample informed consent form is shown in [Figure 2.2 “Sample Consent Form.”](#) Informed consent, conducted before a participant begins a research session, is designed to explain the research procedures and inform the participant of his or her rights during the investigation. The informed consent explains as much as possible about the true nature of the study, particularly everything that might be expected to influence willingness to participate, but it may in some cases withhold some information that allows the study to work.

**Consent Form: Interactions**

I state that I am 18 years of age or older and wish to participate in a program of research being conducted by Dr. Charles Stangor at the University of Maryland, College Park, Department of Psychology.

The purpose of the research is to study how individuals get to know each other. In the remainder of the study I will be having a short conversation with another person. This interaction will be videotaped. At the end of the interaction, I will be asked to complete some questionnaires about how I felt during and what I remember about the interaction. The entire experiment will take about 45 minutes.

I furthermore consent to allow the videotape that has been made of me and my partner to be used in the research. I understand that the videotape will be used for research purposes only, and no one else except the present experimenter and one other person who will help code the tape will ever view it.

I understand that code numbers will be used to identify the videotapes and that all written material that I contribute will be kept separate from the videos. As a result, it will not be possible to connect my name to my videotape.

I understand that both my partner and I have the right to withdraw the tape from the study at any point.

I understand that the experiment is not designed to help me personally but that the researchers hope to learn more about interpersonal interactions.

I understand that I am free to ask questions or to withdraw from participation at any time without penalty.

Dr. Charles Stangor  
Department of Psychology  
Room 3123  
555-5921

Signature of participant

\_\_\_\_\_

Date

\_\_\_\_\_

Figure 2.2 Sample Consent Form. The informed consent form explains the research procedures and informs the participant of his or her rights during the investigation.

Adapted from Stangor, C. (2011). *Research methods for the behavioral sciences* (4th ed.). Mountain View, CA: Cengage.

Because participating in research has the potential to produce long-term changes in the research participants, all participants should be fully debriefed immediately after their participation. The debriefing is a *procedure designed to fully explain the purposes and procedures of the research and remove any harmful aftereffects of participation*.

# RESEARCH WITH ANIMALS

Because animals make up an important part of the natural world, and because some research cannot be conducted using humans, animals are also participants in psychological research. Most psychological research using animals is now conducted with rats, mice, and birds, and the use of other animals in research is declining (Thomas & Blackman, 1992). As with ethical decisions involving human participants, a set of basic principles has been developed that helps researchers make informed decisions about such research; a summary is shown below.

## APA GUIDELINES ON HUMANE CARE AND USE OF ANIMALS IN RESEARCH

The following are some of the most important ethical principles from the American Psychological Association's guidelines on research with animals.

- Psychologists acquire, care for, use, and dispose of animals in compliance with current federal, state, and local laws and regulations, and with professional standards.
- Psychologists trained in research methods and experienced in the care of laboratory animals supervise all procedures involving animals and are responsible for ensuring appropriate consideration of their comfort, health, and humane treatment.
- Psychologists ensure that all individuals under their supervision who are using animals have received instruction in research methods and in the care, maintenance, and handling of the species being used, to the extent appropriate to their role.
- Psychologists make reasonable efforts to minimize the discomfort, infection, illness, and pain of animal subjects.
- Psychologists use a procedure subjecting animals to pain, stress, or privation only when an alternative procedure is unavailable and the goal is justified by its prospective scientific, educational, or applied value.
- Psychologists perform surgical procedures under appropriate anesthesia and follow techniques to avoid infection and minimize pain during and after surgery.
- When it is appropriate that an animal's life be terminated, psychologists proceed rapidly, with an effort to minimize pain and in accordance with accepted procedures. (American Psychological Association, 2002)



Psychologists may use animals in their research, but they make reasonable efforts to minimize the discomfort the animals experience. Understanding Animal Research – Rabbit in Research for Animal Testing – CC BY 2.0.

Because the use of animals in research involves a personal value, people naturally disagree about this practice. Although many people accept the value of such research (Plous, 1996), a minority of people, including animal-rights activists, believes that it is ethically wrong to conduct research on animals. This argument is based on the assumption that because animals are living creatures just as humans are, no harm should ever be done to them.

Most scientists, however, reject this view. They argue that such beliefs ignore the potential benefits that have and continue to come from research with animals. For instance, drugs that can reduce the incidence of cancer or AIDS may first be tested on animals, and surgery that can save human lives may first be practiced on animals. Research on animals has also led to a better understanding of the physiological causes of depression, phobias, and stress, among other illnesses. In contrast to animal-rights activists, then, scientists believe that because there are many benefits that accrue from animal research, such research can and should continue as long as the humane treatment of the animals used in the research is guaranteed.

## Key Takeaways

- Psychologists use the scientific method to generate, accumulate, and report scientific knowledge.
- Basic research, which answers questions about behavior, and applied research, which finds solutions to everyday problems, inform each other and work together to advance science.

- Research reports describing scientific studies are published in scientific journals so that other scientists and laypersons may review the empirical findings.
- Organizing principles, including laws, theories, and research hypotheses, give structure and uniformity to scientific methods.
- Concerns for conducting ethical research are paramount. Researchers assure that participants are given free choice to participate and that their privacy is protected. Informed consent and debriefing help provide humane treatment of participants.
- A cost-benefit analysis is used to determine what research should and should not be allowed to proceed.

## Exercises and Critical Thinking

1. Give an example from personal experience of how you have or how someone you know has benefited from the results of scientific research.
2. Find and discuss a research project that in your opinion has ethical concerns. Explain why you find these concerns to be troubling.
3. Indicate your personal feelings about the use of animals in research. When should and should not animals be used? What principles have you used to come to these conclusions?

## 8.

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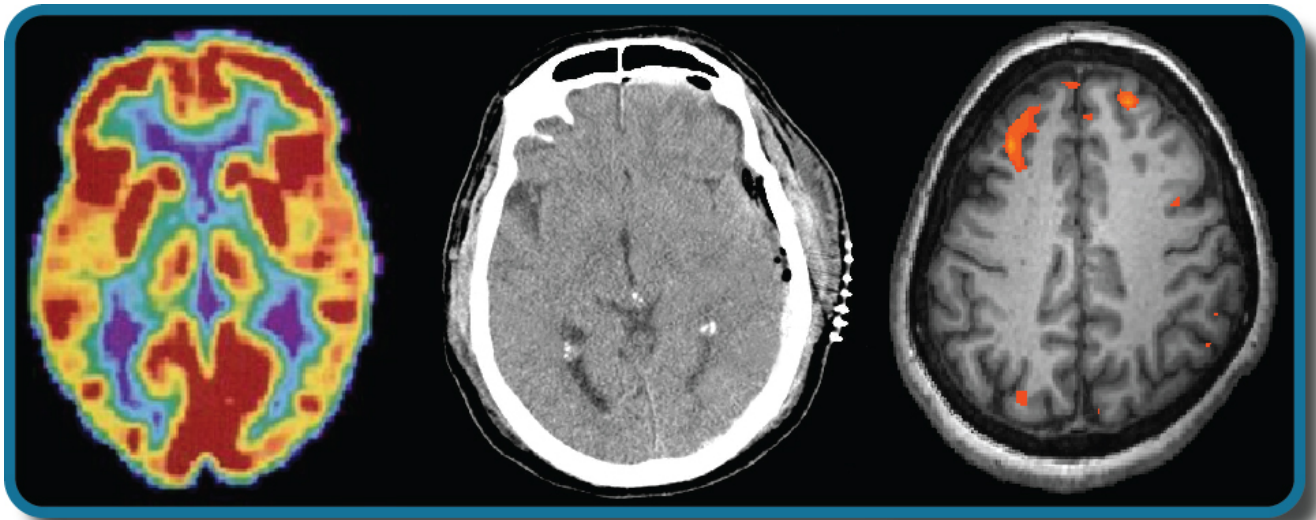
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## PART III

# PHYSIOLOGICAL ASPECTS OF PSYCHOLOGY



Different brain imaging techniques provide scientists with insight into different aspects of how the human brain functions. Left to right, PET scan (positron emission tomography), CT scan (computed tomography), and fMRI (functional magnetic resonance imaging) are three types of scans. (credit “left”: modification of work by Health and Human Services Department, National Institutes of Health; credit “center”: modification of work by “Aceofhearts1968”/Wikimedia Commons; credit “right”: modification of work by Kim J, Matthews NL, Park S.)

Have you ever taken a device apart to find out how it works? Many of us have done so, whether to attempt a repair or simply to satisfy our curiosity. A device’s internal workings are often distinct from its user interface on the outside. For example, we don’t think about microchips and circuits when we turn up the volume on a mobile phone; instead, we think about getting the volume just right. Similarly, the inner workings of the human body are often distinct from the external expression of those workings. It is the job of psychologists to find the connection between these—for example, to figure out how the firings of millions of neurons become a thought.

This chapter strives to explain the biological mechanisms that underlie behavior. These physiological and anatomical foundations are the basis for many areas of psychology. In this chapter, you will learn how genetics influence both physiological and psychological traits. You will become familiar with the structure and function of the nervous system. And, finally, you will learn how the nervous system interacts with the endocrine system.



## 9.

# HUMAN GENETICS

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## Learning Objectives

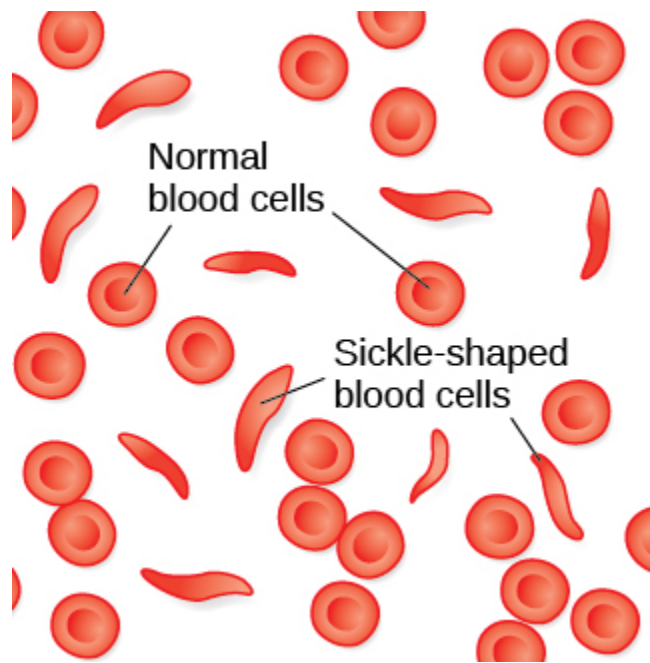
By the end of this section, you will be able to:

- Explain the basic principles of the theory of evolution by natural selection
- Describe the differences between genotype and phenotype
- Discuss how gene-environment interactions are critical for the expression of physical and psychological characteristics

Psychological researchers study genetics in order to better understand the biological basis that contributes to certain behaviors. While all humans share certain biological mechanisms, we are each unique. And while our bodies have many of the same parts—brains and hormones and cells with genetic codes—these are expressed in a wide variety of behaviors, thoughts, and reactions.

Why do two people infected by the same disease have different outcomes: one surviving and one succumbing to the ailment? How are genetic diseases passed through family lines? Are there genetic components to psychological disorders, such as depression or schizophrenia? To what extent might there be a psychological basis for health conditions such as childhood obesity?

To explore these questions, let's start by focusing on a specific disease, sickle-cell anemia, and how it might affect two infected sisters. Sickle-cell anemia is a genetic condition in which red blood cells, which are normally round, take on a crescent-like shape. The changed shape of these cells affects how they function: sickle-shaped cells can clog blood vessels and block blood flow, leading to high fever, severe pain, swelling, and tissue damage.



Normal blood cells travel freely through the blood vessels, while sickle-shaped cells form blockages preventing blood flow.

Many people with sickle-cell anemia—and the particular genetic **mutation** (*sudden, permanent change in a gene*) that causes it—die at an early age. While the notion of “survival of the fittest” may suggest that people suffering from this disease have a low survival rate and therefore the disease will become less common, this is not the case. Despite the negative evolutionary effects associated with this genetic mutation, the sickle-cell gene remains relatively common among people of African descent. Why is this? The explanation is illustrated with the following scenario.

Imagine two young women—Luwi and Sena—sisters in rural Zambia, Africa. Luwi carries the gene for sickle-cell anemia; Sena does not carry the gene. Sickle-cell carriers have one copy of the sickle-cell gene but do not have full-blown sickle-cell anemia. They experience symptoms only if they are severely dehydrated or are deprived of oxygen (as in mountain climbing). Carriers are thought to be immune from malaria (an often deadly disease that is widespread in tropical climates) because changes in their blood chemistry and immune functioning prevent the malaria parasite from having its effects (Gong, Parikh, Rosenthal, & Greenhouse, 2013). However, full-blown sickle-cell anemia, with two copies of the sickle-cell gene, does not provide immunity to malaria.

While walking home from school, both sisters are bitten by mosquitos carrying the malaria parasite. Luwi does not get malaria because she carries the sickle-cell mutation. Sena, on the other hand, develops malaria and dies just two weeks later. Luwi survives and eventually has children, to whom she may pass on the sickle-cell mutation.

Visit this website to learn more about how a mutation in DNA leads to sickle-cell anemia:

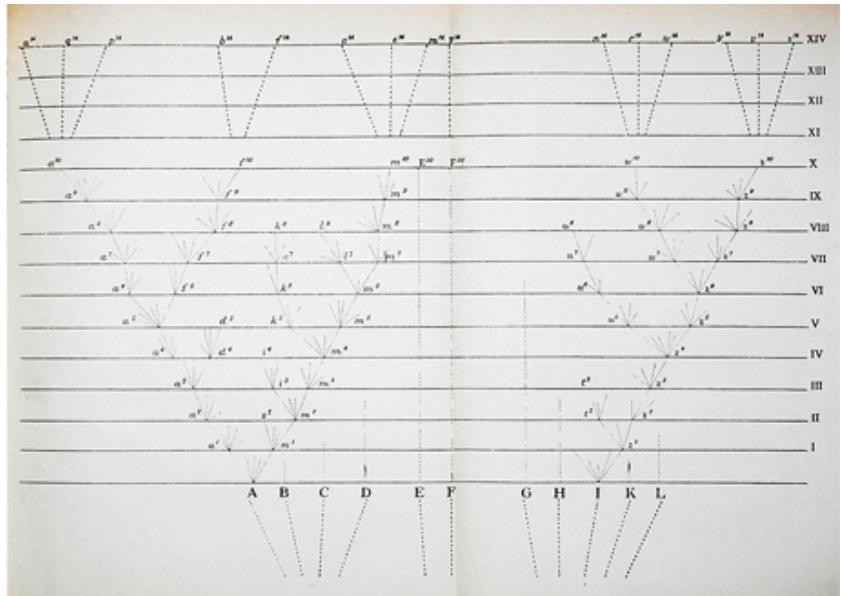
[Biology & 3D Animation Library – Sickle Cell](#),

Malaria is rare in the United States, so the sickle-cell gene benefits nobody: the gene manifests primarily in health problems—minor in carriers, severe in the full-blown disease—with no health benefits for carriers. However, the situation is quite different in other parts of the world. In parts of Africa where malaria is prevalent, having the sickle-cell mutation does provide health benefits for carriers (protection from malaria).

This is precisely the situation that Charles Darwin describes in the **theory of evolution by natural selection**. In simple terms, *the theory states that organisms that are better suited for their environment will survive and reproduce, while those that are poorly suited for their environment will die off*. In our example, we can see that as a carrier, Luwi's mutation is highly adaptive in her African homeland; however, if she resided in the United States (where malaria is much less common), her mutation could prove costly—with a high probability of the disease in her descendants and minor health problems of her own.



(a)



(b)

(a) In 1859, Charles Darwin proposed his theory of evolution by natural selection in his book, *On the Origin of Species*. (b) The book contains just one illustration: this diagram that shows how species evolve over time through natural selection.

# TWO PERSPECTIVES ON GENETICS AND BEHAVIOR

It's easy to get confused about two fields that study the interaction of genes and the environment, such as the fields of evolutionary psychology and behavioral genetics. How can we tell them apart?

In both fields, it is understood that **genes** (*sequence of DNA that controls or partially controls physical characteristics*) not only code for particular traits but also contribute to certain patterns of cognition and behavior. Evolutionary psychology focuses on how universal patterns of behavior and cognitive processes have evolved over time. Therefore, variations in cognition and behavior would make individuals more or less successful in reproducing and passing those genes to their offspring. Evolutionary psychologists study a variety of psychological phenomena that may have evolved as adaptations, including fear response, food preferences, mate selection, and cooperative behaviors (Confer et al., 2010).

Whereas evolutionary psychologists focus on universal patterns that evolved over millions of years, behavioral geneticists study how individual differences arise, in the present, through the interaction of genes and the environment. When studying human behavior, behavioral geneticists often employ twin and adoption studies to research questions of interest. Twin studies compare the rates that a given behavioral trait is shared among **identical twins** (*twins that develop from the same sperm and egg*) and **fraternal twins** (*twins who develop from two different eggs fertilized by different sperm, so their genetic material varies the same as in non-twin siblings*); adoption studies compare those rates among biologically related relatives and adopted relatives. Both approaches provide some insight into the relative importance of genes and environment for the expression of a given trait.

Watch this interview with renowned evolutionary psychologist Davis Buss for an explanation of how a psychologist approaches evolution and how this approach fits within the field of social science: [In the Expert's Chair with Dr. David Buss](#).



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://louis.pressbooks.pub/intropsychology/?p=163#oembed-1>

## Genetic Variation

Genetic variation, the genetic difference between individuals, is what contributes to a species' adaptation to its environment. In humans, genetic variation begins with an egg, about 100 million sperm, and fertilization. Fertile women ovulate roughly once per month, releasing an egg from follicles in the ovary. During the egg's journey from the ovary through the fallopian tubes, to the uterus, a sperm may fertilize an egg.

The egg and the sperm each contain 23 chromosomes. **Chromosomes** are *long strings of genetic material known as deoxyribonucleic acid (DNA)*. **DNA** is a *helix-shaped molecule made up of nucleotide base pairs*. In each chromosome, sequences of DNA make up genes that control or partially control a number of visible characteristics, known as traits, such as eye color, hair color, and so on. A single gene may have multiple possible variations, or alleles. An **allele** is a *specific version of a gene*. So, a given gene may code for the trait of hair color, and the different alleles of that gene affect which hair color an individual has.

When a sperm and egg fuse, their 23 chromosomes pair up and create a zygote with 23 pairs of chromosomes. Therefore, each parent contributes half the genetic information carried by the offspring; the resulting physical characteristics of the offspring (called the phenotype) are determined by the interaction of genetic material supplied by the parents (called the genotype). A person's **genotype** is *the genetic makeup of that individual*. **Phenotype**, on the other hand, *refers to the individual's inherited physical characteristics, which are a combination of genetic and environmental influences*.



(a)



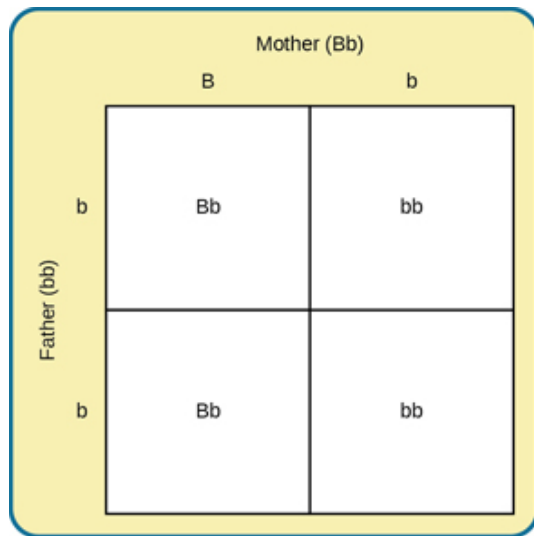
(b)

(a) Genotype refers to the genetic makeup of an individual based on the genetic material (DNA) inherited from one's parents. (b) Phenotype describes an individual's observable characteristics, such as hair color, skin color, height, and build. (credit a: modification of work by Caroline Davis; credit b: modification of work by Cory Zanker)

Most traits are controlled by multiple genes, but some traits are controlled by one gene. A characteristic like cleft chin, for example, is influenced by a single gene from each parent. In this example, we will call the gene for cleft chin "B," and the gene for smooth chin "b." Cleft chin is a dominant trait, which means that having the **dominant allele** (*an allele whose phenotype will be expressed in an individual that possesses that allele*) either

from one parent (Bb) or both parents (BB) will always result in the phenotype associated with the dominant allele. When someone has two copies of the same allele, they are said to be homozygous for that allele. When someone has a combination of alleles for a given gene, they are said to be **heterozygous** (*consisting of two different alleles*). For example, a smooth chin is a recessive trait, which means that an individual will only display the smooth chin phenotype if they are homozygous for that **recessive allele** (*allele whose phenotype will be expressed only if an individual is homozygous for that allele*) (bb).

Imagine that a woman with a cleft chin mates with a man with a smooth chin. What type of chin will their child have? The answer to that depends on which alleles each parent carries. If the woman is homozygous for cleft chin (BB), her offspring will always have a cleft chin. It gets a little more complicated, however, if the mother is heterozygous for this gene (Bb). Since the father has a smooth chin—therefore homozygous for the recessive allele (bb)—we can expect the offspring to have a 50% chance of having a cleft chin and a 50% chance of having a smooth chin.



(a)



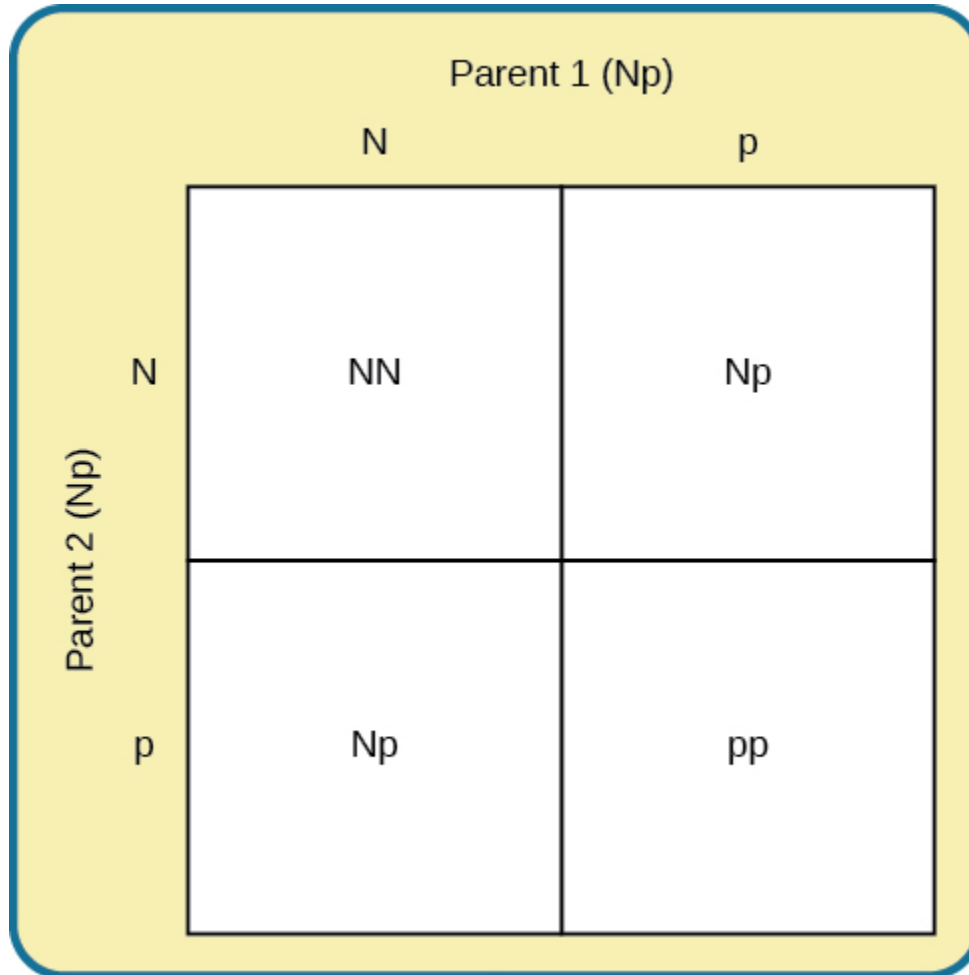
(b)

(a) A Punnett square is a tool used to predict how genes will interact in the production of offspring. The capital B represents the dominant allele, and the lowercase b represents the recessive allele. In the example of the cleft chin, where B is cleft chin (dominant allele), wherever a pair contains the dominant allele, B, you can expect a cleft chin phenotype. You can expect a smooth chin phenotype only when there are two copies of the recessive allele, bb. (b) A cleft chin, shown here, is an inherited trait.

Sickle-cell anemia is just one of many genetic disorders caused by the pairing of two recessive genes. For example, phenylketonuria (PKU) is a condition in which individuals lack an enzyme that normally converts harmful amino acids into harmless byproducts. If someone with this condition goes untreated, he or she will experience significant deficits in cognitive function, seizures, and an increased risk of various psychiatric disorders. Because PKU is a recessive trait, each parent must have at least one copy of the recessive allele in order to produce a child with the condition.

So far, we have discussed traits that involve just one gene, but few human characteristics are controlled by a

single gene. Most traits are **polygenic** (*multiple genes affecting a given trait*): controlled by more than one gene. Height is one example of a polygenic trait, as are skin color and weight.



In this Punnett square, N represents the normal allele, and p represents the recessive allele that is associated with PKU. If two individuals mate who are both heterozygous for the allele associated with PKU, their offspring have a 25% chance of expressing the PKU phenotype.

Where do harmful genes that contribute to diseases like PKU come from? Gene mutations provide one source of harmful genes. A mutation is a sudden, permanent change in a gene. While many mutations can be harmful or lethal, once in a while, a mutation benefits an individual by giving that person an advantage over those who do not have the mutation. Recall that the theory of evolution asserts that individuals best adapted to their particular environments are more likely to reproduce and pass on their genes to future generations. In order for this process to occur, there must be competition—more technically, there must be variability in genes (and resultant traits) that allow for variation in adaptability to the environment. If a population consisted of identical individuals, then any dramatic changes in the environment would affect everyone in the same way, and there would be no variation in selection. In contrast, diversity in genes and associated traits allows

some individuals to perform slightly better than others when faced with environmental change. This creates a distinct advantage for individuals best suited for their environments in terms of successful reproduction and genetic transmission.

## Gene-Environment Interactions

Genes do not exist in a vacuum. Although we are all biological organisms, we also exist in an environment that is incredibly important in determining not only when and how our genes express themselves, but also in what combination. Each of us represents a unique interaction between our genetic makeup and our environment; range of reaction is one way to describe this interaction. **Range of reaction** *asserts that our genes set the boundaries within which we can operate, and our environment interacts with the genes to determine where in that range we will fall.* For example, if an individual's genetic makeup predisposes her to high levels of intellectual potential and she is reared in a rich, stimulating environment, then she will be more likely to achieve her full potential than if she were raised under conditions of significant deprivation. According to the concept of range of reaction, genes set definite limits on potential, and environment determines how much of that potential is achieved. Some disagree with this theory and argue that genes do not set a limit on a person's potential.

Another perspective on the interaction between genes and the environment is the concept of **genetic environmental correlation** (*view of gene-environment interaction that asserts our genes affect our environment, and our environment influences the expression of our genes*). Stated simply, our genes influence our environment, and our environment influences the expression of our genes. Not only do our genes and environment interact, as in range of reaction, but they also influence one another bidirectionally. For example, the child of an NBA player would probably be exposed to basketball from an early age. Such exposure might allow the child to realize his or her full genetic, athletic potential. Thus, the parents' genes, which the child shares, influence the child's environment, and that environment, in turn, is well suited to support the child's genetic potential.



Nature and nurture work together like complex pieces of a human puzzle. The interaction of our environment and genes makes us the individuals we are. (credit “puzzle”: modification of work by Cory Zanker; credit “houses”: modification of work by Ben Salter; credit “DNA”: modification of work by NHGRI)

In another approach to gene-environment interactions, the field of **epigenetics** (*study of gene-environment interactions, such as how the same genotype leads to different phenotypes*) looks beyond the genotype itself and studies how the same genotype can be expressed in different ways. In other words, researchers study how the same genotype can lead to very different phenotypes. As mentioned earlier, gene expression is often influenced by environmental context in ways that are not entirely obvious. For instance, identical twins share the same genetic information (identical twins develop from a single fertilized egg that split, so the genetic material is exactly the same in each; in contrast, fraternal twins develop from two different eggs fertilized by different sperm, so the genetic material varies as with non-twin siblings). But even with identical genes, there remains an incredible amount of variability in how gene expression can unfold over the course of each twin’s life. Sometimes, one twin will develop a disease and the other will not. In one example, Tiffany, an identical twin, died from cancer at age 7, but her twin, now 19 years old, has never had cancer. Although these individuals share an identical genotype, their phenotypes differ as a result of how that genetic information is expressed over time. The epigenetic perspective is very different from range of reaction, because here the genotype is not fixed and limited.

Visit this site for an engaging video primer on the epigenetics of twin studies: [Insights From Identical Twins](#).

Genes affect more than our physical characteristics. Indeed, scientists have found genetic linkages to a number of behavioral characteristics, ranging from basic personality traits to sexual orientation to spirituality (for examples, see Mustanski et al., 2005; Comings, Gonzales, Saucier, Johnson, & MacMurray, 2000). Genes are also associated with temperament and a number of psychological disorders, such as depression and schizophrenia. So while it is true that genes provide the biological blueprints for our cells, tissues, organs, and body, they also have a significant impact on our experiences and our behaviors.

Let's look at the following findings regarding schizophrenia in light of our three views of gene-environment interactions. Which view do you think best explains this evidence?

In a study of people who were given up for adoption, adoptees whose biological mothers had schizophrenia *and* who had been raised in a disturbed family environment were much more likely to develop schizophrenia or another psychotic disorder than were any of the other groups in the study:

- Of adoptees whose biological mothers had schizophrenia (high genetic risk) and who were raised in disturbed family environments, 36.8% were likely to develop schizophrenia.
- Of adoptees whose biological mothers had schizophrenia (high genetic risk) and who were raised in healthy family environments, 5.8% were likely to develop schizophrenia.
- Of adoptees with a low genetic risk (whose mothers did not have schizophrenia) and who were raised in disturbed family environments, 5.3% were likely to develop schizophrenia.
- Of adoptees with a low genetic risk (whose mothers did not have schizophrenia) and who were raised in healthy family environments, 4.8% were likely to develop schizophrenia (Tienari et al., 2004).

The study shows that adoptees with high genetic risk were especially likely to develop schizophrenia only if they were raised in disturbed home environments. This research lends credibility to the notion that both genetic vulnerability and environmental stress are necessary for schizophrenia to develop, and that genes alone do not tell the full tale.

## Test Your Understanding



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## Review Questions



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## Critical Thinking Questions

The theory of evolution by natural selection requires variability of a given trait. Why is variability necessary and where does it come from?

Variability is essential for natural selection to work. If all individuals are the same on a given trait, there will be no relative difference in their reproductive success because everyone will be equally adapted to their environments on that trait. Mutations are one source of variability, but sexual reproduction is another important source of variation given that individuals inherit half of their genetic makeup from each of their parents.

## Personal Application Questions

You share half of your genetic makeup with each of your parents, but you are no doubt very different from both of them. Spend a few minutes jotting down the similarities and differences between you and your parents. How do you think your unique environment and experiences have contributed to some of the differences you see?

## Summary

Genes are sequences of DNA that code for a particular trait. Different versions of a gene are called alleles—sometimes alleles can be classified as dominant or recessive. A dominant allele always results in the dominant phenotype. In order to exhibit a recessive phenotype, an individual must be homozygous for the recessive allele. Genes affect both physical and psychological characteristics. Ultimately, how and when a gene is expressed, and what the outcome will be—in terms of both physical and psychological characteristics—is a function of the interaction between our genes and our environments.

## 10.

# CELLS OF THE NERVOUS SYSTEM

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## Learning Objectives

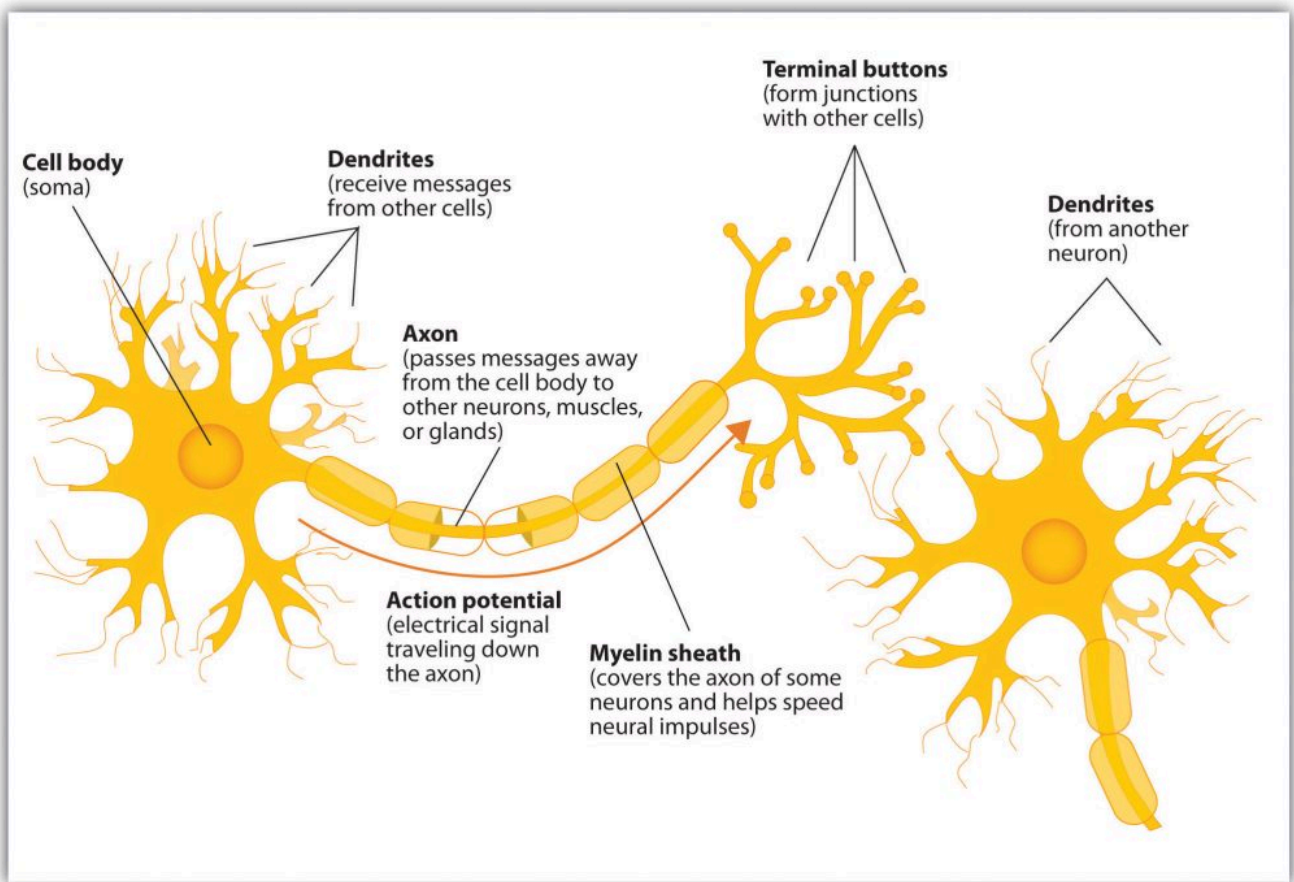
By the end of this section, you will be able to:

- Identify the basic parts of a neuron
- Describe how neurons communicate with each other
- Explain how drugs act as agonists or antagonists for a given neurotransmitter system

Psychologists striving to understand the human mind may study the nervous system. Learning how the cells and organs (like the brain) function helps us understand the biological basis behind human psychology. The nervous system is composed of two basic cell types: glial cells (also known as glia) and neurons. Glial cells, which outnumber neurons ten to one, are traditionally thought to play a supportive role to neurons, both physically and metabolically. Glial cells provide scaffolding on which the nervous system is built, help neurons line up closely with each other to allow neuronal communication, provide insulation to neurons, transport nutrients and waste products, and mediate immune responses. Neurons, on the other hand, serve as interconnected information processors that are essential for all of the tasks of the nervous system. This section briefly describes the structure and function of neurons.

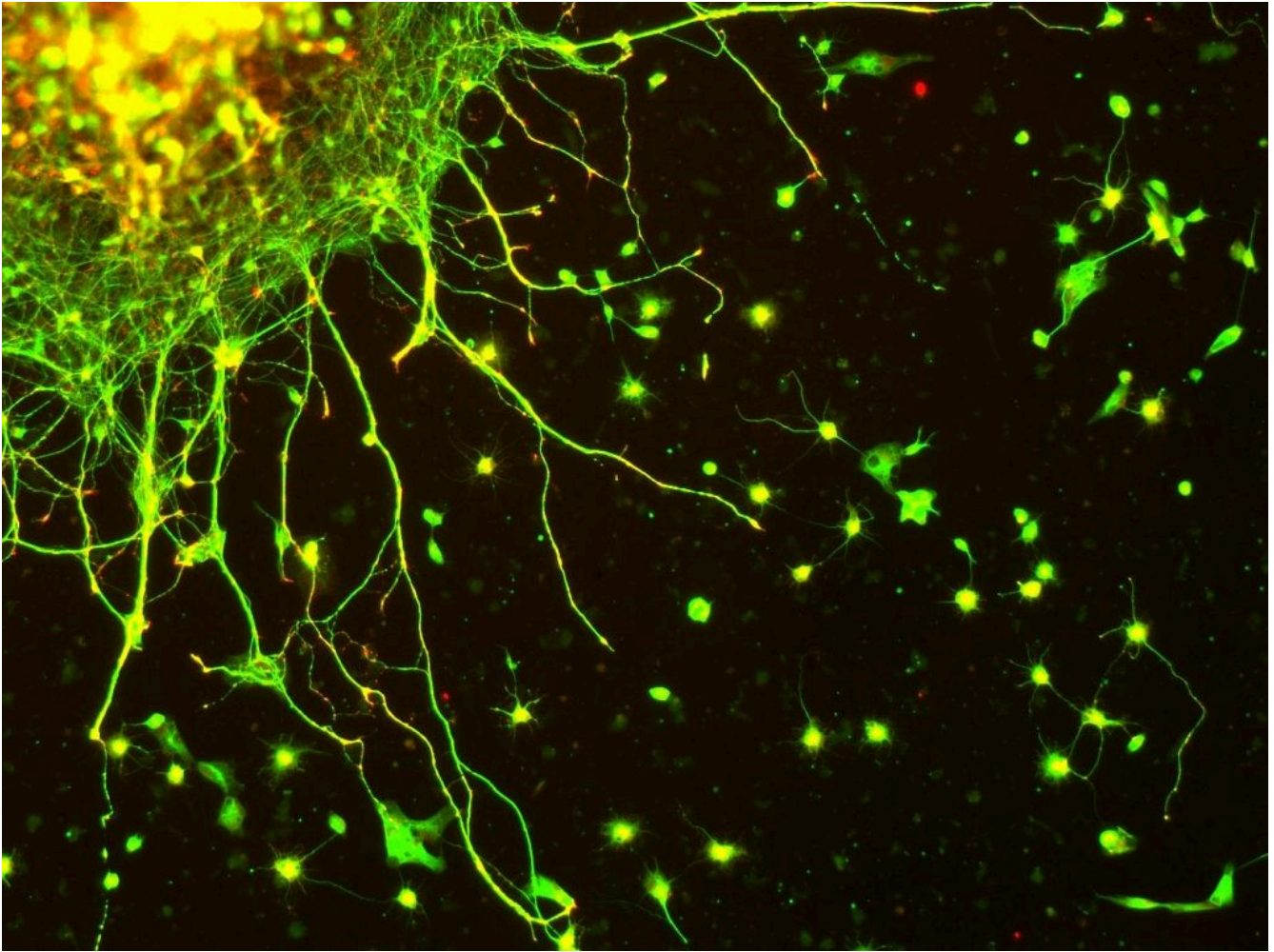
The nervous system is composed of more than 100 billion cells known as *neurons*. A **neuron** is a cell in the nervous system whose function is to receive and transmit information. As you can see in the figure, “Components of the Neuron,” neurons are made up of three major parts: a cell body, or **soma**, which *contains the nucleus of the cell and keeps the cell alive*; a branching treelike fiber known as the **dendrite**, which *collects information from other cells and sends the information to the soma*; and a long, segmented fiber known as the **axon**, which *transmits information away from the cell body toward other neurons or to the muscles and glands*.

### Components of the Neuron



Components of the Neuron

**Neurons, in vitro color**



The nervous system, including the brain, is made up of billions of interlinked neurons. This vast interconnected web is responsible for all human thinking, feeling, and behavior.

Some neurons have hundreds or even thousands of dendrites, and these dendrites may themselves be branched to allow the cell to receive information from thousands of other cells. The axons are also specialized, and some, such as those that send messages from the spinal cord to the muscles in the hands or feet, may be very long—even up to several feet in length. To improve the speed of their communication, and to keep their electrical charges from shorting out with other neurons, axons are often surrounded by a *myelin sheath*. The **myelin sheath** is a layer of fatty tissue surrounding the axon of a neuron that both acts as an insulator and allows faster transmission of the electrical signal. Axons branch out toward their ends, and at the tip of each branch is a *terminal button*.

# Neurons Communicate Using Electricity and Chemicals

The nervous system operates using an electrochemical process. An electrical charge moves through the neuron itself and chemicals are used to transmit information between neurons. Within the neuron, when a signal is received by the dendrites, it is transmitted to the soma in the form of an electrical signal, and, if the signal is strong enough, it may then be passed on to the axon and then to the **Terminal buttons** (*axon terminal containing synaptic vesicles*). If the signal reaches the terminal buttons, they are signaled to emit chemicals known as **neurotransmitters** (*chemical messenger of the nervous system*), which communicate with other neurons across the *spaces between the cells*, known as **synapses**.

This video, Neuron Impulse, shows a model of the electrochemical action of the neuron and neurotransmitters.

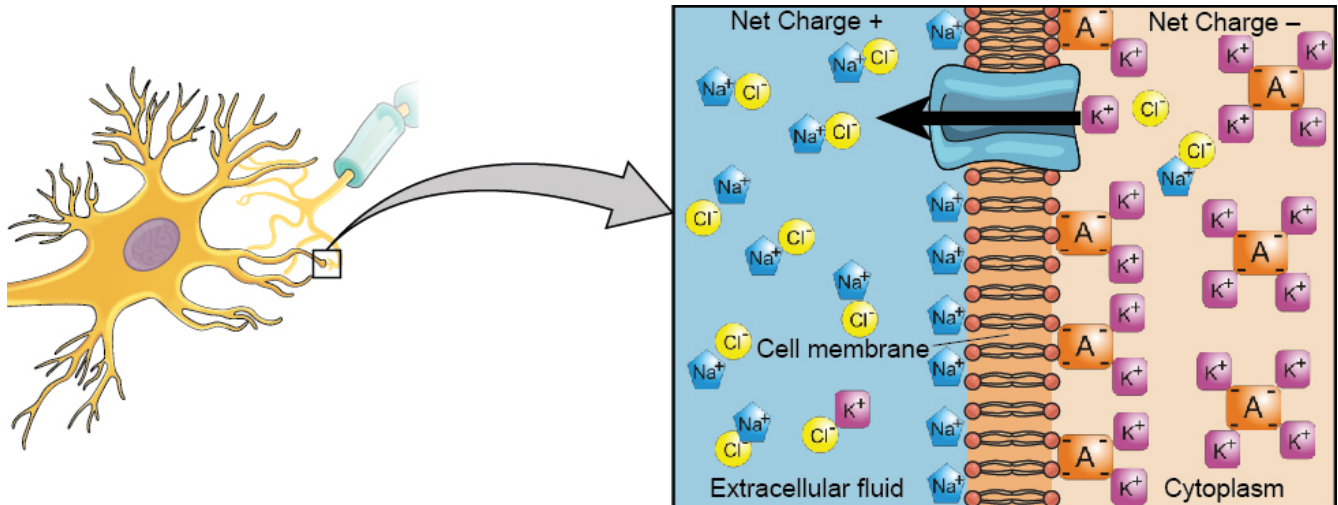


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The electrical signal moves through the neuron as a result of changes in the electrical charge of the axon. Normally, the axon remains in the **resting potential**, *a state in which the interior of the neuron contains a greater number of negatively charged ions than does the area outside the cell*. When the segment of the axon that is closest to the cell body is stimulated by an electrical signal from the dendrites, and if this electrical signal is strong enough that it passes a certain level or *threshold*, the cell membrane in this first segment opens its gates, allowing positively charged sodium ions that were previously kept out to enter. This *change in electrical charge that occurs in a neuron when a nerve impulse is transmitted* is known as the **action potential**. Once the action potential occurs, the number of positive ions exceeds the number of negative ions in this segment, and the segment temporarily becomes positively charged.

Between signals, the neuron membrane's potential is held in a state of readiness, called the resting potential. Like a rubber band stretched out and waiting to spring into action, ions line up on either side of the cell membrane, ready to rush across the membrane when the neuron goes active and the membrane opens its gates (i.e., a sodium-potassium pump that allows movement of ions across the membrane). Ions in high-concentration areas are ready to move to low-concentration areas, and positive ions are ready to move to areas with a negative charge.

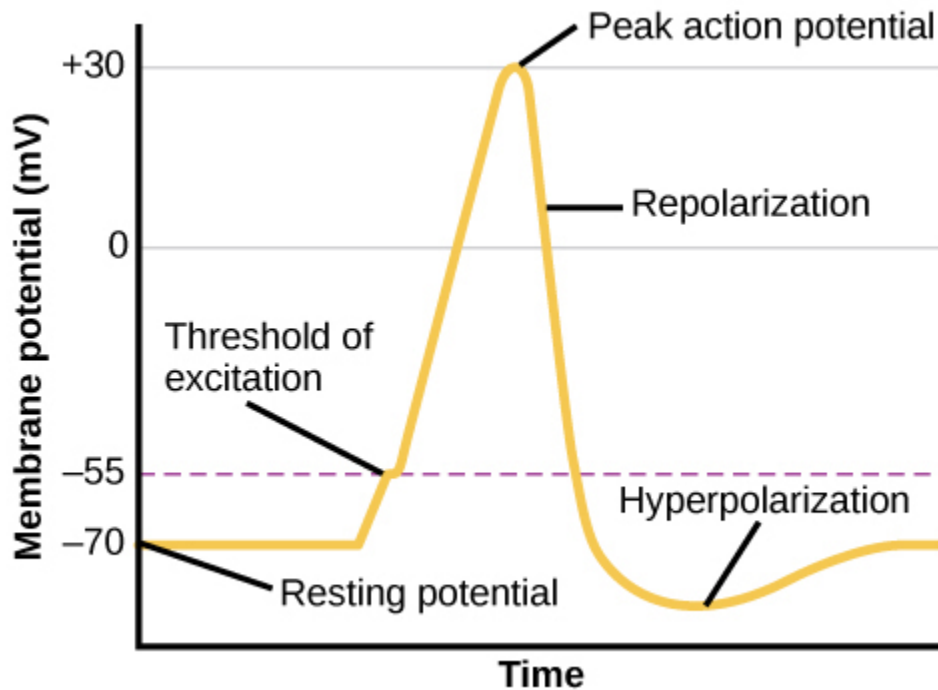
In the resting state, sodium ( $\text{Na}^+$ ) is at higher concentrations outside the cell, so it will tend to move into the cell. Potassium ( $\text{K}^+$ ), on the other hand, is more concentrated inside the cell and will tend to move out of the cell. In addition, the inside of the cell is slightly negatively charged compared to the outside. This provides an additional force on sodium, causing it to move into the cell.



At resting potential,  $\text{Na}^+$  (blue pentagons) is more highly concentrated outside the cell in the extracellular fluid (shown in blue), whereas  $\text{K}^+$  (purple squares) is more highly concentrated near the membrane in the cytoplasm or intracellular fluid. Other molecules, such as chloride ions (yellow circles) and negatively charged proteins (brown squares), help contribute to a positive net charge in the extracellular fluid and a negative net charge in the intracellular fluid.

From this resting potential state, the neuron receives a signal and its state changes abruptly. When a neuron receives signals at the dendrites—due to neurotransmitters from an adjacent neuron binding to its **receptors** (*protein on the cell surface where neurotransmitters attach*)—small pores, or gates, open on the neuronal membrane, allowing  $\text{Na}^+$  ions, propelled by both charge and concentration differences, to move into the cell. With this influx of positive ions, the internal charge of the cell becomes more positive. If that charge reaches a certain level, called the **threshold of excitation** (*level of charge in the membrane that causes the neuron to become active*), the neuron becomes active and the action potential begins.

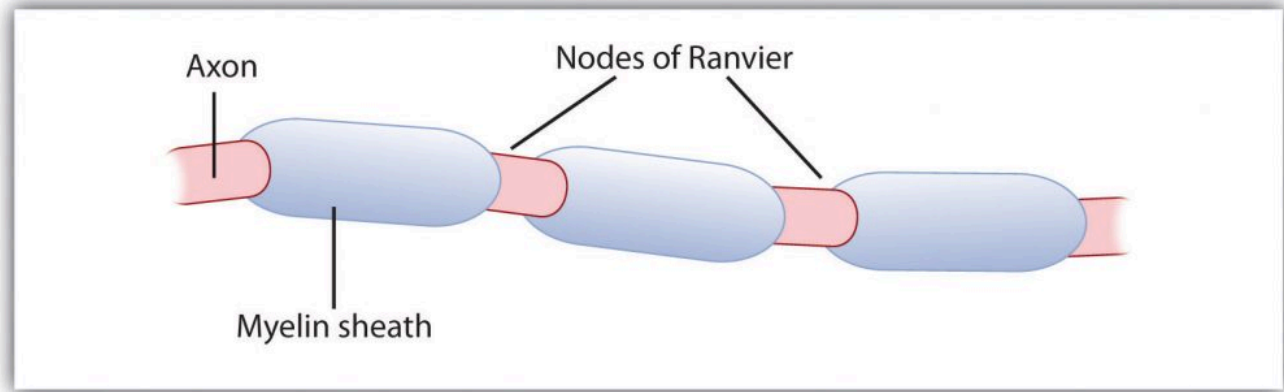
Many additional pores open, causing a massive influx of  $\text{Na}^+$  ions and a huge positive spike in the membrane potential, the peak action potential. At the peak of the spike, the sodium gates close and the potassium gates open. As positively charged potassium ions leave, the cell quickly begins repolarization. At first, it hyperpolarizes, becoming slightly more negative than the resting potential, and then it levels off, returning to the resting potential.



During the action potential, the electrical charge across the membrane changes dramatically.

As you can see in the figure “The Myelin Sheath and the Nodes of Ranvier,” the axon is segmented by a series of *breaks between the sausage-like segments of the myelin sheath*. Each of these gaps is a **node of Ranvier**. The electrical charge moves down the axon from segment to segment, in a set of small jumps, moving from node to node. When the action potential occurs in the first segment of the axon, it quickly creates a similar change in the next segment, which then stimulates the next segment and so forth as the positive electrical impulse continues all the way down to the end of the axon. As each new segment becomes positive, the membrane in the prior segment closes up again, and the segment returns to its negative resting potential. In this way the action potential is transmitted along the axon, toward the terminal buttons. The entire response along the length of the axon is very fast—it can happen up to 1,000 times each second.

### **The Myelin Sheath and the Nodes of Ranvier**



The myelin sheath wraps around the axon but also leaves small gaps called the nodes of Ranvier. The action potential jumps from node to node as it travels down the axon.

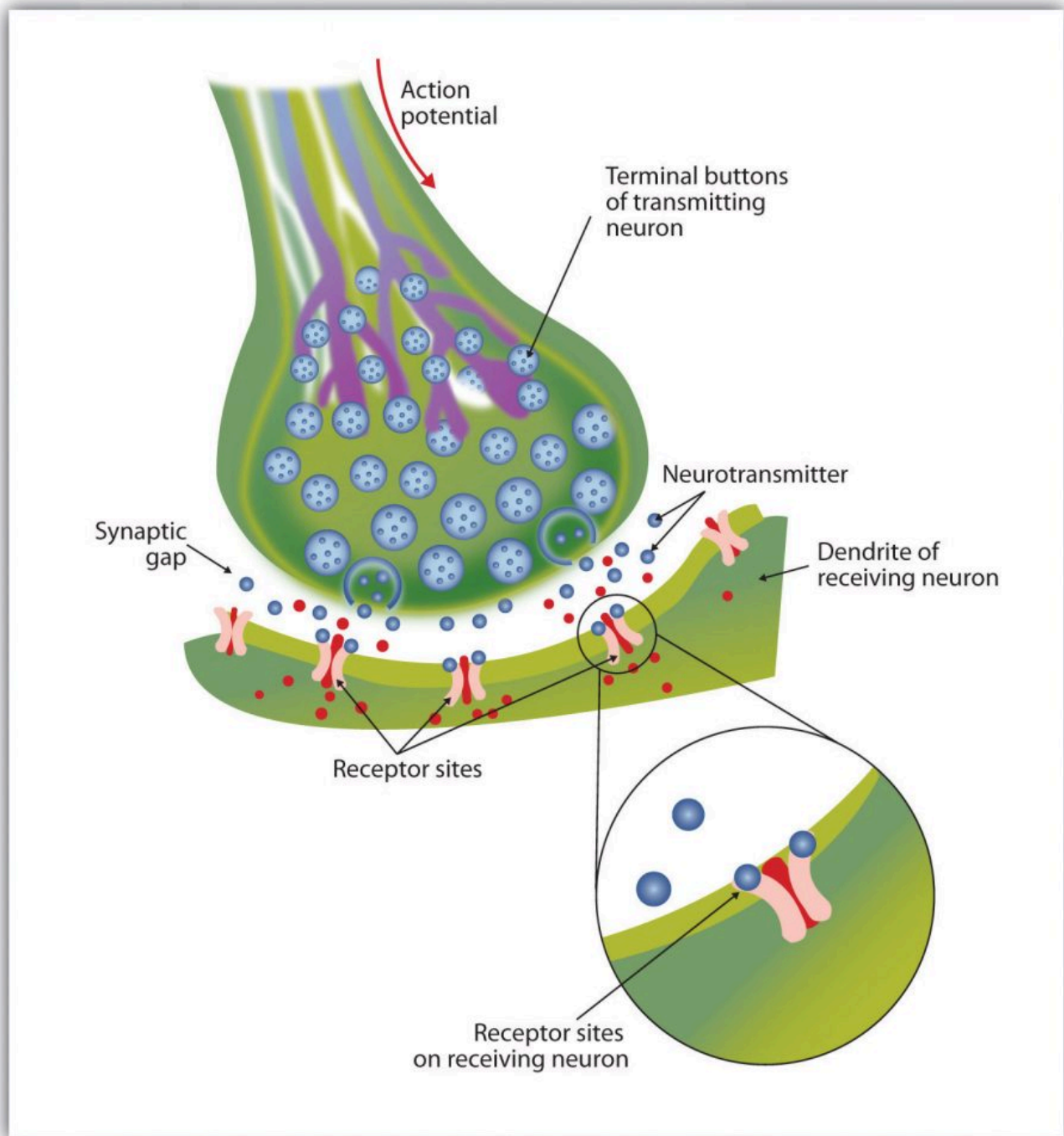
An important aspect of the action potential is that it operates in an *all-or-nothing* manner. What this means is that the neuron either fires completely, such that the action potential moves all the way down the axon, or it does not fire at all. Thus neurons can provide more energy to the neurons down the line by firing faster but not by firing more strongly. Furthermore, the neuron is prevented from repeated firing by the presence of a *refractory period*—a brief time after the firing of the axon in which the axon cannot fire again because the neuron has not yet returned to its resting potential.

## Neurotransmitters: The Body's Chemical Messengers

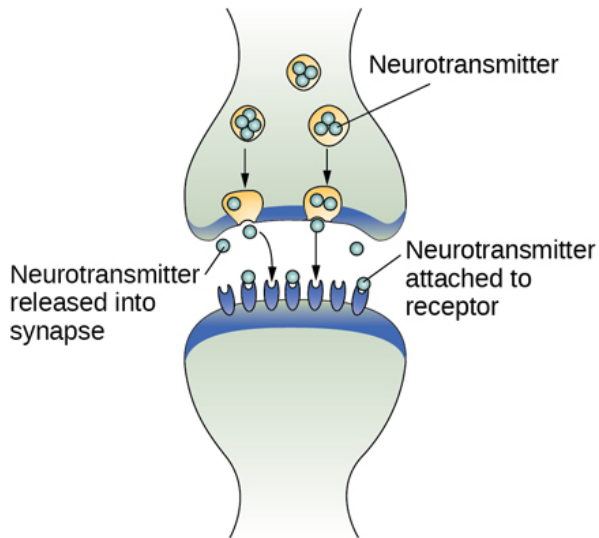
Not only do the neural signals travel via electrical charges *within* the neuron, but they also travel via chemical transmission *between* the neurons. Neurons are separated by junction areas known as **synapses**, *areas where the terminal buttons at the end of the axon of one neuron nearly, but don't quite, touch the dendrites of another*. The synapses provide a remarkable function because they allow each axon to communicate with many dendrites in neighboring cells. Because a neuron may have synaptic connections with thousands of other neurons, the communication links among the neurons in the nervous system allow for a highly sophisticated communication system.

When the electrical impulse from the action potential reaches the end of the axon, it signals the terminal buttons to release neurotransmitters into the synapse. A **neurotransmitter** is *a chemical that relays signals across the synapses between neurons*. Neurotransmitters travel across the synaptic space between the terminal button of one neuron and the dendrites of other neurons, where they bind to the dendrites in the neighboring neurons. Furthermore, different terminal buttons release different neurotransmitters, and different dendrites are particularly sensitive to different neurotransmitters. The dendrites will admit the neurotransmitters only if

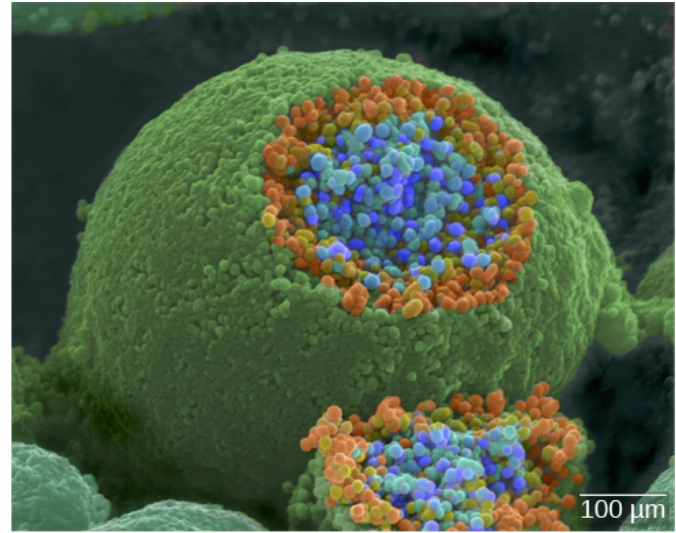
they are the right shape to fit in the receptor sites on the receiving neuron. For this reason, the receptor sites and neurotransmitters are often compared to a lock and key (Figure 3.5 “The Synapse”).



When the nerve impulse reaches the terminal button, it triggers the release of neurotransmitters into the synapse. The neurotransmitters fit into receptors on the receiving dendrites in the manner of a lock and key.



(a)



(b)

(a) The synaptic cleft is the space between the terminal button of one neuron and the dendrite of another neuron. (b) In this pseudo-colored image from a scanning electron microscope, a terminal button (green) has been opened to reveal the synaptic vesicles (orange and blue) inside. Each vesicle contains about 10,000 neurotransmitter molecules. (credit b: modification of work by Tina Carvalho, NIH-NIGMS; scale-bar data from Matt Russell)

When neurotransmitters are accepted by the receptors on the receiving neurons their effect may be either *excitatory* (i.e., they make the cell more likely to fire) or *inhibitory* (i.e., they make the cell less likely to fire). Furthermore, if the receiving neuron is able to accept more than one neurotransmitter, then it will be influenced by the excitatory and inhibitory processes of each. If the excitatory effects of the neurotransmitters are greater than the inhibitory influences of the neurotransmitters, the neuron moves closer to its firing threshold, and if it reaches the threshold, the action potential and the process of transferring information through the neuron begins.

Neurotransmitters that are not accepted by the receptor sites must be removed from the synapse in order for the next potential stimulation of the neuron to happen. This process occurs in part through the breaking down of the neurotransmitters by enzymes, and in part through **reuptake**, *a process in which neurotransmitters that are in the synapse are reabsorbed into the transmitting terminal buttons, ready to again be released after the neuron fires.*

More than 100 chemical substances produced in the body have been identified as neurotransmitters, and these substances have a wide and profound effect on emotion, cognition, and behavior. Neurotransmitters regulate our appetite, our memory, our emotions, as well as our muscle action and movement. And as you can see in Table 3.1 “The Major Neurotransmitters and Their Functions,” some neurotransmitters are also associated with psychological and physical diseases.

Drugs that we might ingest—either for medical reasons or recreationally—can act like neurotransmitters to

influence our thoughts, feelings, and behavior. An **agonist** is *a drug that has chemical properties similar to a particular neurotransmitter and thus mimics the effects of the neurotransmitter*. When an agonist is ingested, it binds to the receptor sites in the dendrites to excite the neuron, acting as if more of the neurotransmitter had been present. As an example, cocaine is an agonist for the neurotransmitter dopamine. Because dopamine produces feelings of pleasure when it is released by neurons, cocaine creates similar feelings when it is ingested. An **antagonist** is *a drug that reduces or stops the normal effects of a neurotransmitter*. When an antagonist is ingested, it binds to the receptor sites in the dendrite, thereby blocking the neurotransmitter. As an example, the poison curare is an antagonist for the neurotransmitter acetylcholine. When the poison enters the brain, it binds to the dendrites, stops communication among the neurons, and usually causes death. Still other drugs work by blocking the reuptake of the neurotransmitter itself—when reuptake is reduced by the drug, more neurotransmitter remains in the synapse, increasing its action.

Certain symptoms of schizophrenia are associated with overactive dopamine neurotransmission. The antipsychotics used to treat these symptoms are antagonists for dopamine—they block dopamine's effects by binding its receptors without activating them. Thus, they prevent dopamine released by one neuron from signaling information to adjacent neurons.

In contrast to agonists and antagonists, which both operate by binding to receptor sites, reuptake inhibitors prevent unused neurotransmitters from being transported back to the neuron. This leaves more neurotransmitters in the synapse for a longer time, increasing its effects. Depression, which has been consistently linked with reduced serotonin levels, is commonly treated with selective serotonin reuptake inhibitors (SSRIs). By preventing reuptake, SSRIs strengthen the effect of serotonin, giving it more time to interact with serotonin receptors on dendrites. Common SSRIs on the market today include Prozac, Paxil, and Zoloft. The drug LSD is structurally very similar to serotonin, and it affects the same neurons and receptors as serotonin. Psychotropic drugs are not instant solutions for people suffering from psychological disorders. Often, an individual must take a drug for several weeks before seeing improvement, and many psychoactive drugs have significant negative side effects. Furthermore, individuals vary dramatically in how they respond to the drugs. To improve chances for success, it is not uncommon for people receiving pharmacotherapy to undergo psychological and/or behavioral therapies as well. Some research suggests that combining drug therapy with other forms of therapy tends to be more effective than any one treatment alone (for one such example, see March et al., 2007).

## Test Your Understanding



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## Key Takeaways

- The central nervous system (CNS) is the collection of neurons that make up the brain and the spinal cord.
- The peripheral nervous system (PNS) is the collection of neurons that link the CNS to our skin, muscles, and glands.
- Neurons are specialized cells, found in the nervous system, which transmit information. Neurons contain a dendrite, a soma, and an axon.
- Some axons are covered with a fatty substance known as the myelin sheath, which surrounds the axon, acting as an insulator and allowing faster transmission of the electrical signal.
- The dendrite is a treelike extension that receives information from other neurons and transmits electrical stimulation to the soma.
- The axon is an elongated fiber that transfers information from the soma to the terminal buttons.

## Review Questions



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## 11.

# PARTS OF THE NERVOUS SYSTEM

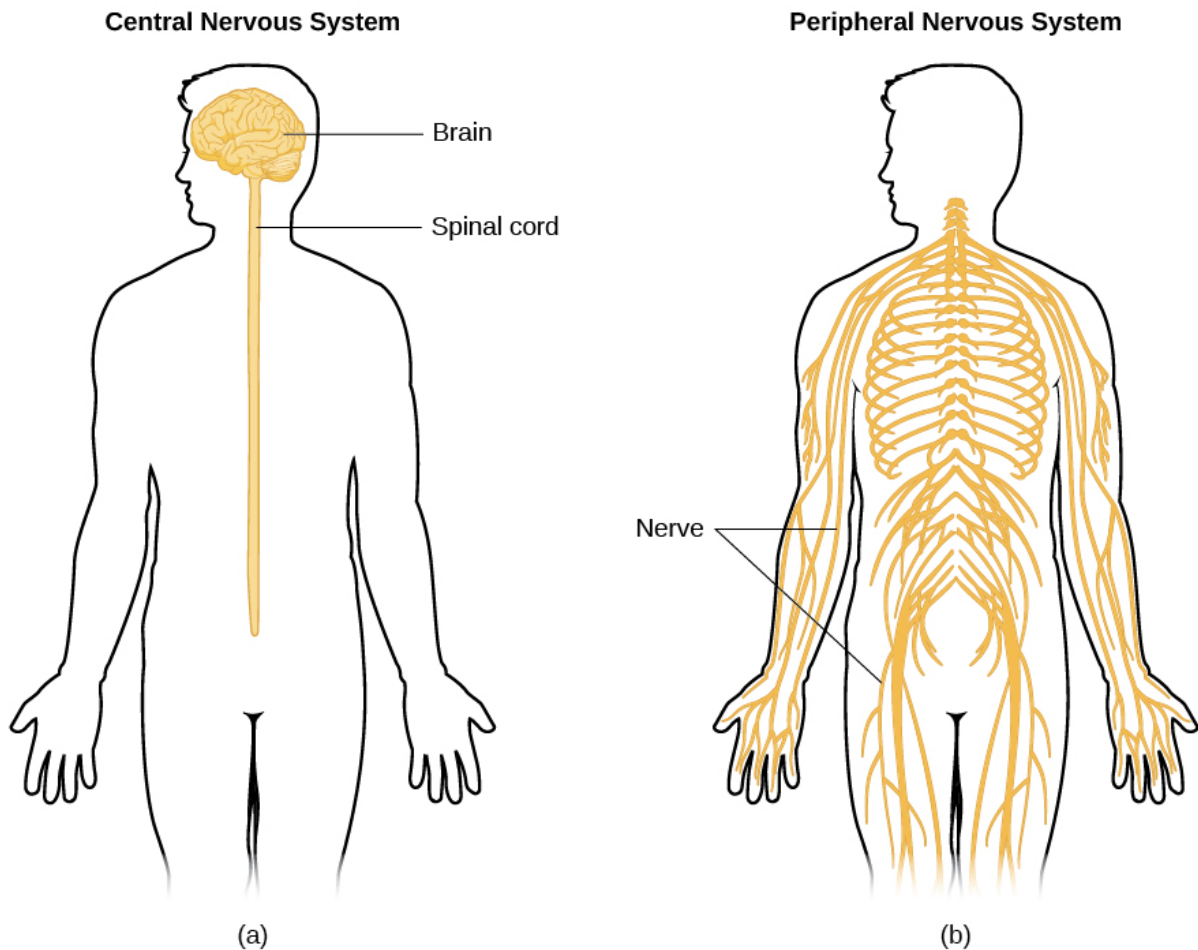
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### Learning Objectives

By the end of this section, you will be able to:

- Describe the difference between the central and peripheral nervous systems
- Explain the difference between the somatic and autonomic nervous systems
- Differentiate between the sympathetic and parasympathetic divisions of the autonomic nervous system

The nervous system can be divided into two major subdivisions: the **central nervous system (CNS)** (*brain and spinal cord*) and the peripheral nervous system (PNS), as shown in the following image. The CNS is comprised of the brain and spinal cord; the PNS connects the CNS to the rest of the body. In this section, we focus on the peripheral nervous system; later, we look at the brain and spinal cord.



The nervous system is divided into two major parts: (a) the Central Nervous System and (b) the Peripheral Nervous System.

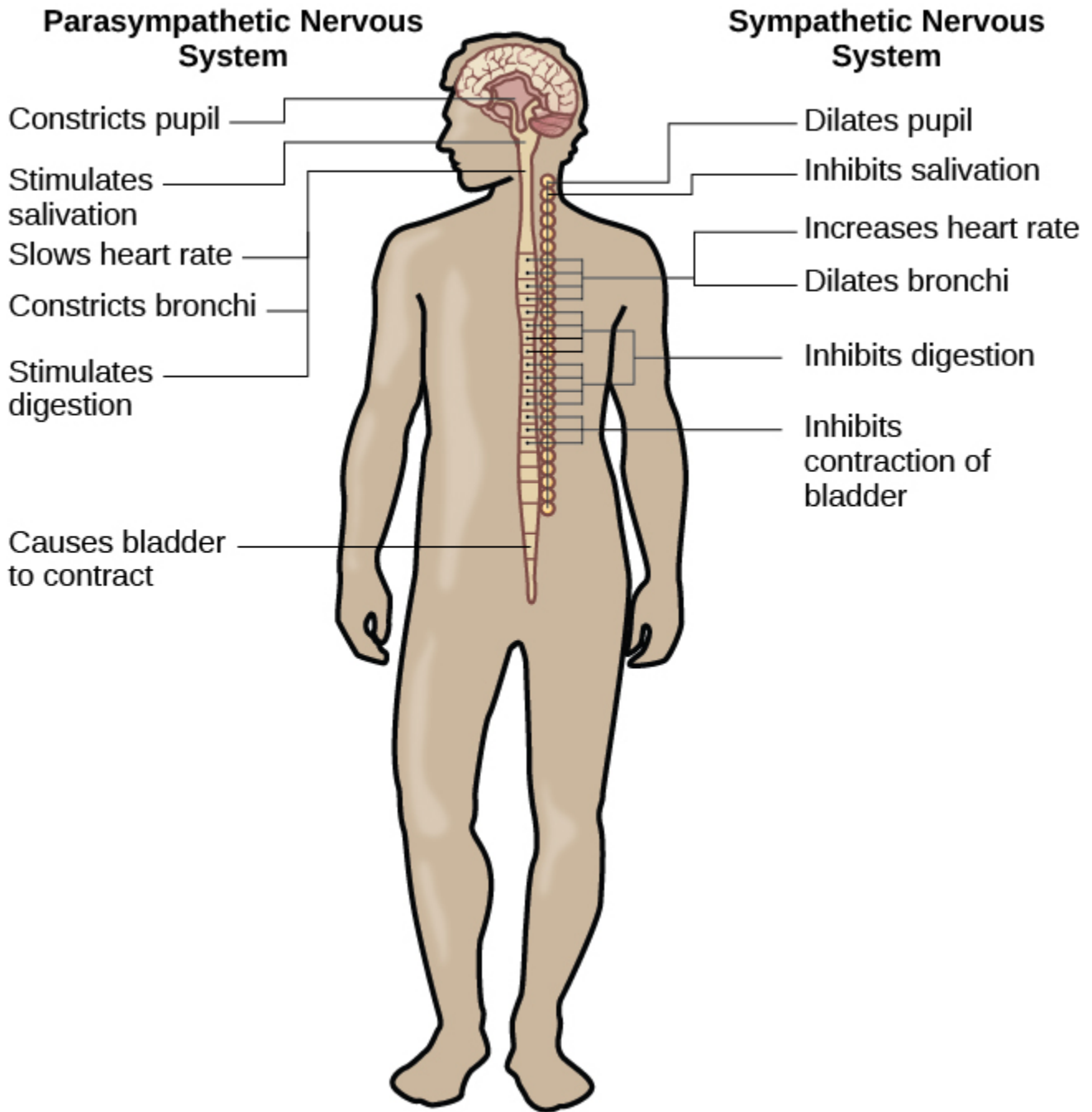
## Peripheral Nervous System

The peripheral nervous system is made up of thick bundles of axons, called nerves, carrying messages back and forth between the CNS and the muscles, organs, and senses in the periphery of the body (i.e., everything outside the CNS). The PNS has two major subdivisions: the somatic nervous system and the **autonomic nervous system** (*controls our internal organs and glands*).

The somatic nervous system is associated with activities traditionally thought of as conscious or voluntary. It is involved in the relay of sensory and motor information to and from the CNS; therefore, it consists of motor neurons and sensory neurons. Motor neurons, carrying instructions from the CNS to the muscles, are efferent fibers (efferent means “moving away from”). Sensory neurons, carrying sensory information to the CNS, are afferent fibers (afferent means “moving toward”). Each nerve is basically a two-way superhighway, containing thousands of axons, both efferent and afferent.

The autonomic nervous system controls our internal organs and glands and is generally considered to be

outside the realm of voluntary control. It can be further subdivided into the sympathetic and parasympathetic divisions. The **sympathetic nervous system** is *involved in preparing the body for stress-related activities*; the **parasympathetic nervous system** is *associated with returning the body to routine, day-to-day operations*. The two systems have complementary functions, operating in tandem to maintain the body's homeostasis. **Homeostasis** is *a state of equilibrium*, in which biological conditions (such as body temperature) are maintained at optimal levels.



The sympathetic and parasympathetic divisions of the autonomic nervous system have the opposite effects on various systems.

The sympathetic nervous system is activated when we are faced with stressful or high-arousal situations. The activity of this system was adaptive for our ancestors, increasing their chances of survival. Imagine, for example, that one of our early ancestors, out hunting small game, suddenly disturbs a large bear with her cubs. At that moment, his body undergoes a series of changes—a direct function of sympathetic activation—preparing him to face the threat. His pupils dilate, his heart rate and blood pressure increase, his bladder relaxes, his liver releases glucose, and adrenaline surges into his bloodstream. This constellation of physiological changes, known as the **fight or flight response** (*activation of the sympathetic division of the autonomic nervous system, allowing access to energy reserves and heightened sensory capacity so that we might fight off a given threat or run away to safety*), allows the body access to energy reserves and heightened sensory capacity so that it might fight off a threat or run away to safety.

While it is clear that such a response would be critical for survival for our ancestors, who lived in a world full of real physical threats, many of the high-arousal situations we face in the modern world are more psychological in nature. For example, think about how you feel when you have to stand up and give a presentation in front of a roomful of people, or right before taking a big test. You are in no real physical danger in those situations, and yet you have evolved to respond to any perceived threat with the fight or flight response. This kind of response is not nearly as adaptive in the modern world; in fact, we suffer negative health consequences when faced constantly with psychological threats that we can neither fight nor flee. Recent research suggests that an increase in susceptibility to heart disease (Chandola, Brunner, & Marmot, 2006) and impaired function of the immune system (Glaser & Kiecolt-Glaser, 2005) are among the many negative consequences of persistent and repeated exposure to stressful situations.

Once the threat has been resolved, the parasympathetic nervous system takes over and returns bodily functions to a relaxed state. Our hunter's heart rate and blood pressure return to normal, his pupils constrict, he regains control of his bladder, and the liver begins to store glucose in the form of glycogen for future use. These processes are associated with activation of the parasympathetic nervous system.

## Test Your Understanding



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## Review Questions



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## Critical Thinking Questions

What are the implications of compromised immune function as a result of exposure to chronic stress?

Chronic stress can lead to increased susceptibility to bacterial and viral infections, and potentially an increased risk of cancer. Ultimately, this could be a vicious cycle with stress leading to increased risk of disease, disease states leading to increased stress and so on.

Examine Figure 3.14, illustrating the effects of sympathetic nervous system activation. How would all of these things play into the fight or flight response?

Most of these effects directly impact energy availability and redistribution of key resources and heightened sensory capacity. The individual experiencing these effects would be better prepared to fight or flee.

## Personal Application Questions

Hopefully, you do not face real physical threats from potential predators on a daily basis. However, you probably have your fair share of stress. What situations are your most common sources of stress? What can you do to try to minimize the negative consequences of these particular stressors in your life?

## Summary

The brain and spinal cord make up the central nervous system. The **peripheral nervous system** (*connects the brain and spinal cord to the muscles, organs, and senses in the periphery of the body*) is comprised of the somatic and autonomic nervous systems. The **somatic nervous system** *transmits sensory and motor signals to and from the central nervous system*. The autonomic nervous system controls the function of our organs and glands and can be divided into the sympathetic and parasympathetic divisions. Sympathetic activation prepares us for fight or flight, while parasympathetic activation is associated with normal functioning under relaxed conditions.

## 12.

# OUR BRAINS CONTROL OUR THOUGHTS, FEELINGS, AND BEHAVIOR

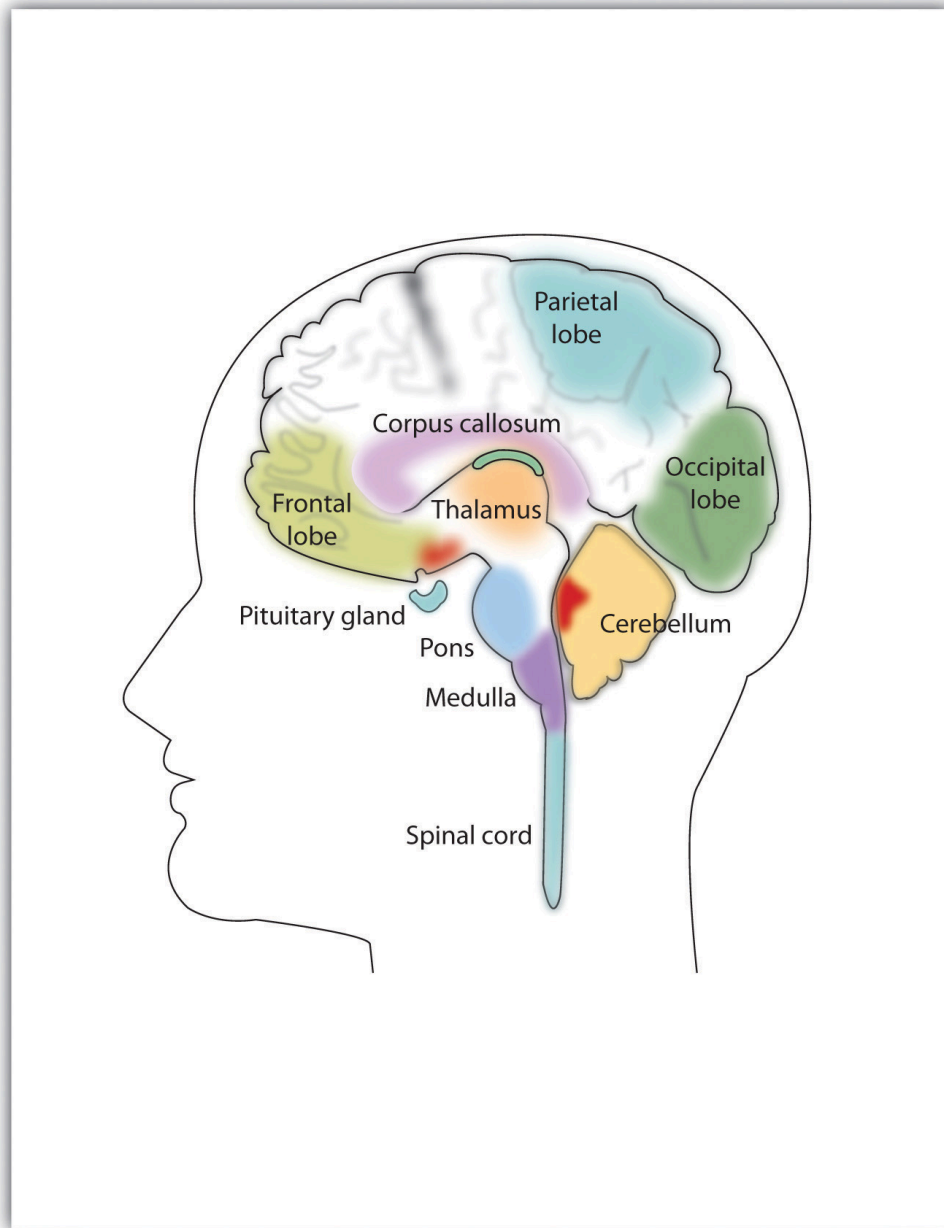
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## Learning Objectives

- Describe the structures and function of the “old brain” and its influence on behavior.
- Explain the structure of the cerebral cortex (its hemispheres and lobes) and the function of each area of the cortex.
- Define the concepts of brain plasticity, neurogenesis, and brain lateralization.

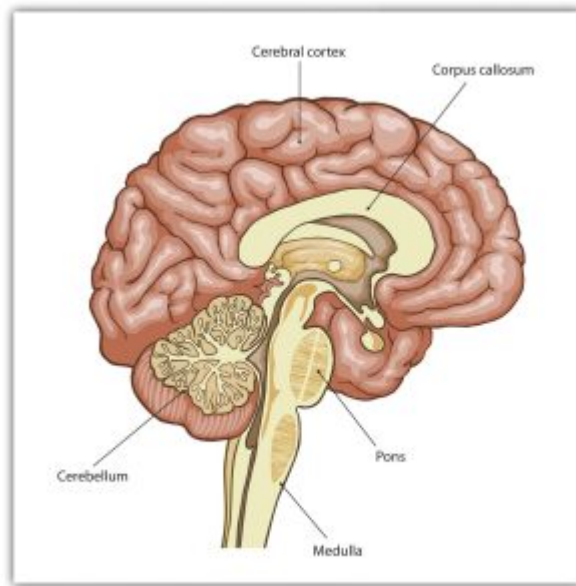
If you were someone who understood brain anatomy and were to look at the brain of an animal that you had never seen before, you would nevertheless be able to deduce the likely capacities of the animal. This is because the brains of all animals are very similar in overall form. In each animal the brain is layered, and the basic structures of the brain are similar (see “The Major Structures in the Human Brain”). The innermost structures of the brain—the parts nearest the spinal cord—are the oldest part of the brain, and these areas carry out the same functions they did for our distant ancestors. The “old brain” regulates basic survival functions, such as breathing, moving, resting, and feeding, and creates our experiences of emotion. Mammals, including humans, have developed further brain layers that provide more advanced functions—for instance, better memory, more sophisticated social interactions, and the ability to experience emotions. Humans have a very large and highly developed outer layer known as the *cerebral cortex* (see “Cerebral Cortex”), which makes us particularly adept at these processes.

## The Major Structures in the Human Brain



The major brain parts are colored and labeled. Source: Adapted from Camazine, S. (n.d.). Images of the brain. Medical, science, and nature things: Photography and digital imagery by Scott Camazine.

## Cerebral Cortex



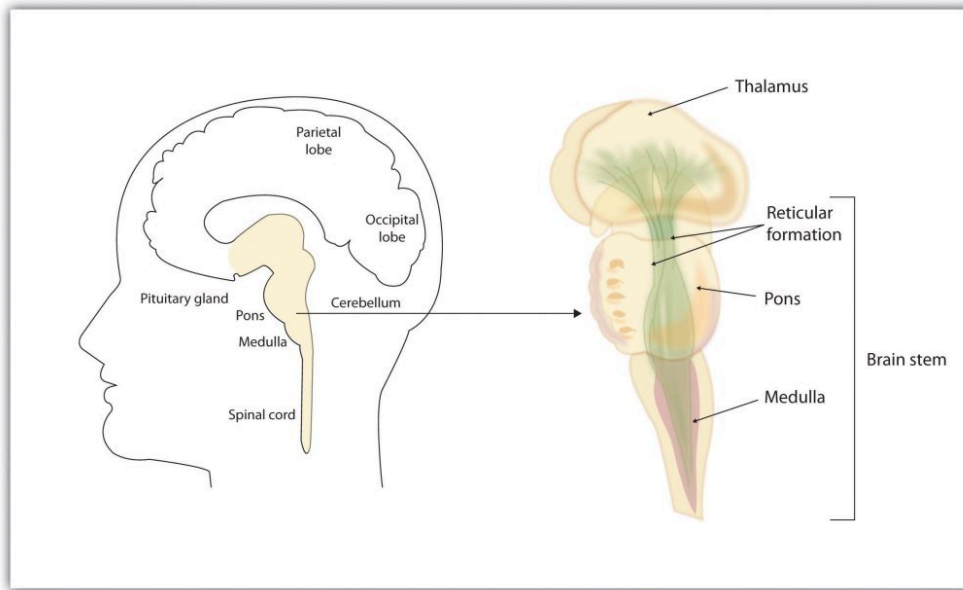
Humans have a very large and highly developed outer brain layer known as the cerebral cortex. The cortex provides humans with excellent memory, outstanding cognitive skills, and the ability to experience complex emotions. Adapted from [Wikia Education](#). (n.d.). Cerebral cortex.

## The Old Brain: Wired for Survival

The **brain stem** is *the oldest and innermost region of the brain*. It's designed to control the most basic functions of life, including breathing, attention, and motor responses. The brain stem begins where the spinal cord enters the skull and forms the **medulla**, *the area of the brain stem that controls heart rate and breathing*. In many cases the medulla alone is sufficient to maintain life—animals that have the remainder of their brains above the medulla severed are still able to eat, breathe, and even move. The spherical shape above the medulla is the **pons**, *a structure in the brain stem that helps control the movements of the body, playing a particularly important role in balance and walking*.

*Running through the medulla and the pons is a long, narrow network of neurons* known as the **reticular formation**. The job of the reticular formation is to filter out some of the stimuli that are coming into the brain from the spinal cord and to relay the remainder of the signals to other areas of the brain. The reticular formation also plays important roles in walking, eating, sexual activity, and sleeping. When electrical stimulation is applied to the reticular formation of an animal, it immediately becomes fully awake, and when the reticular formation is severed from the higher brain regions, the animal falls into a deep coma.

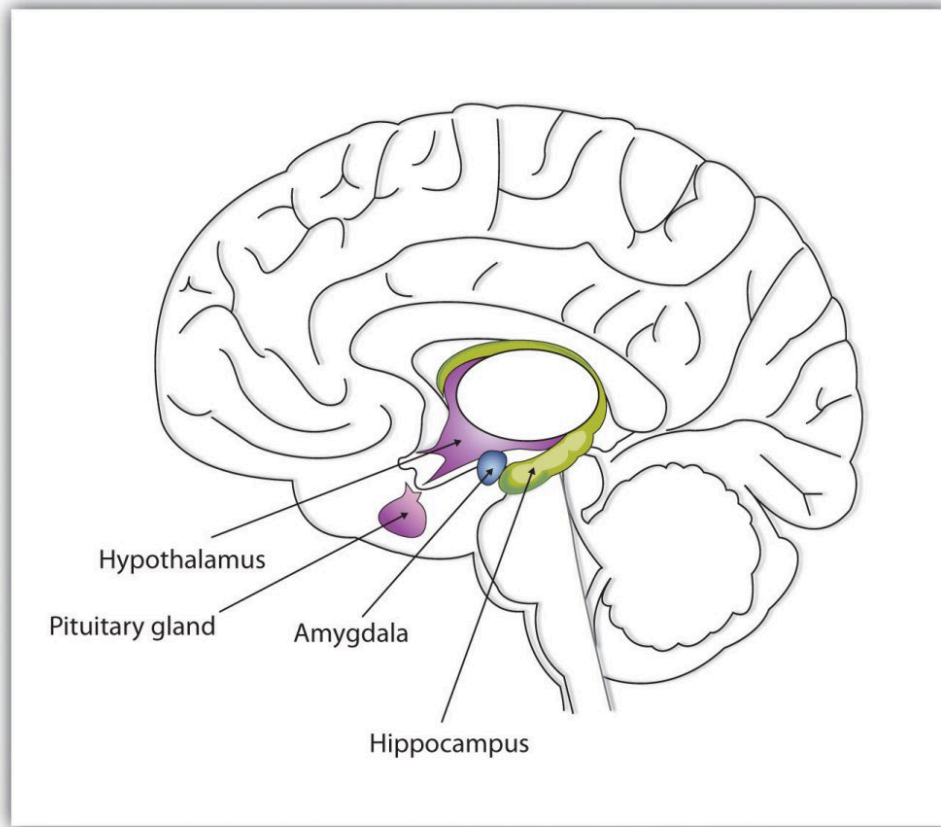
## The Brain Stem and the Thalamus



The brain stem is an extension of the spinal cord, including the medulla, the pons, the thalamus, and the reticular formation.

Above the brain stem are other parts of the old brain that also are involved in the processing of behavior and emotions (see “The Limbic System”). The **thalamus** is *the egg-shaped structure above the brain stem that applies still more filtering to the sensory information that is coming up from the spinal cord and through the reticular formation, and it relays some of these remaining signals to the higher brain levels* (Guillery & Sherman, 2002). The thalamus also receives some of the higher brain’s replies, forwarding them to the medulla and the cerebellum. The thalamus is also important in sleep because it shuts off incoming signals from the senses, allowing us to rest.

## The Limbic System



This diagram shows the major parts of the limbic system, as well as the pituitary gland, which is controlled by it.

The **cerebellum** (literally, “little brain”) *consists of two wrinkled ovals behind the brain stem. It functions to coordinate voluntary movement.* People who have damage to the cerebellum have difficulty walking, keeping their balance, and holding their hands steady. Consuming alcohol influences the cerebellum, which is why people who are drunk have more difficulty walking in a straight line. Also, the cerebellum contributes to emotional responses, helps us discriminate between different sounds and textures, and is important in learning (Bower & Parsons, 2003).

Whereas the primary function of the brain stem is to regulate the most basic aspects of life, including motor functions, the *limbic system* is largely responsible for memory and emotions, including our responses to reward and punishment. The **limbic system** *is a brain area, located between the brain stem and the two cerebral hemispheres, that governs emotion and memory. It includes the amygdala, the hypothalamus, and the hippocampus.*

The **amygdala** *consists of two “almond-shaped” clusters (amygdala comes from the Latin word for “almond”) and is primarily responsible for regulating our perceptions of, and reactions to, aggression and fear.* The amygdala has connections to other bodily systems related to fear, including the sympathetic nervous system (which

we will see later is important in fear responses), facial responses (which perceive and express emotions), the processing of smells, and the release of neurotransmitters related to stress and aggression (Best, 2009). In one early study, Klüver and Bucy (1939) damaged the amygdala of an aggressive rhesus monkey. They found that the once angry animal immediately became passive and no longer responded to fearful situations with aggressive behavior. Electrical stimulation of the amygdala in other animals also influences aggression. In addition to helping us experience fear, the amygdala also helps us learn from situations that create fear. When we experience events that are dangerous, the amygdala stimulates the brain to remember the details of the situation so that we learn to avoid it in the future (Sigurdsson, Doyère, Cain, & LeDoux, 2007).

Located just under the thalamus (hence its name) the **hypothalamus** is *a brain structure that contains a number of small areas that perform a variety of functions, including the important role of linking the nervous system to the endocrine system via the pituitary gland*. Through its many interactions with other parts of the brain, the hypothalamus helps regulate body temperature, hunger, thirst, and sex and responds to the satisfaction of these needs by creating feelings of pleasure. Olds and Milner (1954) discovered these reward centers accidentally after they had momentarily stimulated the hypothalamus of a rat. The researchers noticed that after being stimulated, the rat continued to move to the exact spot in its cage where the stimulation had occurred, as if it were trying to re-create the circumstances surrounding its original experience. Upon further research into these reward centers, Olds (1958) discovered that animals would do almost anything to re-create enjoyable stimulation, including crossing a painful electrified grid to receive it. In one experiment a rat was given the opportunity to electrically stimulate its own hypothalamus by pressing a pedal. The rat enjoyed the experience so much that it pressed the pedal more than 7,000 times per hour until it collapsed from sheer exhaustion.

The **hippocampus** *consists of two “horns” that curve back from the amygdala*. The hippocampus is important in storing information in long-term memory. If the hippocampus is damaged, a person cannot build new memories, living instead in a strange world where everything he or she experiences just fades away, even while older memories from the time before the damage are untouched.

## THE CEREBRAL CORTEX CREATES CONSCIOUSNESS AND THINKING

All animals have adapted to their environments by developing abilities that help them survive. Some animals have hard shells, others run extremely fast, and some have acute hearing. Human beings do not have any of these particular characteristics, but we do have one big advantage over other animals—we are very, very smart.

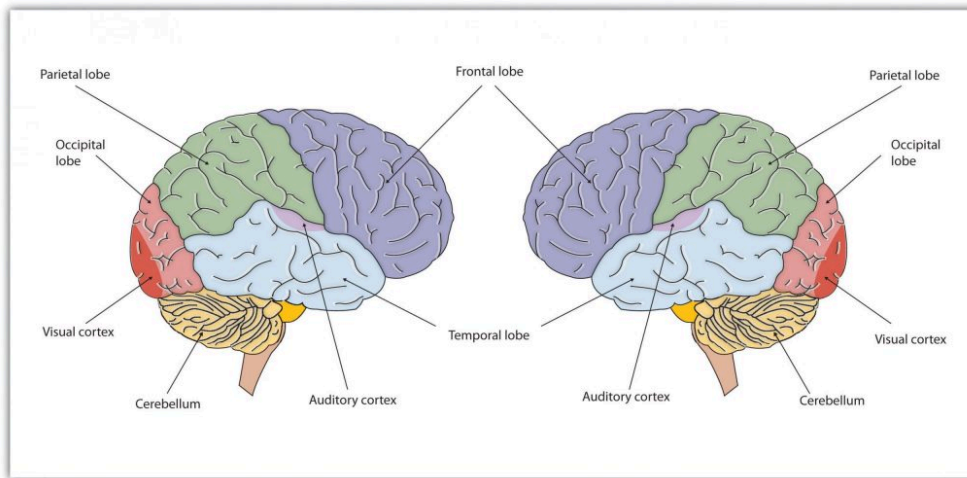
You might think that we should be able to determine the intelligence of an animal by looking at the ratio of the animal's brain weight to the weight of its entire body. But this does not really work. The elephant's brain is one-thousandth of its weight, but the whale's brain is only one-ten-thousandth of its body weight. On the other hand, although the human brain is one 60th of its body weight, the mouse's brain represents one-fortieth of its body weight. Despite these comparisons, elephants do not seem 10 times smarter than whales, and humans definitely seem smarter than mice.

The key to the advanced intelligence of humans is not found in the size of our brains. What sets humans apart from other animals is our larger **cerebral cortex**—*the outer bark-like layer of our brain that allows us to so successfully use language, acquire complex skills, create tools, and live in social groups* (Gibson, 2002). In humans, the cerebral cortex is wrinkled and folded, rather than smooth as it is in most other animals. This creates a much greater surface area and size and allows increased capacities for learning, remembering, and thinking. The folding of the cerebral cortex is referred to as *corticalization*.

Although the cortex is only about one-tenth of an inch thick, it makes up more than 80% of the brain's weight. The cortex contains about 20 billion nerve cells and 300 trillion synaptic connections (de Courten-Myers, 1999). Supporting all these neurons are billions more **glial cells** (glia), *cells that surround and link to the neurons, protecting them, providing them with nutrients, and absorbing unused neurotransmitters*. The glia come in different forms and have different functions. For instance, the myelin sheath surrounding the axon of many neurons is a type of glial cell. The glia are essential partners of neurons, without which the neurons could not survive or function (Miller, 2005).

The cerebral cortex is divided into two *hemispheres*, and each hemisphere is divided into four *lobes*, each separated by folds known as *fissures*. If we look at the cortex starting at the front of the brain and moving over the top (see “The Two Hemispheres”), we see first the **frontal lobe** (behind the forehead), *which is responsible primarily for thinking, planning, memory, and judgment*. Following the frontal lobe is the **parietal lobe**, *which extends from the middle to the back of the skull and which is responsible primarily for processing information about touch*. Then comes the **occipital lobe**, *at the very back of the skull, which processes visual information*. Finally, in front of the occipital lobe (pretty much between the ears) is the **temporal lobe**, *responsible primarily for hearing and language*.

## The Two Hemispheres



The brain is divided into two hemispheres (left and right), each of which has four lobes (temporal, frontal, occipital, and parietal). Furthermore, there are specific cortical areas that control different processes.

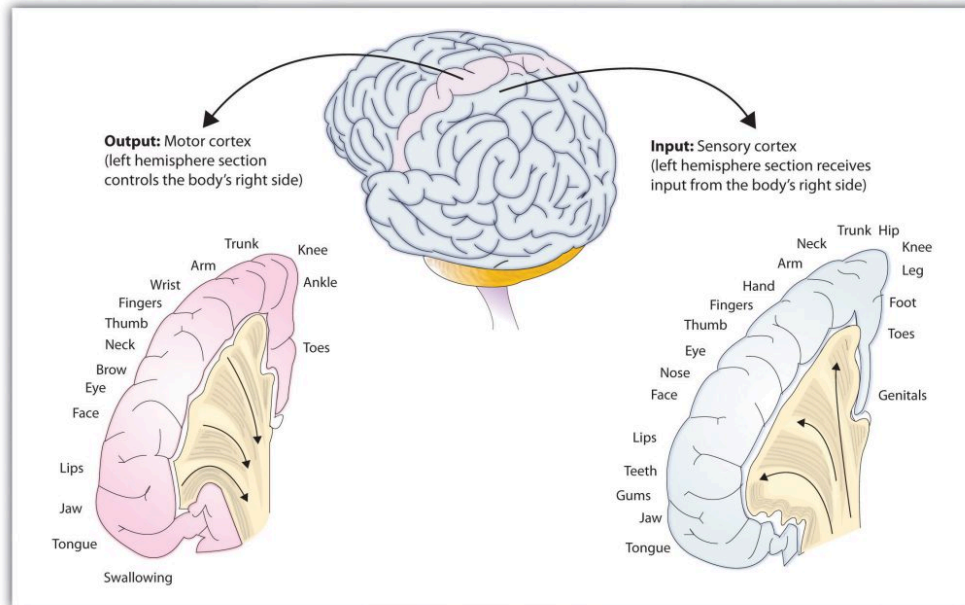
## FUNCTIONS OF THE CORTEX

When the German physicists Gustav Fritsch and Eduard Hitzig (1870/2009) applied mild electric stimulation to different parts of a dog's cortex, they discovered that they could make different parts of the dog's body move. Furthermore, they discovered an important and unexpected principle of brain activity. They found that stimulating the right side of the brain produced movement in the left side of the dog's body, and vice versa. This finding follows from a general principle about how the brain is structured, called *contralateral control*. The brain is wired such that in most cases the left hemisphere receives sensations from and controls the right side of the body, and vice versa.

Fritsch and Hitzig also found that the movement that followed the brain stimulation only occurred when they stimulated a specific arch-shaped region that runs across the top of the brain from ear to ear, just at the front of the parietal lobe (see "The Sensory Cortex and the Motor Cortex"). Fritsch and Hitzig had discovered the **motor cortex**, *the part of the cortex that controls and executes movements of the body by sending signals to the cerebellum and the spinal cord*. More recent research has mapped the motor cortex even more fully, by providing mild electronic stimulation to different areas of the motor cortex in fully conscious patients while observing their bodily responses (because the brain has no sensory receptors, these patients feel no pain). As you can see in "The Sensory Cortex and the Motor Cortex," this research has revealed that the motor cortex is

specialized for providing control over the body, in the sense that the parts of the body that require more precise and finer movements, such as the face and the hands, also are allotted the greatest amount of cortical space.

## The Sensory Cortex and the Motor Cortex



The portion of the sensory and motor cortex devoted to receiving messages that control specific regions of the body is determined by the amount of fine movement that area is capable of performing. Thus the hand and fingers have as much area in the cerebral cortex as does the entire trunk of the body.

Just as the motor cortex sends out messages to the specific parts of the body, the **somatosensory cortex**, *an area just behind and parallel to the motor cortex at the back of the frontal lobe, receives information from the skin's sensory receptors and the movements of different body parts.* Again, the more sensitive the body region, the more area is dedicated to it in the sensory cortex. Our sensitive lips, for example, occupy a large area in the sensory cortex, as do our fingers and genitals.

Other areas of the cortex process other types of sensory information. The **visual cortex** is *the area located in the occipital lobe (at the very back of the brain) that processes visual information.* If you were stimulated in the visual cortex, you would see flashes of light or color, and perhaps you remember having had the experience of “seeing stars” when you were hit in, or fell on, the back of your head. The temporal lobe, located on the lower side of each hemisphere, contains the **auditory cortex**, *which is responsible for hearing and language.* The temporal lobe also processes some visual information, providing us with the ability to name the objects around us (Martin, 2007).

As you can see in “The Sensory Cortex and the Motor Cortex,” the motor and sensory areas of the cortex account for a relatively small part of the total cortex. The remainder of the cortex is made up of **association**

**areas** *in which sensory and motor information is combined and associated with our stored knowledge.* These association areas are the places in the brain that are responsible for most of the things that make human beings seem human. The association areas are involved in higher mental functions, such as learning, thinking, planning, judging, moral reflecting, figuring, and spatial reasoning.

## THE BRAIN IS FLEXIBLE: NEUROPLASTICITY

The control of some specific bodily functions, such as movement, vision, and hearing, is performed in specified areas of the cortex, and if these areas are damaged, the individual will likely lose the ability to perform the corresponding function. For instance, if an infant suffers damage to facial recognition areas in the temporal lobe, it is likely that he or she will never be able to recognize faces (Farah, Rabinowitz, Quinn, & Liu, 2000). On the other hand, the brain is not divided up in an entirely rigid way. The brain's neurons have a remarkable capacity to reorganize and extend themselves to carry out particular functions in response to the needs of the organism, and to repair damage. As a result, the brain constantly creates new neural communication routes and rewires existing ones. **Neuroplasticity** refers to *the brain's ability to change its structure and function in response to experience or damage.* Neuroplasticity enables us to learn and remember new things and adjust to new experiences.

Our brains are the most “plastic” when we are young children, as it is during this time that we learn the most about our environment. On the other hand, neuroplasticity continues to be observed even in adults (Kolb & Fantie, 1989). The principles of neuroplasticity help us understand how our brains develop to reflect our experiences. For instance, accomplished musicians have a larger auditory cortex compared with the general population (Bengtsson et al., 2005) and also require less neural activity to move their fingers over the keys than do novices (Münste, Altenmüller, & Jäncke, 2002). These observations reflect the changes in the brain that follow our experiences.

Plasticity is also observed when there is damage to the brain or to parts of the body that are represented in the motor and sensory cortexes. When a tumor in the left hemisphere of the brain impairs language, the right hemisphere will begin to compensate to help the person recover the ability to speak (Thiel et al., 2006). And if a person loses a finger, the area of the sensory cortex that previously received information from the missing finger will begin to receive input from adjacent fingers, causing the remaining digits to become more sensitive to touch (Fox, 1984).

Although neurons cannot repair or regenerate themselves as skin or blood vessels can, new evidence suggests that the brain can engage in **neurogenesis**, *the forming of new neurons* (Van Praag, Zhao, Gage, & Gazzaniga, 2004). These new neurons originate deep in the brain and may then migrate to other brain areas where

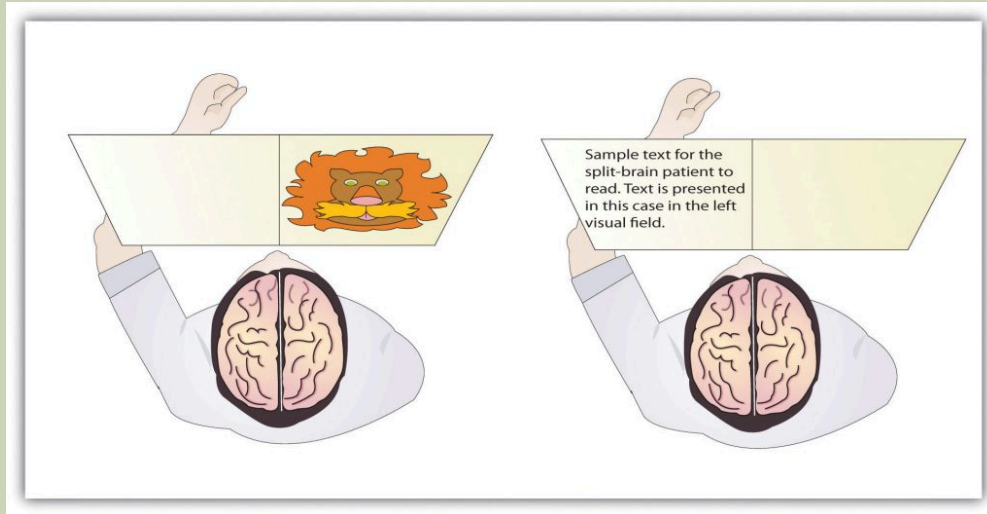
they form new connections with other neurons (Gould, 2007). This leaves open the possibility that someday scientists might be able to “rebuild” damaged brains by creating drugs that help grow neurons.

## RESEARCH FOCUS: IDENTIFYING THE UNIQUE FUNCTIONS OF THE LEFT AND RIGHT HEMISPHERES USING SPLIT-BRAIN PATIENTS

We have seen that the left hemisphere of the brain primarily senses and controls the motor movements on the right side of the body, and vice versa. This fact provides an interesting way to study **brain lateralization**—*the idea that the left and the right hemispheres of the brain are specialized to perform different functions*. Gazzaniga, Bogen, and Sperry (1965) studied a patient, known as W. J., who had undergone an operation to relieve severe seizures. In this surgery, *the region that normally connects the two halves of the brain and supports communication between the hemispheres*, known as the **corpus callosum**, is severed. As a result, the patient essentially becomes a person with two separate brains. Because the left and right hemispheres are separated, each hemisphere develops a mind of its own, with its own sensations, concepts, and motivations (Gazzaniga, 2005).

In their research, Gazzaniga and his colleagues tested the ability of W. J. to recognize and respond to objects and written passages that were presented to only the left or to only the right brain hemispheres (see “Visual and Verbal Processing in the Split-Brain Patient”). The researchers had W. J. look straight ahead and then flashed, for a fraction of a second, a picture of a geometrical shape to the left of where he was looking. By doing so, they assured that—because the two hemispheres had been separated—the image of the shape was experienced only in the right brain hemisphere (remember that sensory input from the left side of the body is sent to the right side of the brain). Gazzaniga and his colleagues found that W. J. was able to identify what he had been shown when he was asked to pick the object from a series of shapes, using his left hand, but that he could not do this when the object was shown in the right visual field. On the other hand, W. J. could easily read written material presented in the right visual field (and thus experienced in the left hemisphere) but not when it was presented in the left visual field.

## VISUAL AND VERBAL PROCESSING IN THE SPLIT-BRAIN PATIENT



The information that is presented on the left side of our field of vision is transmitted to the right brain hemisphere, and vice versa. In split-brain patients, the severed corpus callosum does not permit information to be transferred between hemispheres, which allows researchers to learn about the functions of each hemisphere. In the sample on the left, the split-brain patient could not choose which image had been presented because the left hemisphere cannot process visual information. In the sample on the right the patient could not read the passage because the right brain hemisphere cannot process language.

This research, and many other studies following it, has demonstrated that the two brain hemispheres specialize in different abilities. In most people the ability to speak, write, and understand language is located in the left hemisphere. This is why W. J. could read passages that were presented on the right side and thus transmitted to the left hemisphere, but could not read passages that were only experienced in the right brain hemisphere. The left hemisphere is also better at math and at judging time and rhythm. It is also superior in coordinating the order of complex movements—for example, lip movements needed for speech. The right hemisphere, on the other hand, has only very limited verbal abilities, and yet it excels in perceptual skills. The right hemisphere is able to recognize objects, including faces, patterns, and melodies, and it can put a puzzle together or draw a picture. This is why W. J. could pick out the image when he saw it on the left, but not the right, visual field.

Although Gazzaniga's research demonstrated that the brain is in fact lateralized, such that the two hemispheres specialize in different activities, this does not mean that when people behave in a certain way or perform a certain activity they are only using one hemisphere of their brains at a time. That would be drastically oversimplifying the concept of brain differences. We normally use both hemispheres at the same time, and the difference between the abilities of the two hemispheres is not absolute (Soroker et al., 2005).

## PSYCHOLOGY IN EVERYDAY LIFE: WHY ARE SOME PEOPLE LEFT-HANDED?

Across cultures and ethnic groups, about 90% of people are mainly right-handed, whereas only 10% are primarily left-handed (Peters, Reimers, & Manning, 2006). This fact is puzzling, in part because the number of left-handers is so low, and in part because other animals, including our closest primate relatives, do not show any type of handedness. The existence of right-handers and left-handers provides an interesting example of the relationship among evolution, biology, and social factors and how the same phenomenon can be understood at different levels of analysis (Harris, 1990; McManus, 2002).

At least some handedness is determined by genetics. Ultrasound scans show that 9 out of 10 fetuses suck the thumb of their right hand, suggesting that the preference is determined before birth (Hepper, Wells, & Lynch, 2005), and the mechanism of transmission has been linked to a gene on the X chromosome (Jones & Martin, 2000). It has also been observed that left-handed people are likely to have fewer children, and this may be in part because the mothers of left-handers are more prone to miscarriages and other prenatal problems (McKeever, Cerone, Suter, & Wu, 2000).

But culture also plays a role. In the past, left-handed children were forced to write with their right hands in many countries, and this practice continues, particularly in collectivistic cultures, such as India and Japan, where left-handedness is viewed negatively as compared with individualistic societies, such as the United States. For example, India has about half as many left-handers as the United States (Ida & Mandal, 2003).

There are both advantages and disadvantages to being left-handed in a world where most people are right-handed. One problem for lefties is that the world is designed for right-handers. Automatic teller machines (ATMs), classroom desks, scissors, microscopes, drill presses, and table saws are just some examples of everyday machinery that is designed with the most important controls on the right side. This may explain in part why left-handers suffer somewhat more accidents than right-handers do (Dutta & Mandal, 2006).

Despite the potential difficulty of living and working in a world designed for right-handers, there seem to be some advantages to being left-handed. Throughout history, a number of prominent

artists have been left-handed, including Leonardo da Vinci, Michelangelo, Pablo Picasso, and Max Escher. Because the right hemisphere is superior in imaging and visual abilities, there may be some advantages to using the left hand for drawing or painting (Springer & Deutsch, 1998). Left-handed people are also better at envisioning three-dimensional objects, which may explain why there is such a high number of left-handed architects, artists, and chess players in proportion to their numbers (Coren, 1992). However, there are also more left-handers among those with reading disabilities, allergies, and migraine headaches (Geschwind & Behan, 2007), perhaps due to the fact that a small minority of left-handers owe their handedness to a birth trauma, such as being born prematurely (Betancur, Vélez, Cabanieu, & le Moal, 1990).

In sports in which handedness may matter, such as tennis, boxing, fencing, or judo, left-handers may have an advantage. They play many games against right-handers and learn how to best handle their styles. Right-handers, however, play very few games against left-handers, which may make them more vulnerable. This explains why a disproportionately high number of left-handers are found in sports where direct one-on-one action predominates. In other sports, such as golf, there are fewer left-handed players because the handedness of one player has no effect on the competition.

The fact that left-handers excel in some sports suggests the possibility that they may have also had an evolutionary advantage because their ancestors may have been more successful in important skills such as hand-to-hand combat (Bodmer & McKie, 1994). At this point, however, this idea remains only a hypothesis, and determinants of human handedness are yet to be fully understood.

## Exercises and Critical Thinking

- Do you think that animals experience emotion? What aspects of brain structure might lead you to believe that they do or do not?
- Consider your own experiences and speculate on which parts of your brain might be particularly well developed as a result of these experiences.
- Which brain hemisphere are you likely to be using when you search for a fork in the silverware drawer? Which brain hemisphere are you most likely to be using when you struggle to remember the name of an old friend?
- Do you think that encouraging left-handed children to use their right hands is a good

idea? Why or why not?

13.

## THE ENDOCRINE SYSTEM

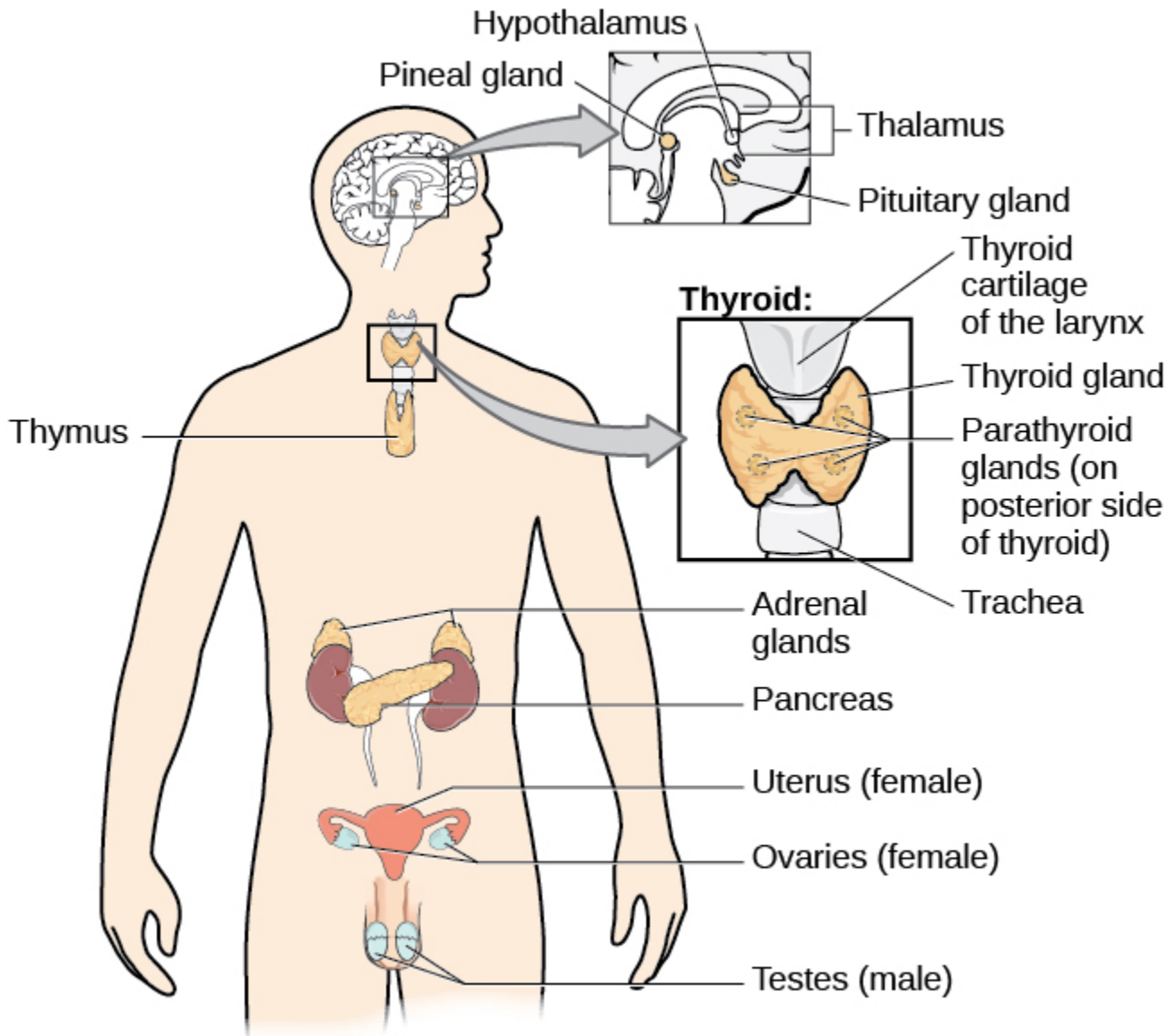
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### Learning Objectives

By the end of this section, you will be able to:

- Identify the major glands of the endocrine system
- Identify the hormones secreted by each gland
- Describe each hormone's role in regulating bodily functions

The endocrine system consists of a series of glands that produce chemical substances known as hormones. Like neurotransmitters, hormones are chemical messengers that must bind to a receptor in order to send their signal. However, unlike neurotransmitters, which are released in close proximity to cells with their receptors, hormones are secreted into the bloodstream and travel throughout the body, affecting any cells that contain receptors for them. Thus, whereas neurotransmitters' effects are localized, the effects of hormones are widespread. Also, hormones are slower to take effect and tend to be longer lasting.



The major glands of the endocrine system are shown.

Hormones are involved in regulating all sorts of bodily functions, and they are ultimately controlled through interactions between the hypothalamus (in the central nervous system) and the pituitary gland (in the endocrine system). Imbalances in hormones are related to a number of disorders. This section explores some of the major glands that make up the endocrine system and the hormones secreted by these glands.

# Test Your Understanding



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<https://louis.pressbooks.pub/intropsychology/?p=172#h5p-49>

## Major Glands

The pituitary gland descends from the hypothalamus at the base of the brain and acts in close association with it. The pituitary is often referred to as the “master gland” because its messenger hormones control all the other glands in the endocrine system, although it mostly carries out instructions from the hypothalamus. In addition to messenger hormones, the pituitary also secretes growth hormone, endorphins for pain relief, and a number of key hormones that regulate fluid levels in the body.

Located in the neck, the thyroid gland releases hormones that regulate growth, metabolism, and appetite. In hyperthyroidism, or Grave’s disease, the thyroid secretes too much of the hormone thyroxine, causing agitation, bulging eyes, and weight loss. In hypothyroidism, reduced hormone levels cause sufferers to experience tiredness, and they often complain of feeling cold. Fortunately, thyroid disorders are often treatable with medications that help reestablish a balance in the hormones secreted by the thyroid.

The adrenal glands sit atop our kidneys and secrete hormones involved in the stress response, such as epinephrine (adrenaline) and norepinephrine (noradrenaline). The pancreas is an internal organ that secretes hormones that regulate blood sugar levels: insulin and glucagon. These pancreatic hormones are essential for maintaining stable levels of blood sugar throughout the day by lowering blood glucose levels (insulin) or raising them (glucagon). People who suffer from diabetes do not produce enough insulin; therefore, they must take medications that stimulate or replace insulin production, and they must closely control the amount of sugars and carbohydrates they consume.

The gonads secrete sexual hormones, which are important in reproduction, and mediate both sexual motivation and behavior. The female gonads are the ovaries; the male gonads are the testes. Ovaries secrete estrogens and progesterone, and the testes secrete androgens, such as testosterone.

## Athletes and Anabolic Steroids

Although it is against federal laws and many professional athletic associations (The National Football League, for example) have banned their use, anabolic steroid drugs continue to be used by amateur and professional athletes. The drugs are believed to enhance athletic performance. Anabolic steroid drugs mimic the effects of the body's own steroid hormones, like testosterone and its derivatives. These drugs have the potential to provide a competitive edge by increasing muscle mass, strength, and endurance, although not all users may experience these results. Moreover, use of performance-enhancing drugs (PEDs) does not come without risks. Anabolic steroid use has been linked with a wide variety of potentially negative outcomes, ranging in severity from largely cosmetic (acne) to life-threatening (heart attack). Furthermore, use of these substances can result in profound changes in mood and can increase aggressive behavior (National Institute on Drug Abuse, 2001).

Baseball player Alex Rodriguez (A-Rod) has been at the center of a media storm regarding his use of illegal PEDs. Rodriguez's performance on the field was unparalleled while using the drugs; his success played a large role in negotiating a contract that made him the highest-paid player in professional baseball. Although Rodriguez maintains that he has not used PEDs for several years, he received a substantial suspension in 2013 that, if upheld, will cost him more than 20 million dollars in earnings (Gaines, 2013). What are your thoughts on athletes and doping? Why or why not should the use of PEDs be banned? What advice would you give an athlete who was considering using PEDs?

## Test Your Understanding



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## Summary

The glands of the endocrine system secrete hormones to regulate normal body functions. The hypothalamus serves as the interface between the nervous system and the endocrine system, and it controls the secretions of

the pituitary. The pituitary serves as the master gland, controlling the secretions of all other glands. The thyroid secretes thyroxine, which is important for basic metabolic processes and growth; the adrenal glands secrete hormones involved in the stress response; the pancreas secretes hormones that regulate blood sugar levels; and the ovaries and testes produce sex hormones that regulate sexual motivation and behavior.

## Review Questions



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## Critical Thinking Questions

Hormone secretion is often regulated through a negative feedback mechanism, which means that once a hormone is secreted it will cause the hypothalamus and pituitary to shut down the production of signals necessary to secrete the hormone in the first place. Most oral contraceptives are made of small doses of estrogen and/or progesterone. Why would this be an effective means of contraception?

The introduction of relatively low, yet constant, levels of gonadal hormones places the hypothalamus and pituitary under inhibition via negative feedback mechanisms. This prevents the alterations in both estrogen and progesterone concentrations that are necessary for successful ovulation and implantation.

Chemical messengers are used in both the nervous system and the endocrine system. What properties do these two systems share? What properties are different? Which one would be faster? Which one would result in long-lasting changes?

Both systems involve chemical messengers that must interact with receptors in order to have an effect. The relative proximity of the release site and target tissue varies dramatically between the two systems. In neurotransmission, reuptake and enzymatic breakdown immediately clear the synapse. Metabolism of hormones must occur in the liver. Therefore, while neurotransmission is much more rapid in signaling information, hormonal signaling can persist for quite some time as the concentrations of the hormone in the bloodstream vary gradually over time.

## Personal Application Questions

Given the negative health consequences associated with the use of anabolic steroids, what kinds of considerations might be involved in a person's decision to use them?

## 14.

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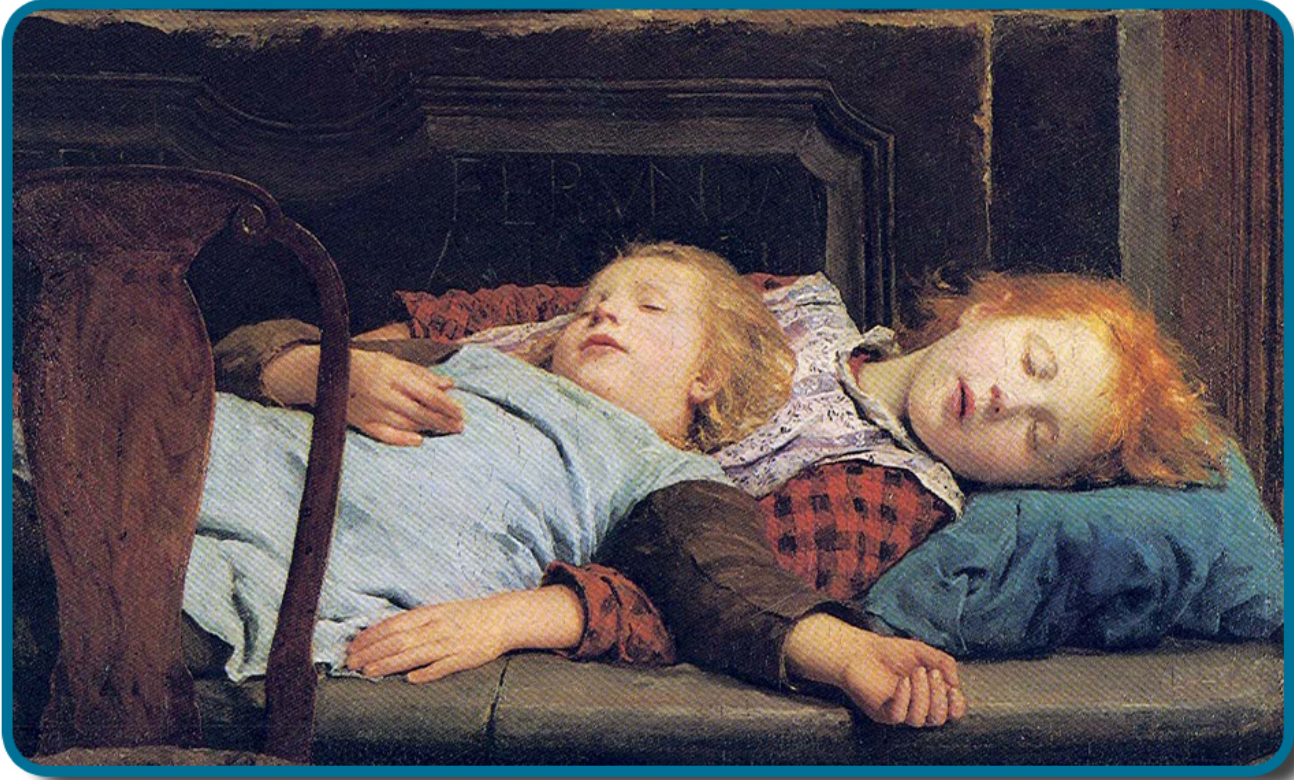
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## PART IV

## STATES OF CONSCIOUSNESS



Sleep, which we all experience, is a quiet and mysterious pause in our daily lives. Two sleeping children are depicted in this 1895 oil painting titled *Zwei schlafende Mädchen auf der Ofenbank*, which translates as “two sleeping girls on the stove,” by Swiss painter Albert Anker.

Our lives involve regular, dramatic changes in the degree to which we are aware of our surroundings and our internal states. While awake, we feel alert and aware of the many important things going on around us. Our experiences change dramatically while we are in deep sleep and once again when we are dreaming.

This chapter will discuss states of consciousness with a particular emphasis on sleep. The different stages of sleep will be identified, and sleep disorders will be described. The chapter will close with discussions of altered states of consciousness produced by psychoactive drugs, hypnosis, and meditation.



15.

## WHAT IS CONSCIOUSNESS?

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### Learning Objectives

By the end of this section, you will be able to:

- Explain what consciousness is
- Explain why we sleep
- Describe the stages of sleep
- Identify substance use and abuse

## Introduction

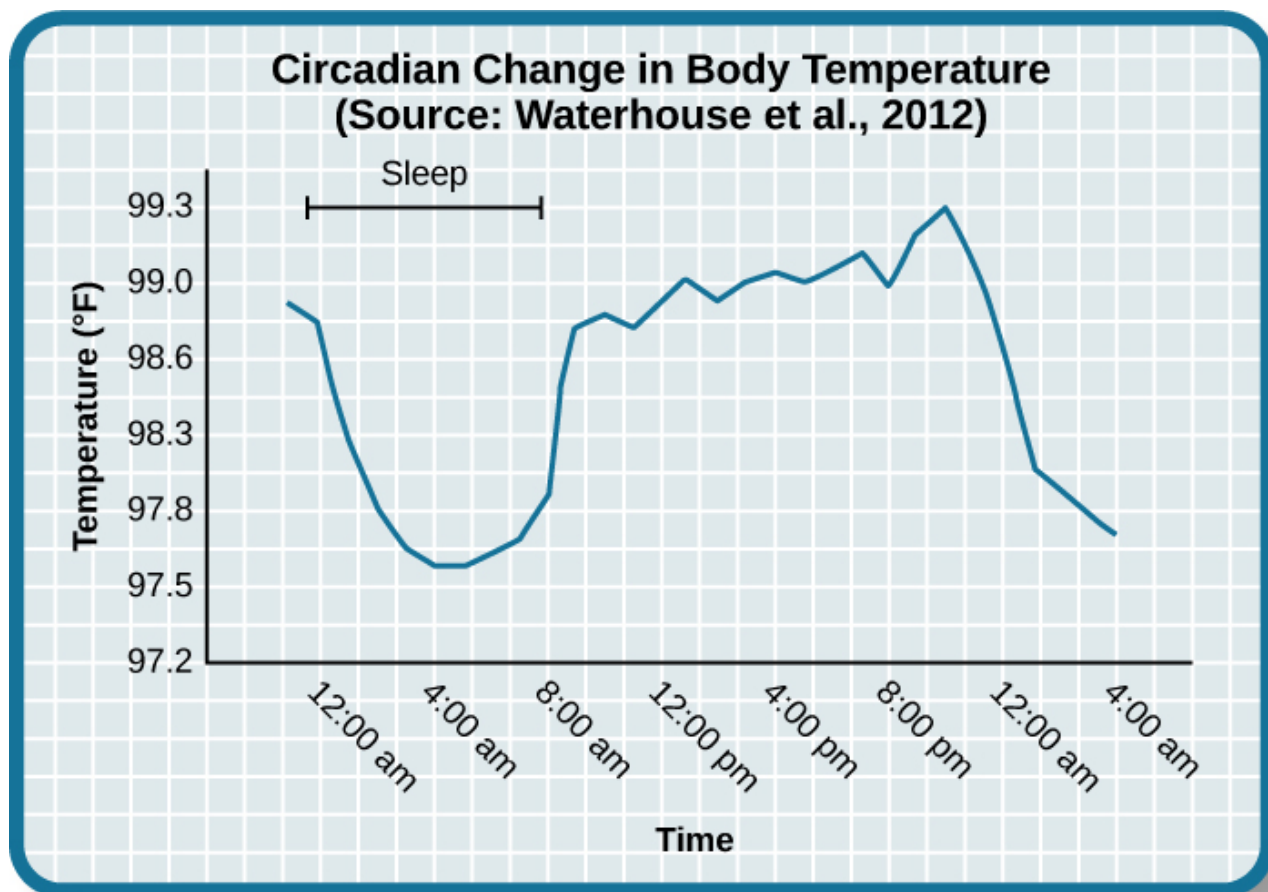
**Consciousness** is our awareness of internal and external stimuli. Awareness of internal stimuli includes feeling pain, hunger, thirst, sleepiness, and being aware of our thoughts and emotions. Awareness of external stimuli includes seeing the light from the sun, feeling the warmth of a room, and hearing the voice of a friend.

We experience different states of consciousness and different levels of awareness on a regular basis. We might even describe consciousness as a continuum that ranges from full awareness to a deep sleep. Sleep is a state marked by relatively low levels of physical activity and reduced sensory awareness that is distinct from periods of rest that occur during wakefulness. **Wakefulness** is characterized by high levels of sensory awareness, thought, and behavior. In between these extremes are states of consciousness related to daydreaming, intoxication as a result of alcohol or other drug use, meditative states, hypnotic states, and altered states of consciousness following sleep deprivation. We might also experience unconscious states of being via drug-induced anesthesia for medical purposes. Often, we are not completely aware of our surroundings, even when we are fully awake. For instance, have you ever daydreamed while driving home from work or school without really thinking about the drive itself? You were capable of engaging in all of the complex tasks involved with

operating a motor vehicle even though you were not aware of doing so. Many of these processes, like much of psychological behavior, are rooted in our biology.

## Biological Rhythms

**Biological rhythms** are internal rhythms of biological activity. A woman's menstrual cycle is an example of a biological rhythm—a recurring, cyclical pattern of bodily changes. One complete menstrual cycle takes about 28 days—a lunar month—but many biological cycles are much shorter. For example, body temperature fluctuates cyclically over a 24-hour period. Alertness is associated with higher body temperatures, and sleepiness with lower body temperatures.



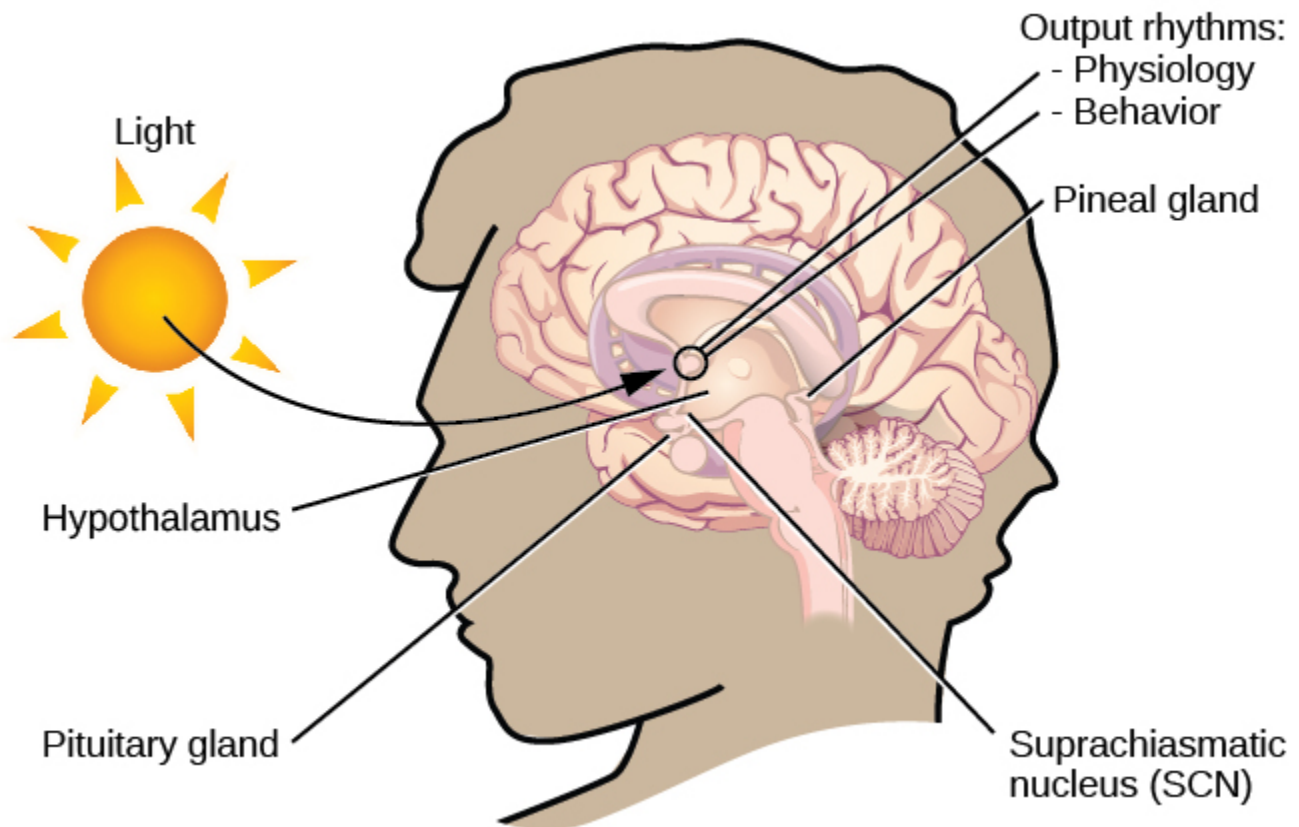
This chart illustrates the circadian change in body temperature over 28 hours in a group of eight young men. Body temperature rises throughout the waking day, peaking in the afternoon, and falls during sleep with the lowest point occurring during the very early morning hours.

This pattern of temperature fluctuation, which repeats every day, is one example of a circadian rhythm. A **circadian rhythm** is a biological rhythm that takes place over a period of about 24 hours. Our sleep-wake

cycle, which is linked to our environment's natural light-dark cycle, is perhaps the most obvious example of a circadian rhythm, but we also have daily fluctuations in heart rate, blood pressure, blood sugar, and body temperature. Some circadian rhythms play a role in changes in our state of consciousness.

If we have biological rhythms, then is there some sort of biological clock? In the brain, the **hypothalamus**, which lies above the pituitary gland, is the main center of homeostasis. **Homeostasis** is the tendency to maintain a balance, or optimal level, within a biological system.

The brain's clock mechanism is located in an area of the hypothalamus known as the suprachiasmatic nucleus (SCN). The axons of light-sensitive neurons in the retina provide information to the SCN based on the amount of light present, allowing this internal clock to be synchronized with the outside world (Klein, Moore, & Reppert, 1991; Welsh, Takahashi, & Kay, 2010).



The suprachiasmatic nucleus (SCN) serves as the brain's clock mechanism. The clock sets itself with light information received through projections from the retina.

## Test Your Understanding



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## Problems with Circadian Rhythms

Generally, and for most people, our circadian cycles are aligned with the outside world. For example, most people sleep during the night and are awake during the day. One important regulator of sleep-wake cycles is the hormone melatonin. The pineal gland, an endocrine structure located inside the brain that releases melatonin, is thought to be involved in the regulation of various biological rhythms and of the immune system during sleep (Hardeland, Pandi-Perumal, & Cardinali, 2006). Melatonin release is stimulated by darkness and inhibited by light.

There are individual differences with regard to our sleep-wake cycle. For instance, some people would say they are morning people, while others would consider themselves to be night owls. These individual differences in circadian patterns of activity are known as a person's chronotype, and research demonstrates that morning larks and night owls differ with regard to sleep regulation (Taillard, Philip, Coste, Sagaspe, & Bioulac, 2003). Sleep regulation refers to the brain's control of switching between sleep and wakefulness as well as coordinating this cycle with the outside world.

Watch this brief video describing circadian rhythms and how they affect sleep: [Reprogramming Our Circadian Rhythms for the Modern World](#).



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## Disruptions of Normal Sleep

Whether lark, owl, or somewhere in between, there are situations in which a person's circadian clock gets out of synchrony with the external environment. One way that this happens involves traveling across multiple time zones. When we do this, we often experience jet lag. Jet lag is a collection of symptoms that results from the mismatch between our internal circadian cycles and our environment. These symptoms include fatigue, sluggishness, irritability, and insomnia (i.e., a consistent difficulty in falling or staying asleep for at least three nights a week over a month's time) (Roth, 2007).

Individuals who do rotating shift work are also likely to experience disruptions in circadian cycles. Rotating shift work refers to a work schedule that changes from early to late on a daily or weekly basis. For example, a person may work from 7:00 a.m. to 3:00 p.m. on Monday, 3:00 a.m. to 11:00 a.m. on Tuesday, and 11:00 a.m. to 7:00 p.m. on Wednesday. In such instances, the individual's schedule changes so frequently that it becomes difficult for a normal circadian rhythm to be maintained. This often results in sleeping problems, and it can lead to signs of depression and anxiety. These kinds of schedules are common for individuals working in health care professions and service industries, and they are associated with persistent feelings of exhaustion and agitation that can make someone more prone to making mistakes on the job (Gold et al., 1992; Presser, 1995).

Rotating shift work has pervasive effects on the lives and experiences of individuals engaged in that kind of work, which is clearly illustrated in stories reported in a qualitative study that researched the experiences of middle-aged nurses who worked rotating shifts (West, Boughton, & Byrnes, 2009). Several of the nurses interviewed commented that their work schedules affected their relationships with their families. One of the nurses said,

If you've had a partner who does work regular job 9 to 5 office hours . . . the ability to spend time, good time with them when you're not feeling absolutely exhausted . . . that would be one of the problems that I've encountered.  
(West et al., 2009, p. 114)

While disruptions in circadian rhythms can have negative consequences, there are things we can do to help us realign our biological clocks with the external environment. Some of these approaches, such as using a

bright light as shown in the image below, have been shown to alleviate some of the problems experienced by individuals suffering from jet lag or from the consequences of rotating shift work. Because the biological clock is driven by light, exposure to bright light during working shifts and dark exposure when not working can help combat insomnia and symptoms of anxiety and depression (Huang, Tsai, Chen, & Hsu, 2013).



Devices like this are designed to provide exposure to bright light to help people maintain a regular circadian cycle. They can be helpful for people working night shifts or for people affected by seasonal variations in light.

Watch this video to hear tips on how to overcome jet lag: [6 Tips To Beat Jet Lag](#).



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## Insufficient Sleep

When people have difficulty getting sleep due to their work or the demands of day-to-day life, they accumulate a sleep debt. A person with a sleep debt does not get sufficient sleep on a chronic basis. The consequences of

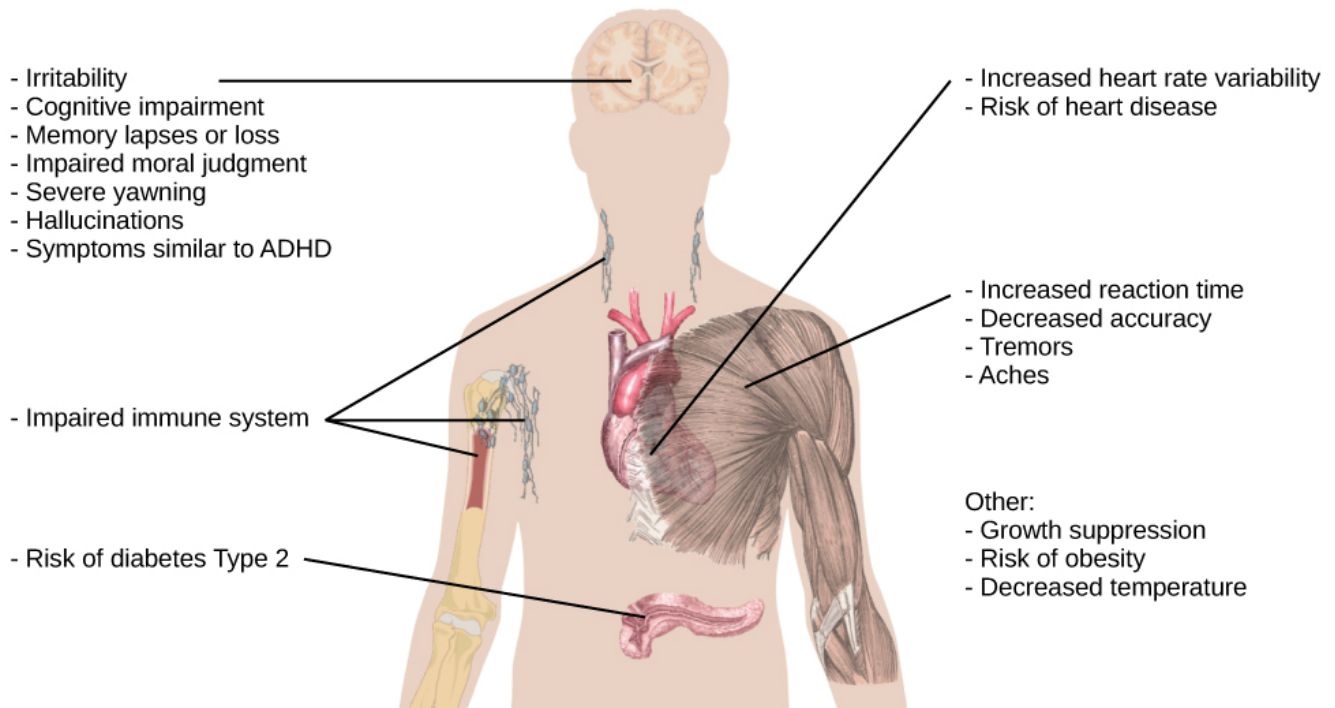
sleep debt include decreased levels of alertness and mental efficiency. Interestingly, since the advent of electric light, the amount of sleep that people get has declined. While we certainly welcome the convenience of having the darkness lit up, we also suffer the consequences of reduced amounts of sleep because we are more active during the nighttime hours than our ancestors were. As a result, many of us sleep less than 7–8 hours a night and accrue a sleep debt. While there is tremendous variation in any given individual's sleep needs, the National Sleep Foundation (n.d.) cites research to estimate that newborns require the most sleep (between 12 and 18 hours a night) and that this amount declines to just 7–9 hours by the time we are adults.

If you lie down to take a nap and fall asleep very easily, chances are you may have sleep debt. Given that college students are notorious for suffering from significant sleep debt (Hicks, Fernandez, & Pelligrini, 2001; Hicks, Johnson, & Pelligrini, 1992; Miller, Shattuck, & Matsangas, 2010), chances are you and your classmates deal with sleep debt-related issues on a regular basis. The chart below shows recommended amounts of sleep at different ages.

**Sleep Needs at Different Ages**

<b>Age</b>	<b>Nightly Sleep Needs</b>
0–3 months	12–18 hours
3 months–1 year	14–15 hours
1–3 years	12–14 hours
3–5 years	11–13 hours
5–10 years	10–11 hours
10–18 years	8–10 hours
18 and older	7–9 hours

Sleep debt and sleep deprivation have significant negative psychological and physiological consequences. As mentioned earlier, lack of sleep can result in decreased mental alertness and cognitive function. In addition, sleep deprivation often results in depression-like symptoms. These effects can occur as a function of accumulated sleep debt or in response to more acute periods of sleep deprivation. It may surprise you to know that sleep deprivation is associated with obesity, increased blood pressure, increased levels of stress hormones, and reduced immune functioning (Banks & Dinges, 2007). A sleep-deprived individual generally will fall asleep more quickly than if she were not sleep-deprived. Some sleep-deprived individuals have difficulty staying awake when they stop moving (for example, while sitting and watching television or driving a car). That is why individuals suffering from sleep deprivation can also put themselves and others at risk when they put themselves behind the wheel of a car or work with dangerous machinery. Some research suggests that sleep deprivation affects cognitive and motor function as much as, if not more than, alcohol intoxication (Williamson & Feyer, 2000).



This figure illustrates some of the negative consequences of sleep deprivation. While cognitive deficits may be the most obvious, many body systems are negatively impacted by lack of sleep. (credit: modification of work by Mikael Häggström)

To assess your own sleeping habits, read this article about sleep needs: [How Much Sleep Do We Really Need?](#)

The amount of sleep we get varies across the lifespan. When we are very young, we spend up to 16 hours a day sleeping. As we grow older, we sleep less. In fact, a meta-analysis, which is a study that combines the results of many related studies, conducted within the last decade indicates that by the time we are 65 years old, we average fewer than 7 hours of sleep per day (Ohayon, Carskadon, Guilleminault, & Vitiello, 2004). As the amount of time we sleep varies over our lifespan, presumably the sleep debt would adjust accordingly.

## Test Your Understanding



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## Summary

States of consciousness vary over the course of the day and throughout our lives. Important factors in these changes are the biological rhythms, and, more specifically, the circadian rhythms generated by the suprachiasmatic nucleus (SCN). Typically, our biological clocks are aligned with our external environment, and light tends to be an important cue in setting this clock. When people travel across multiple time zones or work rotating shifts, they can experience disruptions of their circadian cycles that can lead to insomnia, sleepiness, and decreased alertness. Bright light therapy has shown to be promising in dealing with circadian disruptions. If people go extended periods of time without sleep, they will accrue a sleep debt and potentially experience a number of adverse psychological and physiological consequences.

## Review Questions



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## Critical Thinking Questions

Healthcare professionals often work rotating shifts. Why is this problematic? What can be done to deal with potential problems?

Given that rotating shift work can lead to exhaustion and decreased mental efficiency, individuals working under these conditions are more likely to make mistakes on the job. The implications for this in the health care professions are obvious. Those in health care professions could be educated about the benefits of light-dark exposure to help alleviate such problems.

Generally, humans are considered diurnal which means we are awake during the day and asleep during the night. Many rodents, on the other hand, are nocturnal. Why do you think different animals have such different sleep-wake cycles?

Different species have different evolutionary histories, and they have adapted to their environments in different ways. There are a number of different possible explanations as to why a given species is diurnal or nocturnal. Perhaps humans would be most vulnerable to threats during the evening hours when light levels are low. Therefore, it might make sense to be in shelter during this time. Rodents, on the other hand, are faced with a number of predatory threats, so perhaps being active at night minimizes the risk from predators such as birds that use their visual senses to locate prey.

## Personal Application Questions

We experience shifts in our circadian clocks in the fall and spring of each year with time changes associated with daylight saving time. Is springing ahead or falling back easier for you to adjust to, and why do you think that is?

What do you do to adjust to the differences in your daily schedule throughout the week? Are you running a sleep debt when daylight saving time begins or ends?

16.

## WHY WE SLEEP

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### Learning Objectives

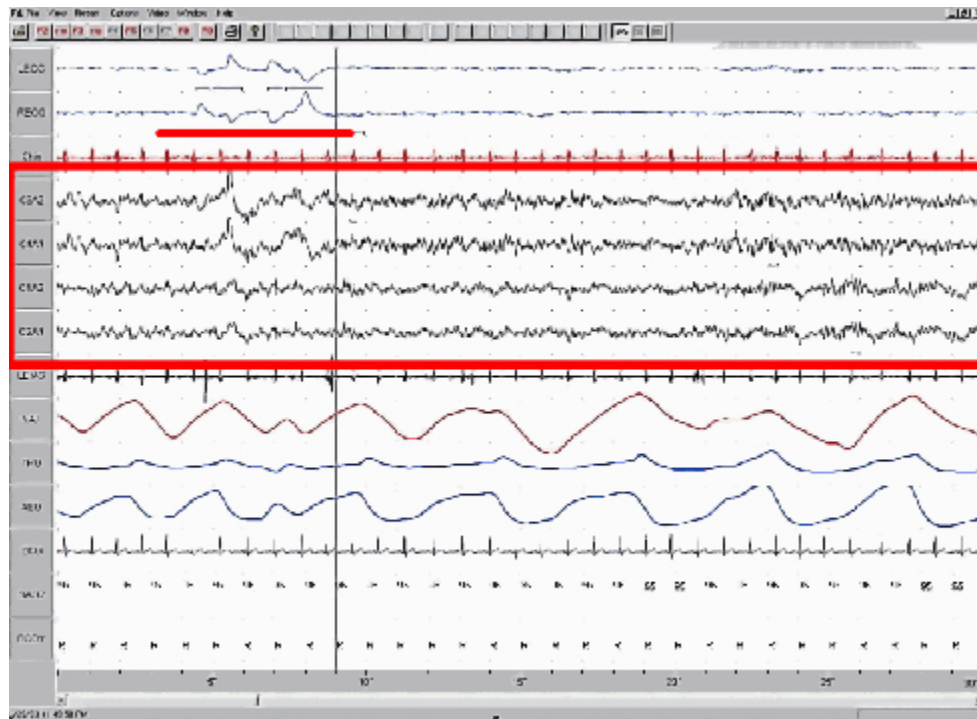
By the end of this section, you will be able to:

- Describe areas of the brain involved in sleep
- Understand hormone secretions associated with sleep
- Describe several theories aimed at explaining the function of sleep

We spend approximately one-third of our lives sleeping. Given the average life expectancy for U.S. citizens falls between 73 and 79 years old (Singh & Siahpush, 2006), we can expect to spend approximately 25 years of our lives sleeping. Some animals never sleep (e.g., several fish and amphibian species); other animals can go extended periods of time without sleep and without apparent negative consequences (e.g., dolphins); yet some animals (e.g., rats) die after two weeks of sleep deprivation (Siegel, 2008). Why do we devote so much time to sleeping? Is it absolutely essential that we sleep? This section will consider these questions and explore various explanations for why we sleep.

### What is Sleep?

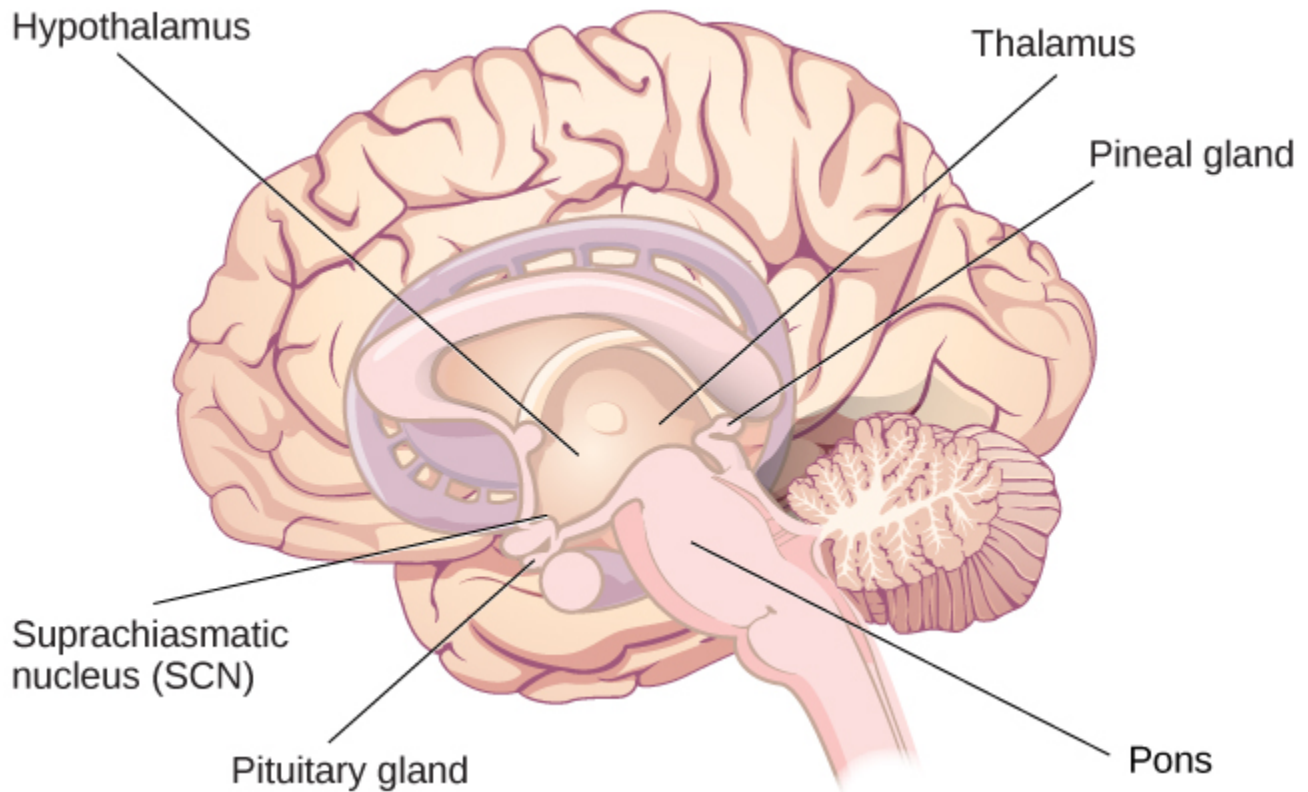
You have read that sleep is distinguished by low levels of physical activity and reduced sensory awareness. As discussed by Siegel (2008), a definition of sleep must also include mention of the interplay of the circadian and homeostatic mechanisms that regulate sleep. Homeostatic regulation of sleep is evidenced by sleep rebound following sleep deprivation. Sleep rebound refers to the fact that a sleep-deprived individual will tend to take a shorter time to fall asleep during subsequent opportunities for sleep. Sleep is characterized by certain patterns of activity of the brain that can be visualized using electroencephalography (EEG), and different phases of sleep can be differentiated using EEG as well.



This is a segment of a polysomnogram (PSG), a recording of several physical variables during sleep. The x-axis shows the passage of time in seconds; this record includes 30 seconds of data. The location of the sets of electrodes that produced each signal is labeled on the y-axis. The red box encompasses EEG output, and the waveforms are characteristic of a specific stage of sleep. Other curves show other sleep-related data, such as body temperature, muscle activity, and heartbeat.

Sleep-wake cycles seem to be controlled by multiple brain areas acting in conjunction with one another. Some of these areas include the thalamus, the hypothalamus, and the pons. As already mentioned, the hypothalamus contains the SCN—the biological clock of the body—in addition to other nuclei that, in conjunction with the thalamus, regulate slow-wave sleep. The pons is important for regulating rapid eye movement (REM) sleep (National Institutes of Health, n.d.).

Sleep is also associated with the secretion and regulation of a number of hormones from several endocrine glands including: melatonin, follicle-stimulating hormone (FSH), luteinizing hormone (LH), and growth hormone (National Institutes of Health, n.d.). You have read that the pineal gland releases melatonin during sleep. Melatonin is thought to be involved in the regulation of various biological rhythms and the immune system (Hardeland et al., 2006). During sleep, the pituitary gland secretes both FSH and LH which are important in regulating the reproductive system (Christensen et al., 2012; Sofikitis et al., 2008). The pituitary gland also secretes growth hormone, during sleep, which plays a role in physical growth and maturation as well as other metabolic processes (Bartke, Sun, & Longo, 2013).



The pineal and pituitary glands secrete a number of hormones during sleep.

## Test Your Understanding



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## Why Do We Sleep?

Given the central role that sleep plays in our lives and the number of adverse consequences that have been

associated with sleep deprivation, one would think that we would have a clear understanding of why it is that we sleep. Unfortunately, this is not the case; however, several hypotheses have been proposed to explain the function of sleep.

## Adaptive Function of Sleep

One popular hypothesis of sleep incorporates the perspective of evolutionary psychology. Evolutionary psychology is a discipline that studies how universal patterns of behavior and cognitive processes have evolved over time as a result of natural selection. Variations and adaptations in cognition and behavior make individuals more or less successful in reproducing and passing their genes to their offspring. One hypothesis from this perspective might argue that sleep is essential to restore resources that are expended during the day. Just as bears hibernate in the winter when resources are scarce, perhaps people sleep at night to reduce their energy expenditures. While this is an intuitive explanation of sleep, there is little research that supports this explanation. In fact, it has been suggested that there is no reason to think that energetic demands could not be addressed with periods of rest and inactivity (Frank, 2006; Rial et al., 2007), and some research has actually found a negative correlation between energetic demands and the amount of time spent sleeping (Capellini, Barton, McNamara, Preston, & Nunn, 2008).

Another evolutionary hypothesis of sleep holds that our sleep patterns evolved as an adaptive response to predatory risks, which increase in darkness. Thus we sleep in safe areas to reduce the chance of harm. Again, this is an intuitive and appealing explanation for why we sleep. Perhaps our ancestors spent extended periods of time asleep to reduce attention to themselves from potential predators. Comparative research indicates, however, that the relationship that exists between predatory risk and sleep is very complex and equivocal. Some research suggests that species that face higher predatory risks sleep fewer hours than other species (Capellini et al., 2008), while other researchers suggest there is no relationship between the amount of time a given species spends in deep sleep and its predation risk (Lesku, Roth, Amlaner, & Lima, 2006).

It is quite possible that sleep serves no single universally adaptive function, and different species have evolved different patterns of sleep in response to their unique evolutionary pressures. While we have discussed the negative outcomes associated with sleep deprivation, it should be pointed out that there are many benefits that are associated with adequate amounts of sleep. A few such benefits listed by the National Sleep Foundation (n.d.) include maintaining healthy weight, lowering stress levels, improving mood, and increasing motor coordination, as well as a number of benefits related to cognition and memory formation.

## Cognitive Function of Sleep

Another theory regarding why we sleep involves sleep's importance for cognitive function and memory formation (Rattenborg, Lesku, Martinez-Gonzalez, & Lima, 2007). Indeed, we know sleep deprivation results

in disruptions in cognition and memory deficits (Brown, 2012), leading to impairments in our abilities to maintain attention, make decisions, and recall long-term memories. Moreover, these impairments become more severe as the amount of sleep deprivation increases (Alhola & Polo-Kantola, 2007). Furthermore, slow-wave sleep after learning a new task can improve resultant performance on that task (Huber, Ghilardi, Massimini, & Tononi, 2004) and seems essential for effective memory formation (Stickgold, 2005). Understanding the impact of sleep on cognitive function should help you understand that cramming all night for a test may be not effective and can even prove counterproductive.

Watch this brief video describing sleep deprivation in college students: [Sleep Deprivation Among College Students](#).



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Sleep has also been associated with other cognitive benefits. Research indicates that included among these possible benefits are increased capacities for creative thinking (Cai, Mednick, Harrison, Kanady, & Mednick, 2009; Wagner, Gais, Haider, Verleger, & Born, 2004), language learning (Fenn, Nusbaum, & Margoliash, 2003; Gómez, Bootzin, & Nadel, 2006), and inferential judgments (Ellenbogen, Hu, Payne, Titone, & Walker, 2007). It is possible that even the processing of emotional information is influenced by certain aspects of sleep (Walker, 2009).

Watch this brief video describing the relationship between sleep and memory: [The Connection between Memory and Sleep – Science Nation](#).



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## Summary

We devote a very large portion of time to sleep, and our brains have complex systems that control various aspects of sleep. Several hormones important for physical growth and maturation are secreted during sleep. While the reason we sleep remains something of a mystery, there is some evidence to suggest that sleep is very important to learning and memory.

## Review Questions



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## Critical Thinking Questions

If theories that assert sleep is necessary for restoration and recovery from daily energetic demands are correct, what do you predict about the relationship that would exist between individuals' total sleep duration and their level of activity?

Those individuals (or species) that expend the greatest amounts of energy would require the longest periods of sleep.

How could researchers determine if given areas of the brain are involved in the regulation of sleep?

Researchers could use lesion or brain stimulation techniques to determine how deactivation or

activation of a given brain region affects behavior. Furthermore, researchers could use any number of brain imaging techniques like fMRI or CT scans to come to these conclusions.

Differentiate the evolutionary theories of sleep and make a case for the one with the most compelling evidence.

One evolutionary theory of sleep holds that sleep is essential for restoration of resources that are expended during the demands of day-to-day life. A second theory proposes that our sleep patterns evolved as an adaptive response to predatory risks, which increase in darkness. The first theory has little or no empirical support, and the second theory is supported by some, though not all, research.

## Personal Application Question

Have you (or someone you know) ever experienced significant periods of sleep deprivation because of simple insomnia, high levels of stress, or as a side effect of a medication? What were the consequences of missing out on sleep?

## 17.

# STAGES OF SLEEP

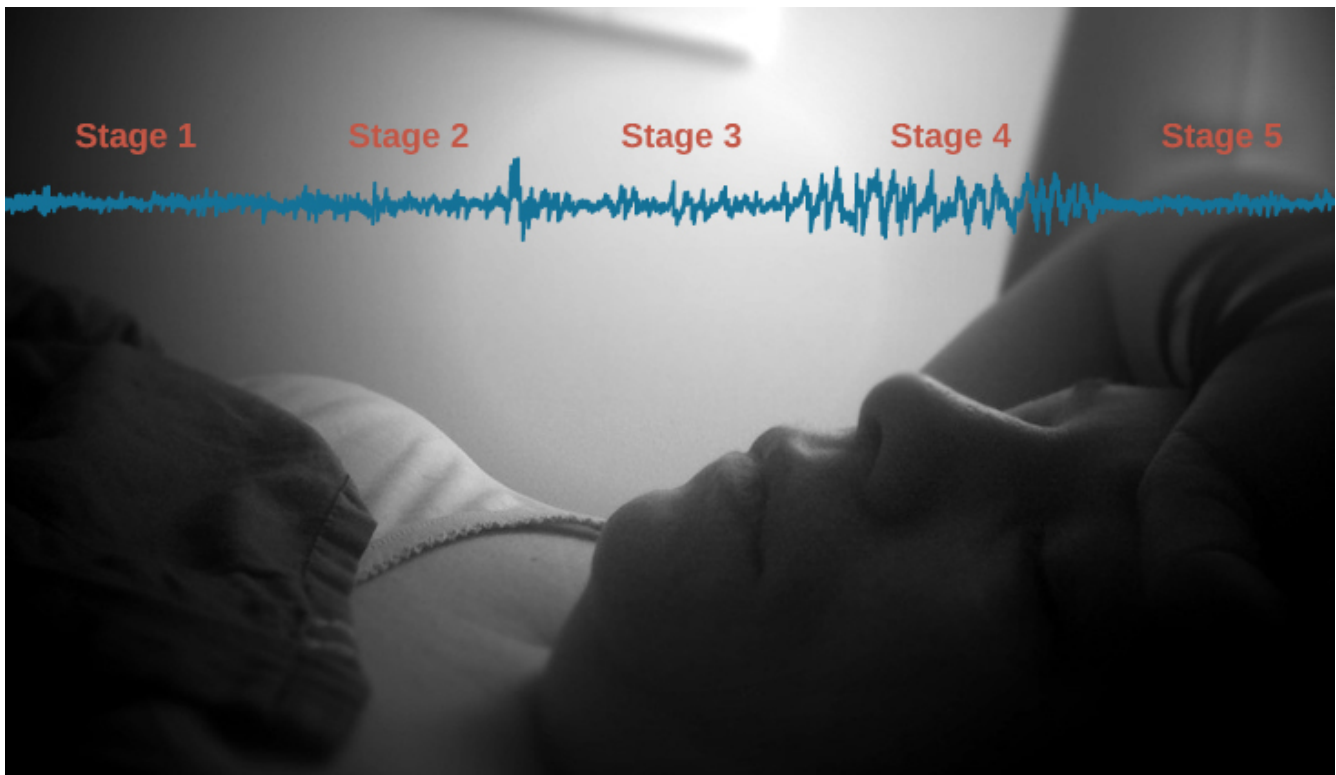
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## Learning Objectives

By the end of this section, you will be able to:

- Differentiate between REM and non-REM sleep
- Describe the differences between the four stages of non-REM sleep
- Understand the roles that REM and non-REM sleep play in learning and memory

Sleep is not a uniform state of being. Instead, sleep is composed of several different stages that can be differentiated from one another by the patterns of brain wave activity that occur during each stage. These changes in brain wave activity can be visualized using EEG and are distinguished from one another by both the frequency and amplitude of brain waves. Sleep can be divided into two different general phases: REM sleep and non-REM (NREM) sleep. **Rapid eye movement (REM) sleep** is characterized by darting movements of the eyes under closed eyelids. Brain waves during REM sleep appear very similar to brain waves during wakefulness. In contrast, non-REM (NREM) sleep is subdivided into four stages distinguished from each other and from wakefulness by characteristic patterns of brain waves. The first four stages of sleep are NREM sleep, while the fifth and final stage of sleep is REM sleep. In this section, we will discuss each of these stages of sleep and their associated patterns of brain wave activity.

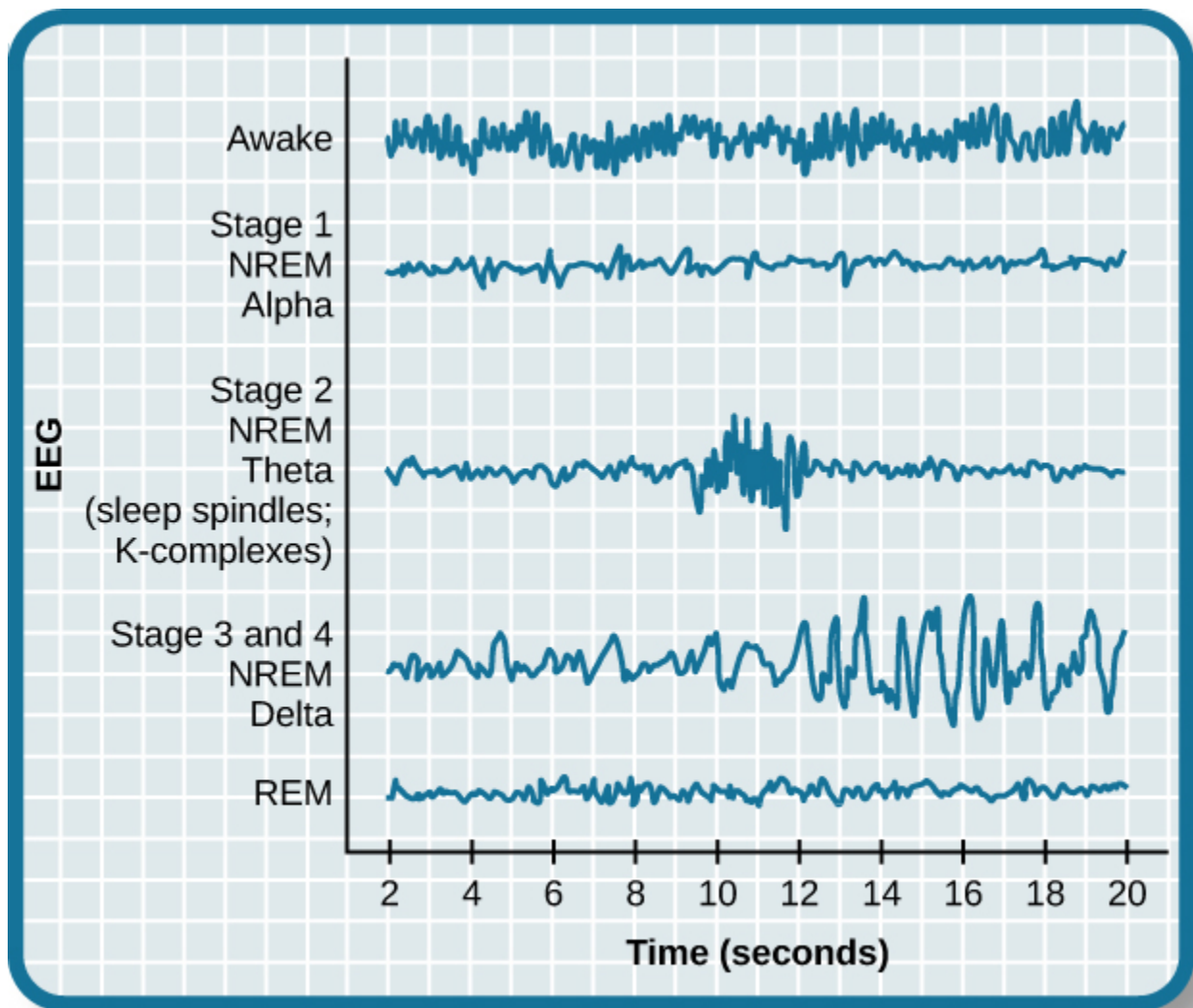


Brainwave activity changes dramatically across the different stages of sleep. (credit “sleeping”: modification of work by Ryan Vaarsi)

## NREM Stages of Sleep

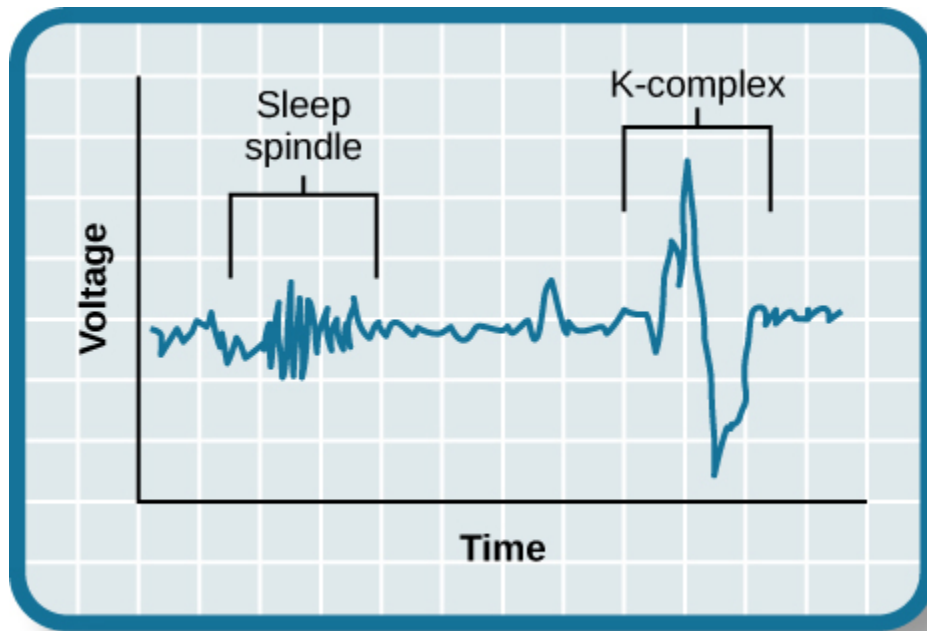
The first stage of NREM sleep is known as stage 1 sleep. Stage 1 sleep is a transitional phase that occurs between wakefulness and sleep, the period during which we drift off to sleep. During this time, there is a slowdown in both the rates of respiration and heartbeat. In addition, stage 1 sleep involves a marked decrease in both overall muscle tension and core body temperature.

In terms of brain wave activity, stage 1 sleep is associated with both alpha and theta waves. The early portion of stage 1 sleep produces alpha waves, which are relatively low frequency (8–13Hz), high amplitude patterns of electrical activity (waves) that become synchronized. This pattern of brain wave activity resembles that of someone who is very relaxed, yet awake. As an individual continues through stage 1 sleep, there is an increase in theta wave activity. Theta waves are even lower frequency (4–7 Hz), higher amplitude brain waves than alpha waves. It is relatively easy to wake someone from stage 1 sleep; in fact, people often report that they have not been asleep if they are awoken during stage 1 sleep.



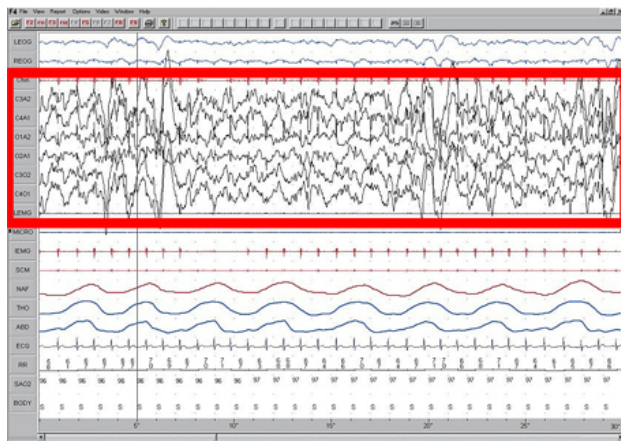
Brainwave activity changes dramatically across the different stages of sleep.

As we move into stage 2 sleep, the body goes into a state of deep relaxation. Theta waves still dominate the activity of the brain, but they are interrupted by brief bursts of activity known as sleep spindles. A sleep spindle is a rapid burst of higher-frequency brain waves that may be important for learning and memory (Fogel & Smith, 2011; Poe, Walsh, & Bjorness, 2010). In addition, the appearance of K-complexes is often associated with stage 2 sleep. A K-complex is a very high amplitude pattern of brain activity that may in some cases occur in response to environmental stimuli. Thus, K-complexes might serve as a bridge to higher levels of arousal in response to what is going on in our environments (Halász, 1993; Steriade & Amzica, 1998).

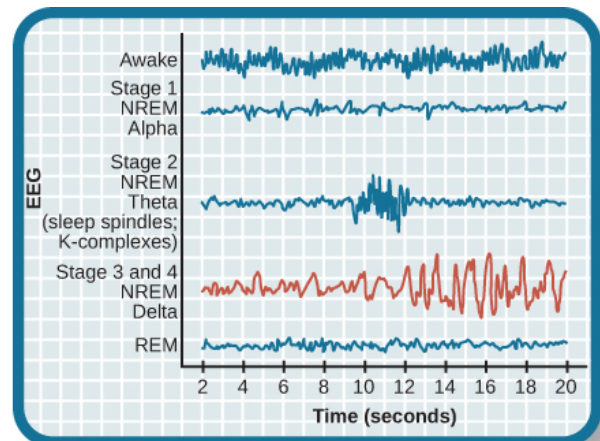


Stage 2 sleep is characterized by the appearance of both sleep spindles and K-complexes.

Stage 3 and stage 4 of sleep are often referred to as deep sleep or slow-wave sleep because these stages are characterized by low frequency (up to 4 Hz), high amplitude delta waves. During this time, an individual's heart rate and respiration slow dramatically. It is much more difficult to awaken someone from sleep during stage 3 and stage 4 than during earlier stages. Interestingly, individuals who have increased levels of alpha brain wave activity (more often associated with wakefulness and transition into stage 1 sleep) during stage 3 and stage 4 often report that they do not feel refreshed upon waking, regardless of how long they slept (Stone, Taylor, McCrae, Kalsekar, & Lichstein, 2008).



(a)

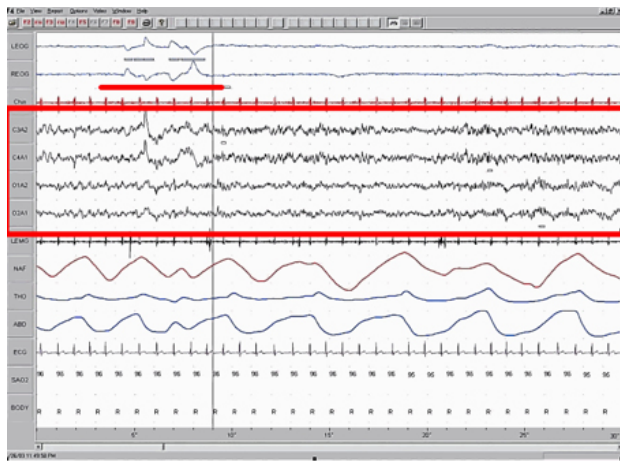


(b)

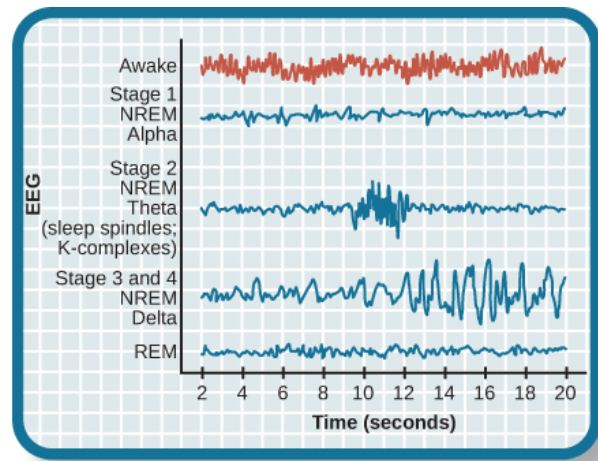
(a) Delta waves, which are low frequency and high amplitude, characterize (b) slow-wave stage 3 and stage 4 sleep.

## REM Sleep

As mentioned earlier, REM sleep is marked by rapid movements of the eyes. The brain waves associated with this stage of sleep are very similar to those observed when a person is awake, as shown in, and this is the period of sleep in which dreaming occurs. It is also associated with paralysis of muscle systems in the body with the exception of those that make circulation and respiration possible. Therefore, no movement of voluntary muscles occurs during REM sleep in a normal individual; REM sleep is often referred to as **paradoxical sleep** because of this combination of high brain activity and lack of muscle tone. Like NREM sleep, REM has been implicated in various aspects of learning and memory (Wagner, Gais, & Born, 2001), although there is disagreement within the scientific community about how important both NREM and REM sleep are for normal learning and memory (Siegel, 2001).



(a)



(b)

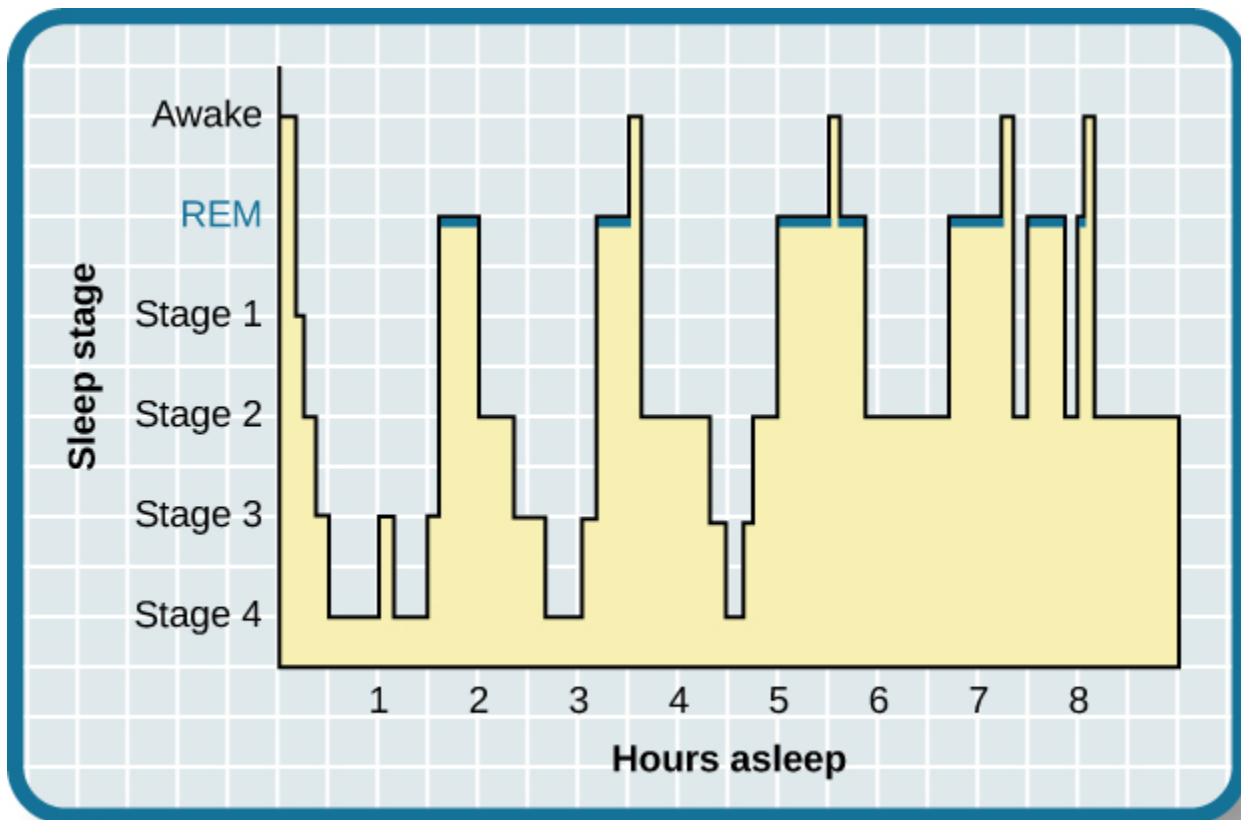
(a) A period of rapid eye movement is marked by the short red line segment. The brain waves associated with REM sleep, outlined in the red box in (a), look very similar to those seen (b) during wakefulness.

If people are deprived of REM sleep and then allowed to sleep without disturbance, they will spend more time in REM sleep in what would appear to be an effort to recoup the lost time in REM. This is known as the REM rebound, and it suggests that REM sleep is also homeostatically regulated. Aside from the role that REM sleep may play in processes related to learning and memory, REM sleep may also be involved in emotional processing and regulation. In such instances, REM rebound may actually represent an adaptive response to stress in nondepressed individuals by suppressing the emotional salience of aversive events that occurred in wakefulness (Suchecki, Tiba, & Machado, 2012).

While sleep deprivation in general is associated with a number of negative consequences (Brown, 2012), the consequences of REM deprivation appear to be less profound (as discussed in Siegel, 2001). In fact, some have suggested that REM deprivation can actually be beneficial in some circumstances. For instance, REM sleep deprivation has been demonstrated to improve symptoms of people suffering from major depression,

and many effective antidepressant medications suppress REM sleep (Riemann, Berger, & Volderholzer, 2001; Vogel, 1975).

It should be pointed out that some reviews of the literature challenge this finding, suggesting that sleep deprivation that is not limited to REM sleep is just as effective or more effective at alleviating depressive symptoms among some patients suffering from depression. In either case, why sleep deprivation improves the mood of some patients is not entirely understood (Giedke & Schwärzler, 2002). Recently, however, some have suggested that sleep deprivation might change emotional processing so that various stimuli are more likely to be perceived as positive in nature (Gujar, Yoo, Hu, & Walker, 2011). The hypnogram below shows a person's passage through the stages of sleep.



A hypnogram is a diagram of the stages of sleep as they occur during a period of sleep. This hypnogram illustrates how an individual moves through the various stages of sleep.

## Dreams

The meaning of dreams varies across different cultures and periods of time. By the late 19th century, German psychiatrist Sigmund Freud had become convinced that dreams represented an opportunity to gain access to the unconscious. By analyzing dreams, Freud thought people could increase self-awareness and gain valuable insight to help them deal with the problems they faced in their lives. Freud made distinctions between the

manifest content and the latent content of dreams. Manifest content is the actual content, or storyline, of a dream. Latent content, on the other hand, refers to the hidden meaning of a dream. For instance, if a woman dreams about being chased by a snake, Freud might have argued that this represents the woman's fear of sexual intimacy, with the snake serving as a symbol of a man's penis.

Freud was not the only theorist to focus on the content of dreams. The 20th-century Swiss psychiatrist Carl Jung believed that dreams allowed us to tap into the collective unconscious. The collective unconscious, as described by Jung, is a theoretical repository of information he believed to be shared by everyone. According to Jung, certain symbols in dreams reflected universal archetypes with meanings that are similar for all people regardless of culture or location.

The sleep and dreaming researcher Rosalind Cartwright, however, believes that dreams simply reflect life events that are important to the dreamer. Unlike Freud and Jung, Cartwright's ideas about dreaming have found empirical support. For example, she and her colleagues published a study in which women going through divorce were asked several times over a five-month period to report the degree to which their former spouses were on their minds. These same women were awakened during REM sleep in order to provide a detailed account of their dream content. There was a significant positive correlation between the degree to which women thought about their former spouses during waking hours and the number of times their former spouses appeared as characters in their dreams (Cartwright, Agargun, Kirkby, & Friedman, 2006). Recent research (Horikawa, Tamaki, Miyawaki, & Kamitani, 2013) has uncovered new techniques by which researchers may effectively detect and classify the visual images that occur during dreaming by using fMRI for neural measurement of brain activity patterns, opening the way for additional research in this area.

Recently, neuroscientists have also become interested in understanding why we dream. For example, Hobson (2009) suggests that dreaming may represent a state of protoconsciousness. In other words, dreaming involves constructing a virtual reality in our heads that we might use to help us during wakefulness. Among a variety of neurobiological evidence, John Hobson cites research on lucid dreams as an opportunity to better understand dreaming in general. Lucid dreams are dreams in which certain aspects of wakefulness are maintained during a dream state. In a lucid dream, a person becomes aware of the fact that they are dreaming, and as such, they can control the dream's content (LaBerge, 1990).

## Summary

The different stages of sleep are characterized by the patterns of brain waves associated with each stage. As a person transitions from being awake to falling asleep, alpha waves are replaced by theta waves. Sleep spindles and K-complexes emerge in stage 2 sleep. Stage 3 and stage 4 are described as slow-wave sleep that is marked by a predominance of delta waves. REM sleep involves rapid movements of the eyes, paralysis of voluntary muscles, and dreaming. Both NREM and REM sleep appear to play important roles in learning and memory. Dreams

may represent life events that are important to the dreamer. Alternatively, dreaming may represent a state of protoconsciousness, or a virtual reality, in the mind that helps a person during consciousness.

## Review Questions



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<https://louis.pressbooks.pub/intropsychology/?p=318#h5p-89>

## Critical Thinking Questions

Freud believed that dreams provide important insight into the unconscious mind. He maintained that a dream's manifest content could provide clues into an individual's unconscious. What potential criticisms exist for this particular perspective?

The subjective nature of dream analysis is one criticism. Psychoanalysts are charged with helping their clients interpret the true meaning of a dream. There is no way to refute or confirm whether or not these interpretations are accurate. The notion that "sometimes a cigar is just a cigar" (sometimes attributed to Freud but not definitively shown to be his) makes it clear that there is no systematic, objective system in place for dream analysis.

Some people claim that sleepwalking and talking in your sleep involve individuals acting out their dreams. Why is this particular explanation unlikely?

Dreaming occurs during REM sleep. One of the hallmarks of this particular stage of sleep is the paralysis of the voluntary musculature which would make acting out dreams improbable.

## Personal Application Question

Researchers believe that one important function of sleep is to facilitate learning and memory. How does

knowing this help you in your college studies? What changes could you make to your study and sleep habits to maximize your mastery of the material covered in class?

18.

# SLEEP PROBLEMS AND DISORDERS

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## Learning Objectives

By the end of this section, you will be able to:

- Describe the symptoms and treatments of insomnia
- Recognize the symptoms of several parasomnias
- Describe the symptoms and treatments for sleep apnea
- Recognize risk factors associated with sudden infant death syndrome (SIDS) and steps to prevent it
- Describe the symptoms and treatments for narcolepsy

Many people experience disturbances in their sleep at some point in their lives. Depending on the population and sleep disorder being studied, between 30% and 50% of the population suffers from a sleep disorder at some point in their lives (Bixler, Kales, Soldatos, Kaels, & Healey, 1979; Hossain & Shapiro, 2002; Ohayon, 1997, 2002; Ohayon & Roth, 2002). This section will describe several sleep disorders as well as some of their treatment options.

## Insomnia

Insomnia, a consistent difficulty in falling or staying asleep, is the most common of the sleep disorders. Individuals with insomnia often experience long delays between the times that they go to bed and actually fall asleep. In addition, these individuals may wake up several times during the night only to find that they have difficulty getting back to sleep. As mentioned earlier, one of the criteria for insomnia involves experiencing these symptoms for at least three nights a week for at least one month's time (Roth, 2007).

It is not uncommon for people suffering from insomnia to experience increased levels of anxiety about

their inability to fall asleep. This becomes a self-perpetuating cycle because increased anxiety leads to increased arousal, and higher levels of arousal make the prospect of falling asleep even more unlikely. Chronic insomnia is almost always associated with feeling overtired and may be associated with symptoms of depression.

There may be many factors that contribute to insomnia, including age, drug use, exercise, mental status, and bedtime routines. Not surprisingly, insomnia treatment may take one of several different approaches. People who suffer from insomnia might limit their use of stimulant drugs (such as caffeine) or increase their amount of physical exercise during the day. Some people might turn to over-the-counter (OTC) or prescribed sleep medications to help them sleep, but this should be done sparingly because many sleep medications result in dependence and alter the nature of the sleep cycle, and they can increase insomnia over time. Those who continue to have insomnia, particularly if it affects their quality of life, should seek professional treatment.

Some forms of psychotherapy, such as cognitive-behavioral therapy, can help sufferers of insomnia. Cognitive-behavioral therapy is a type of psychotherapy that focuses on cognitive processes and problem behaviors. The treatment of insomnia likely would include stress management techniques and changes in problematic behaviors that could contribute to insomnia (e.g., spending more waking time in bed). Cognitive-behavioral therapy has been demonstrated to be quite effective in treating insomnia (Savard, Simard, Ivers, & Morin, 2005; Williams, Roth, Vathauer, & McCrae, 2013).

## Parasomnias

A parasomnia is one of a group of sleep disorders in which unwanted, disruptive motor activity and/or experiences during sleep play a role. Parasomnias can occur in either REM or NREM phases of sleep. Sleepwalking, restless leg syndrome, and night terrors are all examples of parasomnias (Mahowald & Schenck, 2000).

## Sleepwalking

In sleepwalking, or somnambulism, the sleeper engages in relatively complex behaviors ranging from wandering about to driving an automobile. During periods of sleepwalking, sleepers often have their eyes open, but they are not responsive to attempts to communicate with them. Sleepwalking most often occurs during slow-wave sleep, but it can occur at any time during a sleep period in some affected individuals (Mahowald & Schenck, 2000).

Historically, somnambulism has been treated with a variety of pharmacotherapies ranging from benzodiazepines to antidepressants. However, the success rate of such treatments is questionable. Guilleminault et al. (2005) found that sleepwalking was not alleviated with the use of benzodiazepines. However, all of their somnambulistic patients who also suffered from sleep-related breathing problems showed a marked decrease in sleepwalking when their breathing problems were effectively treated.

## A Sleepwalking Defense?

On January 16, 1997, Scott Falater sat down to dinner with his wife and children and told them about difficulties he was experiencing on a project at work. After dinner, he prepared some materials to use in leading a church youth group the following morning, and then he attempted to repair the family's swimming pool pump before retiring to bed. The following morning, he awoke to barking dogs and unfamiliar voices from downstairs. As he went to investigate what was going on, he was met by a group of police officers who arrested him for the murder of his wife (Cartwright, 2004; CNN, 1999).

Yarmila Falater's body was found in the family's pool with 44 stab wounds. A neighbor called the police after witnessing Falater standing over his wife's body before dragging her into the pool. Upon a search of the premises, police found blood-stained clothes and a bloody knife in the trunk of Falater's car, and he had blood stains on his neck.

Remarkably, Falater insisted that he had no recollection of hurting his wife in any way. His children and his wife's parents all agreed that Falater had an excellent relationship with his wife and they couldn't think of a reason that would provide any sort of motive to murder her (Cartwright, 2004).

Scott Falater had a history of regular episodes of sleepwalking as a child, and he had even behaved violently toward his sister once when she tried to prevent him from leaving their home in his pajamas during a sleepwalking episode. He suffered from no apparent anatomical brain anomalies or psychological disorders. It appeared that Scott Falater had killed his wife in his sleep, or at least, that is the defense he used when he was tried for his wife's murder (Cartwright, 2004; CNN, 1999). In Falater's case, a jury found him guilty of first-degree murder in June of 1999 (CNN, 1999); however, there are other murder cases where the sleepwalking defense has been used successfully. As scary as it sounds, many sleep researchers believe that homicidal sleepwalking is possible in individuals suffering from the types of sleep disorders described below (Broughton et al., 1994; Cartwright, 2004; Mahowald, Schenck, & Cramer Bornemann, 2005; Pressman, 2007).

## REM Sleep Behavior Disorder (RBD)

REM sleep behavior disorder (RBD) occurs when the muscle paralysis associated with the REM sleep phase does not occur. Individuals who suffer from RBD have high levels of physical activity during REM sleep,

especially during disturbing dreams. These behaviors vary widely, but they can include kicking, punching, scratching, yelling, and behaving like an animal that has been frightened or attacked. People who suffer from this disorder can injure themselves or their sleeping partners when engaging in these behaviors. Furthermore, these types of behaviors ultimately disrupt sleep, although affected individuals have no memories that these behaviors have occurred (Arnulf, 2012).

This disorder is associated with a number of neurodegenerative diseases such as Parkinson's disease. In fact, this relationship is so robust that some view the presence of RBD as a potential aid in the diagnosis and treatment of a number of neurodegenerative diseases (Ferini-Strambi, 2011). Clonazepam, an anti-anxiety medication with sedative properties, is most often used to treat RBD. It is administered alone or in conjunction with doses of melatonin (the hormone secreted by the pineal gland). As part of treatment, the sleeping environment is often modified to make it a safer place for those suffering from RBD (Zangini, Calandra-Buonaura, Grimaldi, & Cortelli, 2011).

## Other Parasomnias

A person with restless leg syndrome has uncomfortable sensations in the legs during periods of inactivity or when trying to fall asleep. This discomfort is relieved by deliberately moving the legs, which, not surprisingly, contributes to difficulty in falling or staying asleep. Restless leg syndrome is quite common and has been associated with a number of other medical diagnoses, such as chronic kidney disease and diabetes (Mahowald & Schenck, 2000). There are a variety of drugs that treat restless leg syndrome: benzodiazepines, opiates, and anticonvulsants (Restless Legs Syndrome Foundation, n.d.).

Night terrors result in a sense of panic in the sufferer and are often accompanied by screams and attempts to escape from the immediate environment (Mahowald & Schenck, 2000). Although individuals suffering from night terrors appear to be awake, they generally have no memories of the events that occurred, and attempts to console them are ineffective. Typically, individuals suffering from night terrors will fall back asleep again within a short time. Night terrors apparently occur during the NREM phase of sleep (Provini, Tinuper, Bisulli, & Lagaresi, 2011). Generally, treatment for night terrors is unnecessary unless there is some underlying medical or psychological condition that is contributing to the night terrors (Mayo Clinic, n.d.).

## Sleep Apnea

Sleep apnea is defined by episodes during which a sleeper's breathing stops. These episodes can last 10–20 seconds or longer and often are associated with brief periods of arousal. While individuals suffering from sleep apnea may not be aware of these repeated disruptions in sleep, they do experience increased levels of fatigue. Many individuals diagnosed with sleep apnea first seek treatment because their sleeping partners indicate that they snore loudly and/or stop breathing for extended periods of time while sleeping (Henry & Rosenthal,

2013). Sleep apnea is much more common in overweight people and is often associated with loud snoring. Surprisingly, sleep apnea may exacerbate cardiovascular disease (Sánchez-de-la-Torre, Campos-Rodriguez, & Barbé, 2012). While sleep apnea is less common in thin people, anyone, regardless of their weight, who snores loudly or gasps for air while sleeping, should be checked for sleep apnea.

While people are often unaware of their sleep apnea, they are keenly aware of some of the adverse consequences of insufficient sleep. Consider a patient who believed that as a result of his sleep apnea he “had three car accidents in six weeks. They were ALL my fault. Two of them I didn’t even know I was involved in until afterwards” (Henry & Rosenthal, 2013, p. 52). It is not uncommon for people suffering from undiagnosed or untreated sleep apnea to fear that their careers will be affected by the lack of sleep, illustrated by this statement from another patient, “I’m in a job where there’s a premium on being mentally alert. I was really sleepy... and having trouble concentrating.... It was getting to the point where it was kind of scary” (Henry & Rosenthal, 2013, p. 52).

There are two types of sleep apnea: obstructive sleep apnea and central sleep apnea. Obstructive sleep apnea occurs when an individual’s airway becomes blocked during sleep, and air is prevented from entering the lungs. In central sleep apnea, disruption in signals sent from the brain that regulate breathing causes periods of interrupted breathing (White, 2005).

One of the most common treatments for sleep apnea involves the use of a special device during sleep. A continuous positive airway pressure (CPAP) device includes a mask that fits over the sleeper’s nose and mouth, which is connected to a pump that pumps air into the person’s airways, forcing them to remain open, as shown in . Some newer CPAP masks are smaller and cover only the nose. This treatment option has proven to be effective for people suffering from mild to severe cases of sleep apnea (McDaid et al., 2009). However, alternative treatment options are being explored because consistent compliance by users of CPAP devices is a problem. Recently, a new EPAP (expiratory positive air pressure) device has shown promise in double-blind trials as one such alternative (Berry, Kryger, & Massie, 2011).



(a)



(b)

(a) A typical CPAP device used in the treatment of sleep apnea is (b) affixed to the head with straps, and a mask that covers the nose and mouth.

## SIDS

In sudden infant death syndrome (SIDS) an infant stops breathing during sleep and dies. Infants younger than 12 months appear to be at the highest risk for SIDS, and boys have a greater risk than girls. A number of risk factors have been associated with SIDS including premature birth, smoking within the home, and hyperthermia. There may also be differences in both brain structure and function in infants who die from SIDS (Berkowitz, 2012; Mage & Donner, 2006; Thach, 2005).

The substantial amount of research on SIDS has led to a number of recommendations to parents to protect their children. For one, research suggests that infants should be placed on their backs when put down to sleep, and their cribs should not contain any items that pose suffocation threats, such as blankets, pillows, or padded crib bumpers (cushions that cover the bars of a crib). Infants should not have caps placed on their heads when put down to sleep in order to prevent overheating, and people in the child's household should abstain from smoking in the home. Recommendations like these have helped to decrease the number of infant deaths from SIDS in recent years (Mitchell, 2009; Task Force on Sudden Infant Death Syndrome, 2011).



The Safe to Sleep campaign educates the public about how to minimize risk factors associated with SIDS. This campaign is sponsored in part by the National Institute of Child Health and Human Development.

## Narcolepsy

Unlike the other sleep disorders described in this section, a person with narcolepsy cannot resist falling asleep at inopportune times. These sleep episodes are often associated with cataplexy, which is a lack of muscle tone or muscle weakness, and in some cases involves complete paralysis of the voluntary muscles. This is similar to the kind of paralysis experienced by healthy individuals during REM sleep (Burgess & Scammell, 2012; Hishikawa & Shimizu, 1995; Luppi et al., 2011). Narcoleptic episodes take on other features of REM sleep. For example, around one-third of individuals diagnosed with narcolepsy experience vivid, dream-like hallucinations during narcoleptic attacks (Chokroverty, 2010).

Surprisingly, narcoleptic episodes are often triggered by states of heightened arousal or stress. The typical episode can last from a minute or two to half an hour. Once awakened from a narcoleptic attack, people report that they feel refreshed (Chokroverty, 2010). Obviously, regular narcoleptic episodes could interfere with the ability to perform one's job or complete schoolwork, and in some situations, narcolepsy can result in significant harm and injury (e.g., driving a car or operating machinery or other potentially dangerous equipment).

Generally, narcolepsy is treated using psychomotor stimulant drugs, such as amphetamines (Mignot, 2012). These drugs promote increased levels of neural activity. Narcolepsy is associated with reduced levels of the signaling molecule hypocretin in some areas of the brain (De la Herrán-Arita & Drucker-Colín, 2012; Han, 2012), and the traditional stimulant drugs do not have direct effects on this system. Therefore, it is quite likely that new medications that are developed to treat narcolepsy will be designed to target the hypocretin system.

There is a tremendous amount of variability among sufferers, both in terms of how symptoms of narcolepsy manifest and the effectiveness of currently available treatment options. This is illustrated by McCarty's (2010) case study of a 50-year-old woman who sought help for the excessive sleepiness during normal waking hours that she had experienced for several years. She indicated that she had fallen asleep at inappropriate or dangerous times, including while eating, while socializing with friends, and while driving her car. During periods of emotional arousal, the woman complained that she felt some weakness in the right side of her body. Although

she did not experience any dream-like hallucinations, she was diagnosed with narcolepsy as a result of sleep testing. In her case, the fact that her cataplexy was confined to the right side of her body was quite unusual. Early attempts to treat her condition with a stimulant drug alone were unsuccessful. However, when a stimulant drug was used in conjunction with a popular antidepressant, her condition improved dramatically.

## Summary

Many individuals suffer from some type of sleep disorder or disturbance at some point in their lives. Insomnia is a common experience in which people have difficulty falling or staying asleep. Parasomnias involve unwanted motor behavior or experiences throughout the sleep cycle and include RBD, sleepwalking, restless leg syndrome, and night terrors. Sleep apnea occurs when individuals stop breathing during their sleep, and in the case of sudden infant death syndrome, infants will stop breathing during sleep and die. Narcolepsy involves an irresistible urge to fall asleep during waking hours and is often associated with cataplexy and hallucination.

## Review Questions



*An interactive H5P element has been excluded from this version of the text. You can view it online here:*

<https://louis.pressbooks.pub/intropsychology/?p=320#h5p-92>

## Critical Thinking Questions

One of the recommendations that therapists will make to people who suffer from insomnia is to spend less waking time in bed. Why do you think spending waking time in bed might interfere with the ability to fall asleep later?

Answers will vary. One possible explanation might invoke principles of associative learning. If the bed represents a place for socializing, studying, eating, and so on, then it is possible that it

will become a place that elicits higher levels of arousal, which would make falling asleep at the appropriate time more difficult. Answers could also consider self-perpetuating cycle referred to when describing insomnia. If an individual is having trouble falling asleep and that generates anxiety, it might make sense to remove him from the context where sleep would normally take place to try to avoid anxiety being associated with that context.

How is narcolepsy with cataplexy similar to and different from REM sleep? Similarities include muscle atony and the hypnagogic hallucinations associated with narcoleptic episodes. The differences involve the uncontrollable nature of narcoleptic attacks and the fact that these come on in situations that would normally not be associated with sleep of any kind (e.g., instances of heightened arousal or emotionality).

## Personal Application Question

What factors might contribute to your own experiences with insomnia?

## 19.

# SUBSTANCE USE AND ABUSE

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## Learning Objectives

By the end of this section, you will be able to:

- Describe the diagnostic criteria for substance use disorders
- Identify the neurotransmitter systems affected by various categories of drugs
- Describe how different categories of drugs affect behavior and experience

While we all experience altered states of consciousness in the form of sleep on a regular basis, some people use drugs and other substances that result in altered states of consciousness as well. This section will present information relating to the use of various psychoactive drugs and problems associated with such use. This will be followed by brief descriptions of the effects of some of the more well-known drugs commonly used today.

## Substance Use Disorders

The *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5) is used by clinicians to diagnose individuals suffering from various psychological disorders. Drug use disorders are addictive disorders, and the criteria for specific substance (drug) use disorders are described in DSM-5. A person who has a substance use disorder often uses more of the substance than they originally intended to and continues to use that substance despite experiencing significant adverse consequences. In individuals diagnosed with a substance use disorder, there is a compulsive pattern of drug use that is often associated with both physical and psychological dependence.

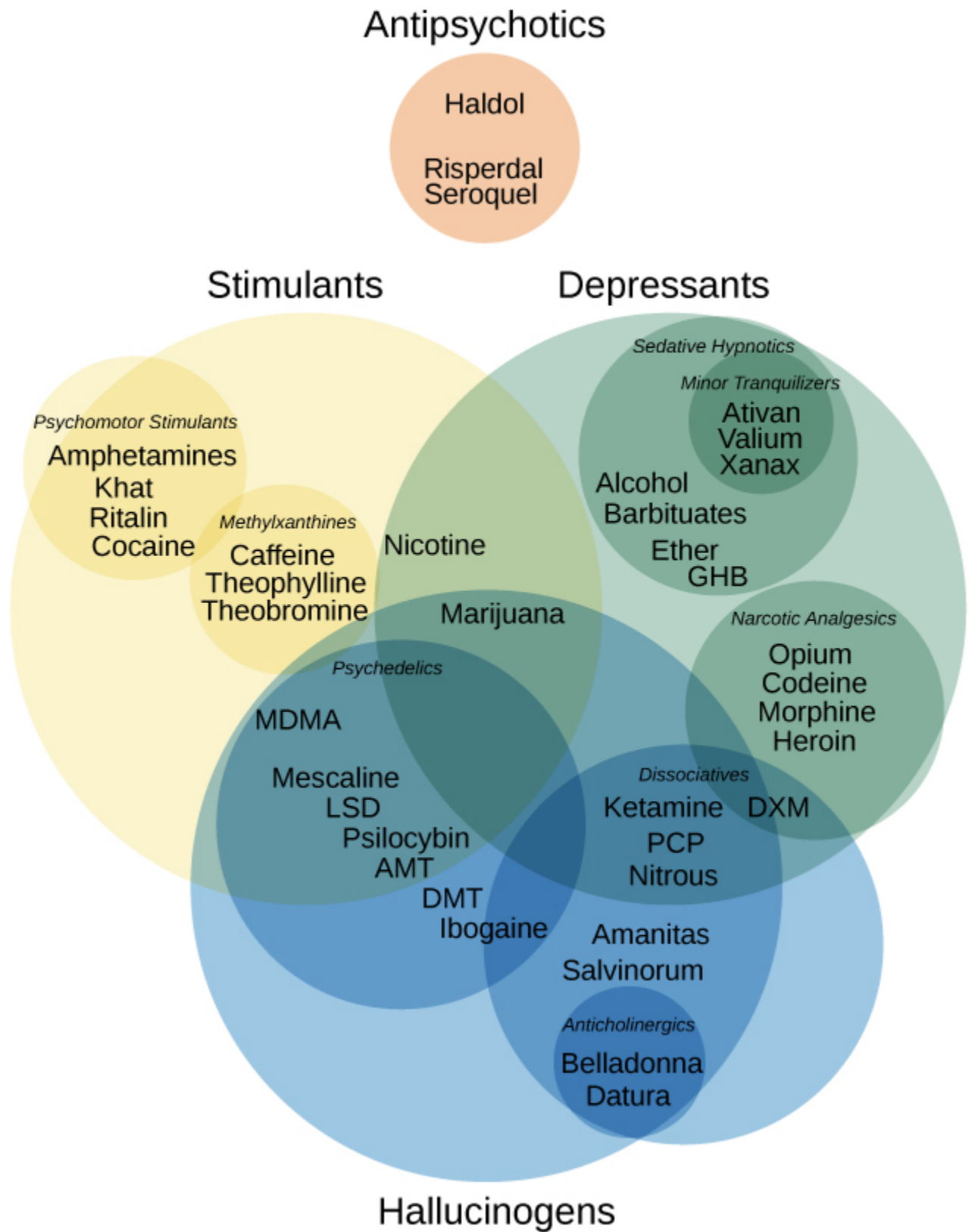
**Physical dependence** involves changes in normal bodily functions—the user will experience withdrawal from the drug upon cessation of use. In contrast, a person who has **psychological dependence** has an emotional, rather than physical, need for the drug and may use the drug to relieve psychological distress.

**Tolerance** is linked to physiological dependence, and it occurs when a person requires more and more of a drug to achieve effects previously experienced at lower doses. Tolerance can cause the user to increase the amount of a drug used to a dangerous level—even to the point of overdose and death.

**Drug withdrawal** includes a variety of negative symptoms experienced when drug use is discontinued. These symptoms are usually the opposite of the effects of the drug. For example, withdrawal from sedative drugs often produces unpleasant arousal and agitation. In addition to withdrawal, many individuals who are diagnosed with substance use disorders will also develop tolerances to these substances. Psychological dependence, or drug craving, is a recent addition to the diagnostic criteria for substance use disorder in DSM-5. This is an important factor because we can develop tolerance and experience withdrawal from any number of drugs that we do not abuse. In other words, physical dependence in and of itself is of limited utility in determining whether or not someone has a substance use disorder.

## Drug Categories

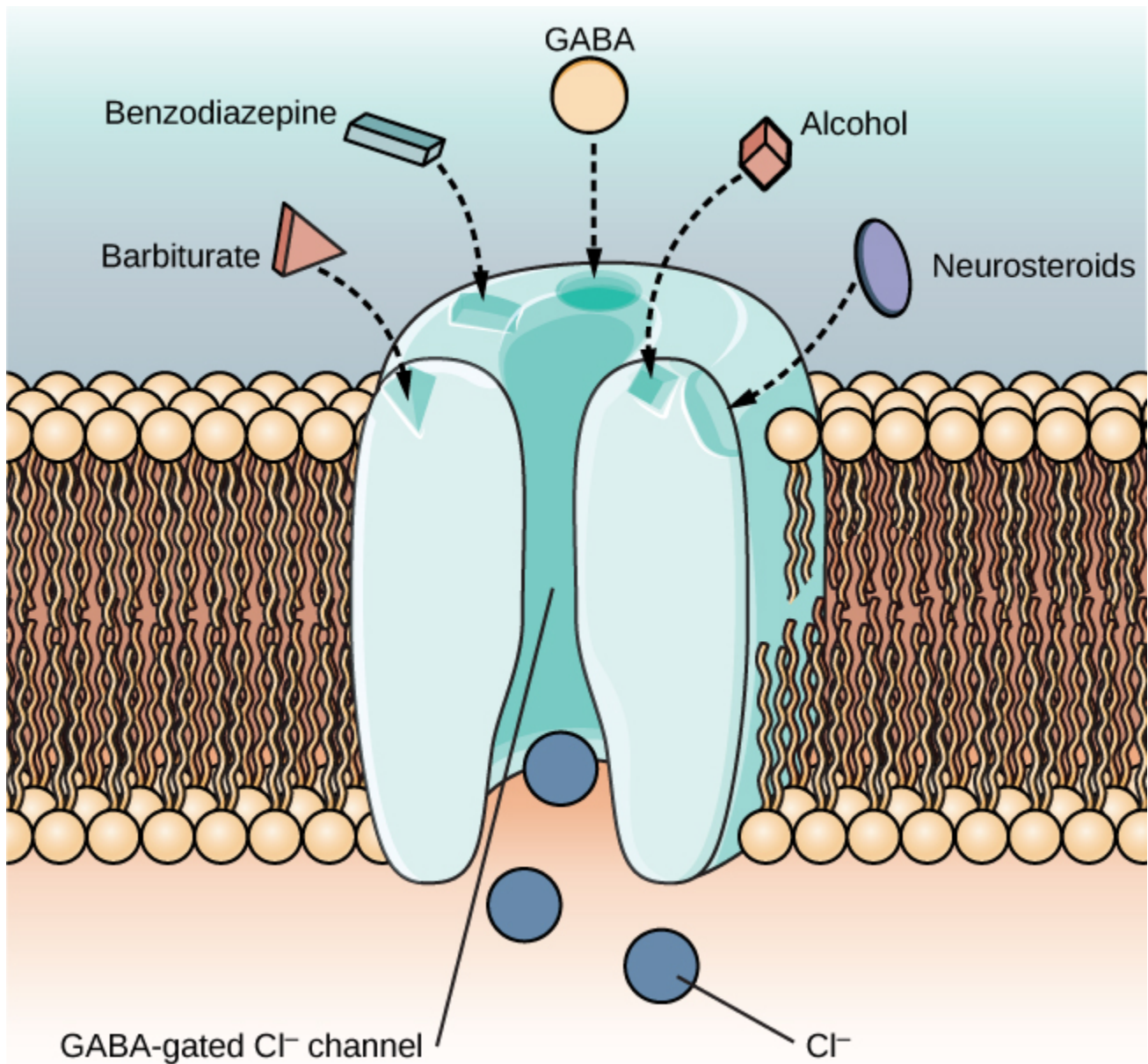
The effects of all psychoactive drugs occur through their interactions with our endogenous neurotransmitter systems. Many of these drugs, and their relationships, are shown in . As you have learned, drugs can act as agonists or antagonists of a given neurotransmitter system. An agonist facilitates the activity of a neurotransmitter system, and antagonists impede neurotransmitter activity.



This figure illustrates various drug categories and overlap among them. (credit: modification of work by Derrick Snider)

## Alcohol and Other Depressants

Ethanol, which we commonly refer to as alcohol, is in a class of psychoactive drugs known as depressants. A **depressant** is a drug that tends to suppress central nervous system activity. Other depressants include barbiturates and benzodiazepines. These drugs share in common their ability to serve as agonists of the gamma-aminobutyric acid (GABA) neurotransmitter system. Because GABA has a quieting effect on the brain, GABA agonists also have a quieting effect; these types of drugs are often prescribed to treat both anxiety and insomnia.



The GABA-gated chloride (Cl<sup>-</sup>) channel is embedded in the cell membrane of certain neurons. The channel has multiple receptor sites where alcohol, barbiturates, and benzodiazepines bind to exert their effects. The binding of these molecules opens the chloride channel, allowing negatively charged chloride ions (Cl<sup>-</sup>) into the neuron's cell body. Changing its charge in a negative direction pushes the neuron away from firing; thus, activating a GABA neuron has a quieting effect on the brain.

Acute alcohol administration results in a variety of changes to consciousness. At rather low doses, alcohol use is associated with feelings of euphoria. As the dose increases, people report feeling sedated. Generally, alcohol is associated with decreases in reaction time and visual acuity, lowered levels of alertness, and a reduction in behavioral control. With excessive alcohol use, a person might experience a complete loss of consciousness and/or difficulty remembering events that occurred during a period of intoxication (McKim & Hancock, 2013). In

addition, if a pregnant woman consumes alcohol, her infant may be born with a cluster of birth defects and symptoms collectively called **fetal alcohol spectrum disorder (FASD) or fetal alcohol syndrome (FAS)**.

With repeated use of many central nervous system depressants, such as alcohol, a person becomes physically dependent upon the substance and will exhibit signs of both tolerance and withdrawal. Psychological dependence on these drugs is also possible. Therefore, the abuse potential of central nervous system depressants is relatively high.

Drug withdrawal is usually an aversive experience, and it can be a life-threatening process in individuals who have a long history of very high doses of alcohol and/or barbiturates. This is of such concern that people who are trying to overcome addiction to these substances should only do so under medical supervision.

## Stimulants

**Stimulants** are drugs that tend to increase overall levels of neural activity. Many of these drugs act as agonists of the dopamine neurotransmitter system. Dopamine activity is often associated with reward and craving; therefore, drugs that affect dopamine neurotransmission often have abuse liability. Drugs in this category include cocaine, amphetamines (including methamphetamine), cathinones (i.e., bath salts), MDMA (ecstasy), nicotine, and caffeine.

Cocaine can be taken in multiple ways. While many users snort cocaine, intravenous injection and ingestion are also common. The freebase version of cocaine, known as crack, is a potent, smokable version of the drug. Like many other stimulants, cocaine agonizes the dopamine neurotransmitter system by blocking the reuptake of dopamine in the neuronal synapse.

## CRACK COCAINE

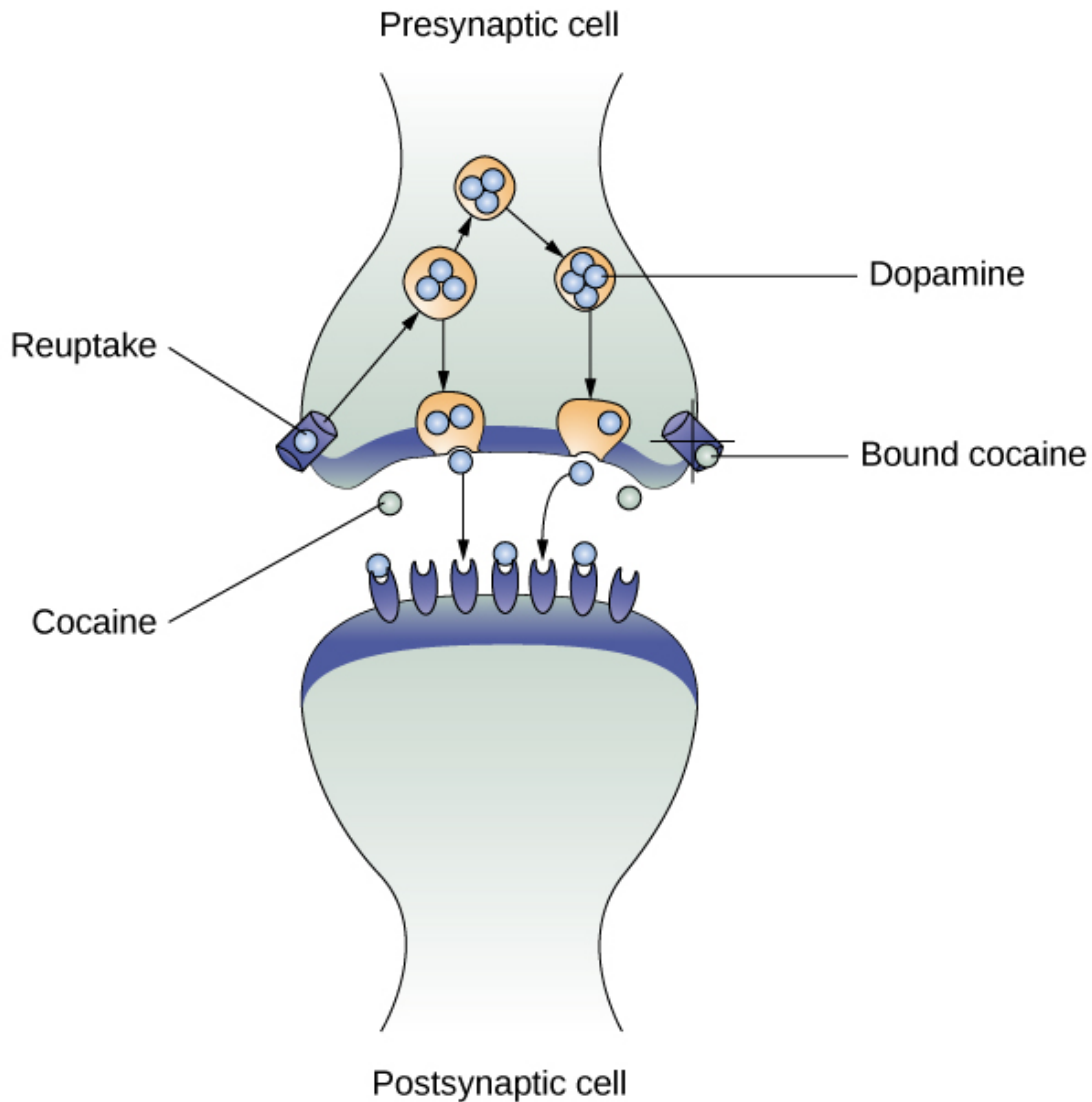
Crack is often considered to be more addictive than cocaine itself because it is smokable and reaches the brain very quickly. Crack is often less expensive than other forms of cocaine; therefore, it tends to be a more accessible drug for individuals from impoverished segments of society. During the 1980s, many drug laws were rewritten to punish crack users more severely than cocaine users. This led to discriminatory sentencing with low-income, inner-city minority populations receiving the harshest punishments. The wisdom of these laws has recently been called into question, especially given research that suggests crack may not be more addictive than other forms of cocaine, as previously thought (Haasen & Krausz, 2001; Reinerman, 2007).



Crack rocks like these are smoked to achieve a high. Compared with other routes of administration, smoking a drug allows it to enter the brain more rapidly, which can often enhance the user's experience. (credit: modification of work by U.S. Department of Justice)

Read this interesting newspaper article describing myths about crack cocaine: [5 Myths About That Demon Crack](#).

Amphetamines have a mechanism of action quite similar to cocaine in that they block the reuptake of dopamine in addition to stimulating its release. While amphetamines are often abused, they are also commonly prescribed to children diagnosed with attention deficit hyperactivity disorder (ADHD). It may seem counterintuitive that stimulant medications are prescribed to treat a disorder that involves hyperactivity, but the therapeutic effect comes from increases in neurotransmitter activity within certain areas of the brain associated with impulse control.



As one of their mechanisms of action, cocaine and amphetamines block the reuptake of dopamine from the synapse into the presynaptic cell.

In recent years, methamphetamine (meth) use has become increasingly widespread. **Methamphetamine** is a type of amphetamine that can be made from ingredients that are readily available (e.g., medications containing pseudoephedrine, a compound found in many over-the-counter cold and flu remedies). Despite recent changes in laws designed to make obtaining pseudoephedrine more difficult, methamphetamine continues to be an easily accessible and relatively inexpensive drug option (Shukla, Crump, & Chrisco, 2012).

Cocaine, amphetamine, cathinone, and MDMA users seek a euphoric high, feelings of intense elation and pleasure, especially in those users who take the drug via intravenous injection or smoking. Repeated use of these stimulants can have significant adverse consequences. Users can experience physical symptoms that include nausea, elevated blood pressure, and increased heart rate. In addition, these drugs can cause feelings of anxiety, hallucinations, and paranoia (Fiorentini et al., 2011). Normal brain functioning is altered after

repeated use of these drugs. For example, repeated use can lead to overall depletion among the monoamine neurotransmitters (dopamine, norepinephrine, and serotonin). People may engage in compulsive use of these stimulant substances in part to try to reestablish normal levels of these neurotransmitters (Jayanthi & Ramamoorthy, 2005; Rothman, Blough, & Baumann, 2007).

**Caffeine** is another stimulant drug. While it is probably the most commonly used drug in the world, the potency of this particular drug pales in comparison to the other stimulant drugs described in this section. Generally, people use caffeine to maintain increased levels of alertness and arousal. Caffeine is found in many common medicines (such as weight loss drugs), beverages, foods, and even cosmetics (Herman & Herman, 2013). While caffeine may have some indirect effects on dopamine neurotransmission, its primary mechanism of action involves antagonizing adenosine activity (Porkka-Heiskanen, 2011).

While caffeine is generally considered a relatively safe drug, high blood levels of caffeine can result in insomnia, agitation, muscle twitching, nausea, irregular heartbeat, and even death (Reissig, Strain, & Griffiths, 2009; Wolt, Ganetsky, & Babu, 2012). In 2012, Kromann and Nielson reported on a case study of a 40-year-old woman who suffered significant ill effects from her use of caffeine. The woman used caffeine in the past to boost her mood and to provide energy, but over the course of several years, she increased her caffeine consumption to the point that she was consuming three liters of soda each day. Although she had been taking a prescription antidepressant, her symptoms of depression continued to worsen and she began to suffer physically, displaying significant warning signs of cardiovascular disease and diabetes. Upon admission to an outpatient clinic for treatment of mood disorders, she met all of the diagnostic criteria for substance dependence and was advised to dramatically limit her caffeine intake. Once she was able to limit her use to less than 12 ounces of soda a day, both her mental and physical health gradually improved. Despite the prevalence of caffeine use and the large number of people who confess to suffering from caffeine addiction, this was the first published description of soda dependence appearing in scientific literature.

Nicotine is highly addictive, and the use of tobacco products is associated with increased risks of heart disease, stroke, and a variety of cancers. Nicotine exerts its effects through its interaction with acetylcholine receptors. Acetylcholine functions as a neurotransmitter in motor neurons. In the central nervous system, it plays a role in arousal and reward mechanisms. Nicotine is most commonly used in the form of tobacco products like cigarettes or chewing tobacco; therefore, there is a tremendous interest in developing effective smoking cessation techniques. To date, people have used a variety of nicotine replacement therapies in addition to various psychotherapeutic options in an attempt to discontinue their use of tobacco products. In general, smoking cessation programs may be effective in the short term, but it is unclear whether these effects persist (Cropley, Theadom, Pravettoni, & Webb, 2008; Levitt, Shaw, Wong, & Kaczorowski, 2007; Smedslund, Fisher, Boles, & Lichtenstein, 2004).

## Opioids

An **opioid** is one of a category of drugs that includes heroin, morphine, methadone, and codeine. Opioids

have analgesic properties; that is, they decrease pain. Humans have an endogenous opioid neurotransmitter system—the body makes small quantities of opioid compounds that bind to opioid receptors reducing pain and producing euphoria. Thus, opioid drugs, which mimic this endogenous painkilling mechanism, have an extremely high potential for abuse. Natural opioids, called opiates, are derivatives of opium, which is a naturally occurring compound found in the poppy plant. There are now several synthetic versions of opiate drugs (correctly called opioids) that have very potent painkilling effects, and they are often abused. For example, the National Institute on Drug Abuse has sponsored research that suggests the misuse and abuse of the prescription painkillers hydrocodone and oxycodone are significant public health concerns (Maxwell, 2006). In 2013, the U.S. Food and Drug Administration recommended tighter controls on their medical use.

Historically, heroin has been a major opioid drug of abuse. Heroin can be snorted, smoked, or injected intravenously. Like the stimulants described earlier, the use of heroin is associated with an initial feeling of euphoria followed by periods of agitation. Because heroin is often administered via intravenous injection, users often bear needle track marks on their arms and, like all abusers of intravenous drugs, have an increased risk for contraction of both tuberculosis and HIV.



(a)



(b)

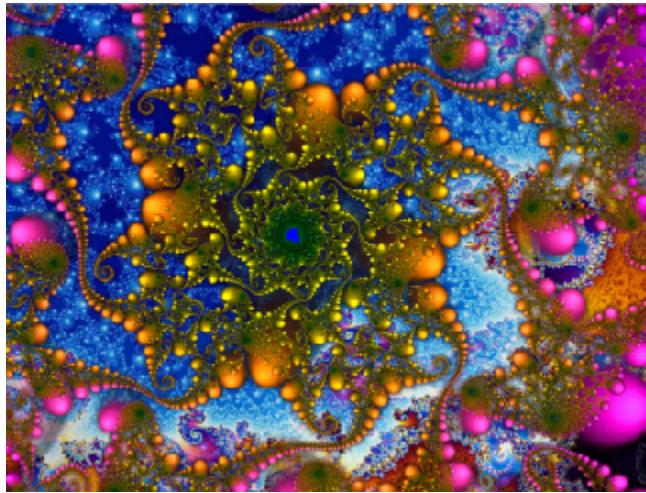
(a) Common paraphernalia for heroin preparation and use are shown here in a needle exchange kit. (b) Heroin is cooked on a spoon over a candle. (credit a: modification of work by Todd Huffman)

Aside from their utility as analgesic drugs, opioid-like compounds are often found in cough suppressants, anti-nausea, and anti-diarrhea medications. Given that withdrawal from a drug often involves an experience opposite to the effect of the drug, it should be no surprise that opioid withdrawal resembles a severe case of the flu. While opioid withdrawal can be extremely unpleasant, it is not life-threatening (Julien, 2005). Still, people experiencing opioid withdrawal may be given methadone to make withdrawal from the drug less difficult. Methadone is a synthetic opioid that is less euphorogenic than heroin and similar drugs. Methadone clinics help people who previously struggled with opioid addiction manage withdrawal symptoms through the use of methadone. Other drugs, including the opioid buprenorphine, have also been used to alleviate symptoms of opiate withdrawal.

Codeine is an opioid with relatively low potency. It is often prescribed for minor pain, and it is available over-the-counter in some other countries. Like all opioids, codeine does have abuse potential. In fact, abuse of prescription opioid medications is becoming a major concern worldwide (Aquina, Marques-Baptista, Bridgeman, & Merlin, 2009; Casati, Sedefov, & Pfeiffer-Gerschel, 2012).

## Hallucinogens

A **hallucinogen** is one of a class of drugs that results in profound alterations in sensory and perceptual experiences. In some cases, users experience vivid visual hallucinations. It is also common for these types of drugs to cause hallucinations of body sensations (e.g., feeling as if you are a giant) and a skewed perception of the passage of time.



Psychedelic images like this are often associated with hallucinogenic compounds. (credit: modification of work by “new 1lluminati”/Flickr)

As a group, hallucinogens are incredibly varied in terms of the neurotransmitter systems they affect. Mescaline and LSD are serotonin agonists, and PCP (angel dust) and ketamine (an animal anesthetic) act as antagonists of the NMDA glutamate receptor. In general, these drugs are not thought to possess the same sort of abuse potential as other classes of drugs discussed in this section.

To learn more about some of the most commonly abused prescription and street drugs, check out the [Commonly Abused Drugs Chart](#) and the [Commonly Abused Prescription Drugs Chart \[PDF\]](#) from the National Institute on Drug Abuse.

## Medical Marijuana

While possession and use of marijuana are illegal in most states, it is now legal in Washington and Colorado to possess limited quantities of marijuana for recreational use. In contrast, medical marijuana use is now legal in nearly half of the United States and in the District of Columbia. Medical marijuana is marijuana that is prescribed by a doctor for the treatment of a health condition. For example, people who undergo chemotherapy will often be prescribed marijuana to stimulate their appetites and prevent excessive weight loss resulting from the side effects of chemotherapy treatment. Marijuana may also have some promise in the treatment of a variety of medical conditions (Mather, Rauwendaal, Moxham-Hall, & Wodak, 2013; Robson, 2014; Schicho & Storr, 2014).



Medical marijuana shops are becoming more and more common in the United States. (credit: Laurie Avocado)

While medical marijuana laws have been passed on a state-by-state basis, federal laws still classify this as an illicit substance, making conducting research on the potentially beneficial medicinal uses of marijuana problematic. There is quite a bit of controversy within the scientific community as to the extent to which marijuana might have medicinal benefits due to a lack of large-scale, controlled research (Bostwick, 2012). As a result, many scientists have urged the federal government to allow for the relaxation of current marijuana laws and classifications in order to facilitate a more widespread study of the drug's effects (Aggarwal et al., 2009; Bostwick, 2012; Kogan & Mechoulam, 2007).

Until recently, the United States Department of Justice routinely arrested people involved and seized marijuana used in medicinal settings. In the latter part of 2013, however, the United States Department of Justice issued statements indicating that they would not continue to challenge state medical marijuana laws. This shift in policy may be in response to the scientific community's recommendations and/or reflect changing public opinion regarding marijuana.

## Test Your Understanding



*An interactive H5P element has been excluded from this version of the text. You can view it online here:*

<https://louis.pressbooks.pub/intropsychology/?p=322#h5p-94>

## Summary

Substance use disorder is defined in DSM-5 as a compulsive pattern of drug use despite negative consequences. Both physical and psychological dependence are important parts of this disorder. Alcohol, barbiturates, and benzodiazepines are central nervous system depressants that affect GABA neurotransmission. Cocaine, amphetamine, cathinones, and MDMA are all central nervous stimulants that agonize dopamine neurotransmission, while nicotine and caffeine affect acetylcholine and adenosine, respectively. Opiate drugs serve as powerful analgesics through their effects on the endogenous opioid neurotransmitter system, and hallucinogenic drugs cause pronounced changes in sensory and perceptual experiences. The hallucinogens are variable with regard to the specific neurotransmitter systems they affect.

## Review Questions



*An interactive H5P element has been excluded from this version of the text. You can view it online here:*

<https://louis.pressbooks.pub/intropsychology/?p=322#h5p-95>

## Critical Thinking Questions

The negative health consequences of both alcohol and tobacco products are well-documented. A drug like marijuana, on the other hand, is generally considered to be as safe as, if not safer than, these legal drugs. Why do you think marijuana use continues to be illegal in many parts of the United States?

One possibility involves the cultural acceptance and long history of alcohol and tobacco use in our society. No doubt, money comes into play as well. Growing tobacco and producing alcohol on a large scale is a well-regulated and taxed process. Given that marijuana is essentially a weed that requires little care to grow, it would be much more difficult to regulate its production. Recent events suggest that cultural attitudes regarding marijuana are changing, and it is quite likely that its illicit status will be adapted accordingly.

Why are programs designed to educate people about the dangers of using tobacco products just as important as developing tobacco cessation programs?

Given that currently available programs designed to help people quit using tobacco products are not necessarily effective in the long term, programs designed to prevent people from using these products in the first place may be the best hope for dealing with the enormous public health concerns associated with tobacco use.

## Personal Application Question

Many people experiment with some sort of psychoactive substance at some point in their lives. Why do you think people are motivated to use substances that alter consciousness?

## 20.

# OTHER STATES OF CONSCIOUSNESS

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## Learning Objectives

By the end of this section, you will be able to:

- Define hypnosis and meditation
- Understand the similarities and differences between hypnosis and meditation

Our states of consciousness change as we move from wakefulness to sleep. We also alter our consciousness through the use of various psychoactive drugs. This final section will consider hypnotic and meditative states as additional examples of altered states of consciousness experienced by some individuals.

## Hypnosis

**Hypnosis** is *a state of extreme self-focus and attention in which minimal attention is given to external stimuli*. In the therapeutic setting, a clinician may use relaxation and suggestion in an attempt to alter the thoughts and perceptions of a patient. Hypnosis has also been used to draw out information believed to be buried deeply in someone's memory. For individuals who are especially open to the power of suggestion, hypnosis can prove to be a very effective technique, and brain imaging studies have demonstrated that hypnotic states are associated with global changes in brain functioning (Del Casale et al., 2012; Guldenmund, Vanhaudenhuyse, Boly, Laureys, & Soddu, 2012).

Historically, hypnosis has been viewed with some suspicion because of its portrayal in popular media and entertainment. Therefore, it is important to make a distinction between hypnosis as an empirically based therapeutic approach versus as a form of entertainment. Contrary to popular belief, individuals undergoing hypnosis usually have clear memories of the hypnotic experience and are in control of their own behaviors.

While hypnosis may be useful in enhancing memory or a skill, such enhancements are very modest in nature (Raz, 2011).



Popular portrayals of hypnosis have led to some widely-held misconceptions.

How exactly does a hypnotist bring a participant to a state of hypnosis? While there are variations, there are four parts that appear consistent in bringing people into the state of suggestibility associated with hypnosis (National Research Council, 1994). These components include:

- The participant is guided to focus on one thing, such as the hypnotist's words or a ticking watch.
- The participant is made comfortable and is directed to be relaxed and sleepy.
- The participant is told to be open to the process of hypnosis, trust the hypnotist, and let go.
- The participant is encouraged to use his or her imagination.

These steps are conducive to being open to the heightened suggestibility of hypnosis.

People vary in terms of their ability to be hypnotized, but a review of available research suggests that

most people are at least moderately hypnotizable (Kihlstrom, 2013). Hypnosis in conjunction with other techniques is used for a variety of therapeutic purposes and has shown to be at least somewhat effective for pain management, treatment of depression and anxiety, smoking cessation, and weight loss (Alladin, 2012; Elkins, Johnson, & Fisher, 2012; Golden, 2012; Montgomery, Schnur, & Kravits, 2012).

Some scientists are working to determine whether the power of suggestion can affect cognitive processes such as learning, with a view to using hypnosis in educational settings (Wark, 2011). Furthermore, there is some evidence that hypnosis can alter processes that were once thought to be automatic and outside the purview of voluntary control, such as reading (Lifshitz, Aubert Bonn, Fischer, Kashem, & Raz, 2013; Raz, Shapiro, Fan, & Posner, 2002). However, it should be noted that others have suggested that the automaticity of these processes remains intact (Augustinova & Ferrand, 2012).

How does hypnosis work? Two theories attempt to answer this question: One theory views hypnosis as dissociation and the other theory views it as the performance of a social role. According to the dissociation view, hypnosis is effectively a dissociated state of consciousness, much like our earlier example where you may drive to work, but you are only minimally aware of the process of driving because your attention is focused elsewhere. This theory is supported by Ernest Hilgard's research into hypnosis and pain. In Hilgard's experiments, he induced participants into a state of hypnosis and placed their arms in ice water. Participants were told they would not feel pain, but they could press a button if they did; while they reported not feeling pain, they did, in fact, press the button, suggesting a dissociation of consciousness while in the hypnotic state (Hilgard & Hilgard, 1994).

Taking a different approach to explain hypnosis, the social-cognitive theory of hypnosis sees people in hypnotic states as performing the social role of a hypnotized person. As you will learn when you study social roles, people's behavior can be shaped by their expectations of how they should act in a given situation. Some view a hypnotized person's behavior not as an altered or dissociated state of consciousness, but as their fulfillment of the social expectations for that role.

## Meditation

**Meditation** is the *act of focusing on a single target (such as the breath or a repeated sound) to increase awareness of the moment*. While hypnosis is generally achieved through the interaction of a therapist and the person being treated, an individual can perform meditation alone. Often, however, people wishing to learn to meditate receive some training in techniques to achieve a meditative state. A meditative state, as shown by EEG recordings of newly practicing meditators, is not an altered state of consciousness per se; however, patterns of brain waves exhibited by expert meditators may represent a unique state of consciousness (Fell, Axmacher, & Haupt, 2010).

Although there are a number of different techniques in use, the central feature of all meditation is clearing the mind in order to achieve a state of relaxed awareness and focus (Chen et al., 2013; Lang et al., 2012).

Mindfulness meditation has recently become popular. In the variation of meditation, the meditator's attention is focused on some internal process or an external object (Zeidan, Grant, Brown, McHaffie, & Coghill, 2012).

Meditative techniques have their roots in religious practices, but their use has grown in popularity among practitioners of alternative medicine. Research indicates that meditation may help reduce blood pressure, and the American Heart Association suggests that meditation might be used in conjunction with more traditional treatments as a way to manage hypertension, although there is not sufficient data for a recommendation to be made (Brook et al., 2013). Like hypnosis, meditation also shows promise in stress management, sleep quality (Caldwell, Harrison, Adams, Quin, & Greeson, 2010), treatment of mood and anxiety disorders (Chen et al., 2013; Freeman et al., 2010; Vøllestad, Nielsen, & Nielsen, 2012), and pain management (Reiner, Tibi, & Lipsitz, 2013).



(a)



(b)

(a) This is a statue of a meditating Buddha, representing one of the many religious traditions of which meditation plays a part. (b) People practicing meditation may experience an alternate state of consciousness. (credit a: modification of work by Jim Epler; credit b: modification of work by Caleb Roenigk)

Feeling stressed? Think meditation might help? This instructional video teaches how to use Buddhist meditation techniques to alleviate stress: [Easy Meditation for Beginners – How to do a normal Third Eye Meditation](#).



*One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://louis.pressbooks.pub/intropsychology/?p=324#oembed-1>*

Watch this video describing the results of a brain imaging study in individuals who underwent specific mindfulness-meditative techniques: [Scans “show mindfulness meditation brain boost.”](#)

## Test Your Understanding



*An interactive H5P element has been excluded from this version of the text. You can view it online here: <https://louis.pressbooks.pub/intropsychology/?p=324#h5p-97>*

## Summary

Hypnosis is a focus on the self that involves suggested changes of behavior and experience. Meditation involves relaxed, yet focused, awareness. Both hypnotic and meditative states may involve altered states of consciousness that have potential applications for the treatment of a variety of physical and psychological disorders.

## Review Questions



*An interactive H5P element has been excluded from this version of the text. You can view it online here:*

<https://louis.pressbooks.pub/intropsychology/?p=324#h5p-98>

## Critical Thinking Questions

What advantages exist for researching the potential health benefits of hypnosis? Healthcare and pharmaceutical costs continue to skyrocket. If alternative approaches to dealing with these problems could be developed that would be relatively inexpensive, then the potential benefits are many.

What types of studies would be most convincing regarding the effectiveness of meditation in the treatment for some type of physical or mental disorder? Ideally, double-blind experimental trials would be best suited to speak to the effectiveness of meditation. At the very least, some sort of randomized control trial would be very informative.

## Personal Application Question

Under what circumstances would you be willing to consider hypnosis and/or meditation as a treatment option? What kind of information would you need before you made a decision to use these techniques?

## Media Attributions

- [“Easy Meditation for Beginners – How to do a normal Third Eye Meditation”](#) by [EasyMeditation4Beg.](#)  
Standard YouTube License.

21.

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## PART V

# SENSATION AND PERCEPTION



If you were standing in the midst of this street scene, you would be absorbing and processing numerous pieces of sensory input. (credit: modification of work by Cory Zanker)

Imagine standing on a city street corner. You might be struck by movement everywhere as cars and people go about their business, by the sound of a street musician's melody or a horn honking in the distance, by the smell of exhaust fumes or of food being sold by a nearby vendor, and by the sensation of hard pavement under your feet.

We rely on our sensory systems to provide important information about our surroundings. We use this information to successfully navigate and interact with our environment so that we can find nourishment, seek shelter, maintain social relationships, and avoid potentially dangerous situations.

This chapter will provide an overview of how sensory information is received and processed by the nervous system and how that affects our conscious experience of the world. We begin by learning the distinction between sensation and perception. Then we consider the physical properties of light and sound stimuli, along with an overview of the basic structure and function of the major sensory systems. The chapter will close with a discussion of a historically important theory of perception called Gestalt.



22.

# SENSATION VERSUS PERCEPTION

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## Learning Objectives

By the end of this section, you will be able to:

- Distinguish between sensation and perception
- Describe the concepts of absolute threshold and difference threshold
- Discuss the roles attention, motivation, and sensory adaptation play in perception

## Sensation

What does it mean to sense something? **Sensory receptors** are *specialized neurons that respond to specific types of stimuli*. When sensory information is detected by a sensory receptor, sensation occurs. For example, light that enters the eye causes chemical changes in cells that line the back of the eye. These cells relay messages, in the form of action potentials (as you learned when studying biopsychology), to the central nervous system. The conversion from sensory stimulus energy to action potential is known as transduction.

You have probably known since elementary school that we have five senses: vision, hearing (audition), smell (olfaction), taste (gustation), and touch (somatosensation). It turns out that this notion of five senses is oversimplified. We also have sensory systems that provide information about balance (the vestibular sense), body position and movement (proprioception and kinesthesia), pain (nociception), and temperature (thermoception).

The sensitivity of a given sensory system to the relevant stimuli can be expressed as an absolute threshold. Absolute threshold refers to the minimum amount of stimulus energy that must be present for the stimulus to be detected 50% of the time. Another way to think about this is by asking how dim can a light be or how soft can a sound be and still be detected half of the time. The sensitivity of our sensory receptors can be quite amazing. It has been estimated that on a clear night, the most sensitive sensory cells in the back of the eye can

detect a candle flame 30 miles away (Okawa & Sampath, 2007). Under quiet conditions, the hair cells (the receptor cells of the inner ear) can detect the tick of a clock 20 feet away (Galanter, 1962).

It is also possible for us to get messages that are presented below the threshold for conscious awareness—these are called subliminal messages. A stimulus reaches a physiological threshold when it is strong enough to excite sensory receptors and send nerve impulses to the brain; this is an absolute threshold. A message below that threshold is said to be subliminal; we receive it, but we are not consciously aware of it. Over the years there has been a great deal of speculation about the use of subliminal messages in advertising, rock music, and self-help audio programs. Research evidence shows that in laboratory settings, people can process and respond to information outside of awareness. But this does not mean that we obey these messages like zombies; in fact, hidden messages have little effect on behavior outside the laboratory (Kunst-Wilson & Zajonc, 1980; Rensink, 2004; Nelson, 2008; Radel, Sarrazin, Legrain, & Gobancé, 2009; Loersch, Durso, & Petty, 2013).

Absolute thresholds are generally measured under incredibly controlled conditions in situations that are optimal for sensitivity. Sometimes, we are more interested in how much difference in stimuli is required to detect a difference between them. This is known as the just noticeable difference (jnd) or difference threshold. Unlike the absolute threshold, the difference threshold changes depending on the stimulus intensity. As an example, imagine yourself in a very dark movie theater. If an audience member were to receive a text message on her cell phone which caused her screen to light up, chances are that many people would notice the change in illumination in the theater. However, if the same thing happened in a brightly lit arena during a basketball game, very few people would notice. The cell phone brightness does not change, but its ability to be detected as a change in illumination varies dramatically between the two contexts. Ernst Weber proposed this theory of change in difference threshold in the 1830s, and it has become known as Weber's law: the difference threshold is a constant fraction of the original stimulus, as the example illustrates.

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## Try out the Just Noticeable Difference

The exercise below is to help demonstrate the concept of the *just noticeable difference*. On the left is a yellow circle on a black background. Below this image is a slider with two dots on either end. Notice how the yellow circle in the center becomes brighter when you click on the far right dot.

Now, consider the right-hand image where the yellow circle is against a white background. If you click between the two dots on either side of that slider, do you notice the yellow circle becoming brighter?



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In both cases, the yellow dot increases in brightness with the same intensity. It is, however, much easier to notice when it is against a black background compared to when it is against a white background. This demonstrates how detecting small changes in a stimulus depends on the context around it.

## Test Your Understanding



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## Perception

While our sensory receptors are constantly collecting information from the environment, it is ultimately

how we interpret that information that affects how we interact with the world. Perception refers to the way sensory information is organized, interpreted, and consciously experienced. Perception involves both bottom-up and top-down processing. Bottom-up processing refers to the fact that perceptions are built from sensory input. On the other hand, how we interpret those sensations is influenced by our available knowledge, our experiences, and our thoughts. This is called top-down processing.

One way to think of this concept is that sensation is a physical process, whereas perception is psychological. For example, upon walking into a kitchen and smelling the scent of baking cinnamon rolls, the *sensation* is the scent receptors detecting the odor of cinnamon, but the *perception* may be “Mmm, this smells like the bread Grandma used to bake when the family gathered for holidays.”

Although our perceptions are built from sensations, not all sensations result in perception. In fact, we often don't perceive stimuli that remain relatively constant over prolonged periods of time. This is known as sensory adaptation. Imagine entering a classroom with an old analog clock. Upon first entering the room, you can hear the ticking of the clock; as you begin to engage in conversation with classmates or listen to your professor greet the class, you are no longer aware of the ticking. The clock is still ticking, and that information is still affecting sensory receptors of the auditory system. The fact that you no longer perceive the sound demonstrates sensory adaptation and shows that while closely associated, sensation and perception are different.

There is another factor that affects sensation and perception: attention. Attention plays a significant role in determining what is sensed versus what is perceived. Imagine you are at a party full of music, chatter, and laughter. You get involved in an interesting conversation with a friend, and you tune out all the background noise. If someone interrupted you to ask what song had just finished playing, you would probably be unable to answer that question.

See for yourself how inattentional blindness works by checking out this selective attention test from Simons and Chabris (1999): [selective attention test](#).



One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://louis.pressbooks.pub/intropsychology/?p=362#oembed-1>

One of the most interesting demonstrations of how important attention is in determining our perception of the environment occurred in a famous study conducted by Daniel Simons and Christopher Chabris (1999). In this study, participants watched a video of people dressed in black and white passing basketballs. Participants were asked to count the number of times the team in white passed the ball. During the video, a person dressed

in a black gorilla costume walks among the two teams. You would think that someone would notice the gorilla, right? Nearly half of the people who watched the video didn't notice the gorilla at all, despite the fact that he was clearly visible for nine seconds. Because participants were so focused on the number of times the white team was passing the ball, they completely tuned out other visual information. Failure to notice something that is completely visible because of a lack of attention is called inattention blindness.

In a similar experiment, researchers tested inattention blindness by asking participants to observe images moving across a computer screen. They were instructed to focus on either white or black objects, disregarding the other color. When a red cross passed across the screen, about one-third of subjects did not notice it (Most, Simons, Scholl, & Chabris, 2000).

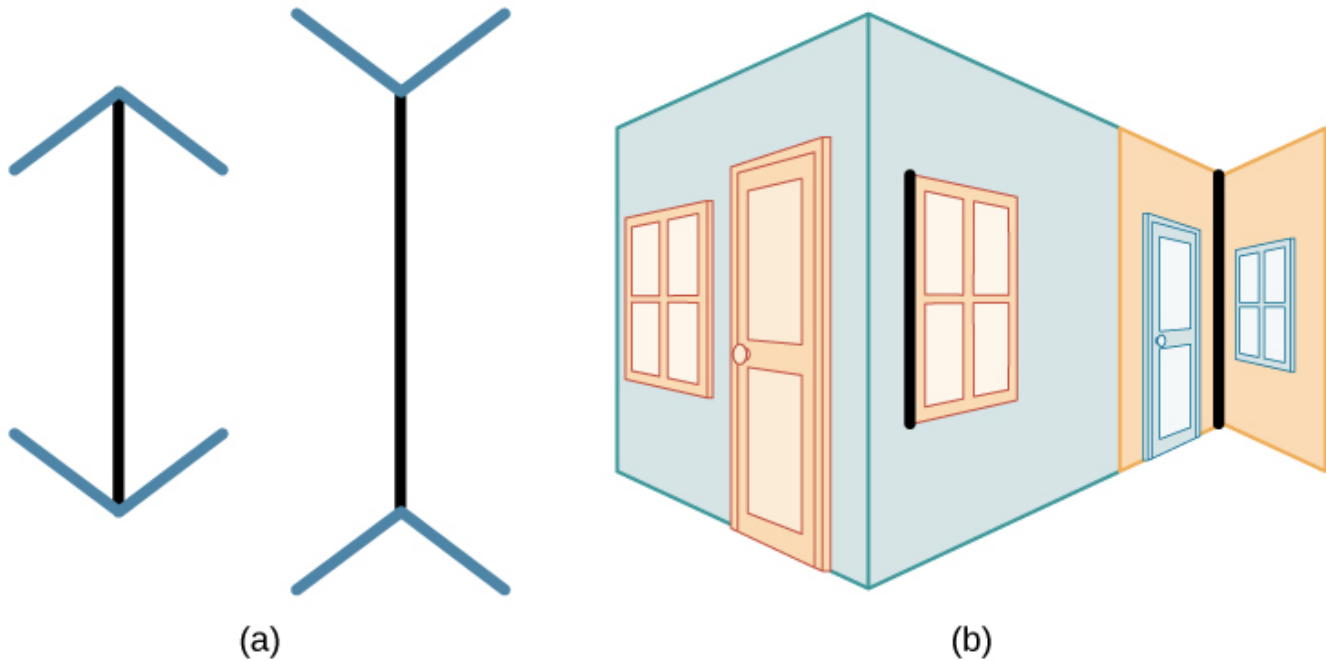


Nearly one-third of participants in a study did not notice that a red cross passed on the screen because their attention was focused on the black or white figures. (credit: Cory Zanker)

Motivation can also affect perception. Have you ever been expecting a really important phone call and, while taking a shower, you think you hear the phone ringing, only to discover that it is not? If so, then you have experienced how motivation to detect a meaningful stimulus can shift our ability to discriminate between a true sensory stimulus and background noise. The ability to identify a stimulus when it is embedded in a distracting background is called signal detection theory. This might also explain why a mother is awakened by a quiet murmur from her baby but not by other sounds that occur while she is asleep. Signal detection theory has practical applications, such as increasing air traffic controller accuracy. Controllers need to be able to detect planes among many signals (blips) that appear on the radar screen and follow those planes as they move through the sky. In fact, the original work of the researcher who developed signal detection theory was focused on improving the sensitivity of air traffic controllers to plane blips (Swets, 1964).

Our perceptions can also be affected by our beliefs, values, prejudices, expectations, and life experiences. As

you will see later in this chapter, individuals who are deprived of the experience of binocular vision during critical periods of development have trouble perceiving depth (Fawcett, Wang, & Birch, 2005). The shared experiences of people within a given cultural context can have pronounced effects on perception. For example, Marshall Segall, Donald Campbell, and Melville Herskovits (1963) published the results of a multinational study in which they demonstrated that individuals from Western cultures were more prone to experience certain types of visual illusions than individuals from non-Western cultures, and vice versa. One such illusion that Westerners were more likely to experience was the Müller-Lyer illusion: the lines appear to be different lengths, but they are actually the same length.



In the Müller-Lyer illusion, lines appear to be different lengths although they are identical. (a) Arrows at the ends of lines may make the line on the right appear longer, although the lines are the same length. (b) When applied to a three-dimensional image, the line on the right again may appear longer although both black lines are the same length.

These perceptual differences were consistent with differences in the types of environmental features experienced on a regular basis by people in a given cultural context. People in Western cultures, for example, have a perceptual context of buildings with straight lines, what Segall's study called a carpentered world (Segall et al., 1966). In contrast, people from certain non-Western cultures with an uncarpentered view, such as the Zulu of South Africa, whose villages are made up of round huts arranged in circles, are less susceptible to this illusion (Segall et al., 1999). It is not just vision that is affected by cultural factors. Indeed, research has demonstrated that the ability to identify an odor, and rate its pleasantness and its intensity, varies cross-culturally (Ayabe-Kanamura, Saito, Distel, Martínez-Gómez, & Hudson, 1998).

Children described as thrill seekers are more likely to show taste preferences for intense sour flavors (Liem, Westerbeek, Wolterink, Kok, & de Graaf, 2004), which suggests that basic aspects of personality might affect

perception. Furthermore, individuals who hold positive attitudes toward reduced-fat foods are more likely to rate foods labeled as reduced fat as tasting better than people who have less positive attitudes about these products (Aaron, Mela, & Evans, 1994).

## Test Your Understanding



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## Summary

Sensation occurs when sensory receptors detect sensory stimuli. Perception involves the organization, interpretation, and conscious experience of those sensations. All sensory systems have both absolute and difference thresholds, which refer to the minimum amount of stimulus energy or the minimum amount of difference in stimulus energy required to be detected about 50% of the time, respectively. Sensory adaptation, selective attention, and signal detection theory can help explain what is perceived and what is not. In addition, our perceptions are affected by a number of factors, including beliefs, values, prejudices, culture, and life experiences.

## Review Questions



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## Critical Thinking Question

Not everything that is sensed is perceived. Do you think there could ever be a case where something could be perceived without being sensed?

This would be a good time for students to think about claims of extrasensory perception.

Another interesting topic would be the phantom limb phenomenon experienced by amputees.

Please generate a novel (new) example of how just noticeable difference can change as a function of stimulus intensity.

There are many potential examples. One example involves the detection of weight differences.

If two people are holding standard envelopes and one contains a quarter while the other is empty, the difference in weight between the two is easy to detect. However, if those envelopes are placed inside two textbooks of equal weight, the ability to discriminate which is heavier is much more difficult.

## Personal Application Question

Think about a time when you failed to notice something around you because your attention was focused elsewhere. If someone pointed it out, were you surprised that you hadn't noticed it right away?

23.

# VISION

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## Learning Objectives

By the end of this section, you will be able to:

- Describe the basic anatomy of the visual system
- Discuss how rods and cones contribute to different aspects of vision
- Describe how monocular and binocular cues are used in the perception of depth

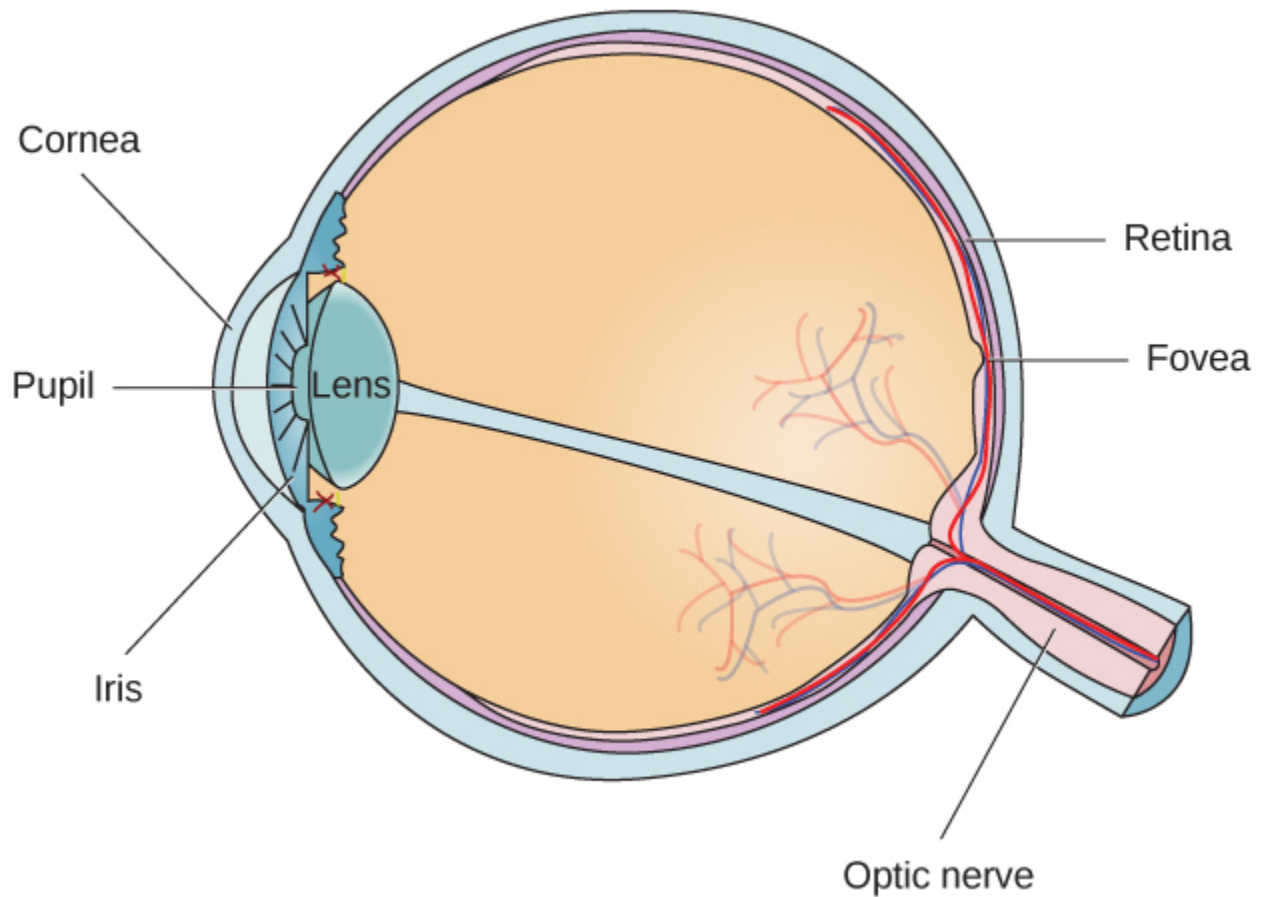
The visual system constructs a mental representation of the world around us. This contributes to our ability to successfully navigate through physical space and interact with important individuals and objects in our environments. This section will provide an overview of the basic anatomy and function of the visual system. In addition, we will explore our ability to perceive color and depth.



Our eyes take in sensory information that helps us understand the world around us. (credit “top left”: modification of work by “rajkumar1220”/Flickr; credit “top right”: modification of work by Thomas Leuthard; credit “middle left”: modification of work by Demietrich Baker; credit “middle right”: modification of work by “kaybee07”/Flickr; credit “bottom left”: modification of work by “Isengardt”/Flickr; credit “bottom right”: modification of work by Willem Heerbaart)

## Anatomy of the Visual System

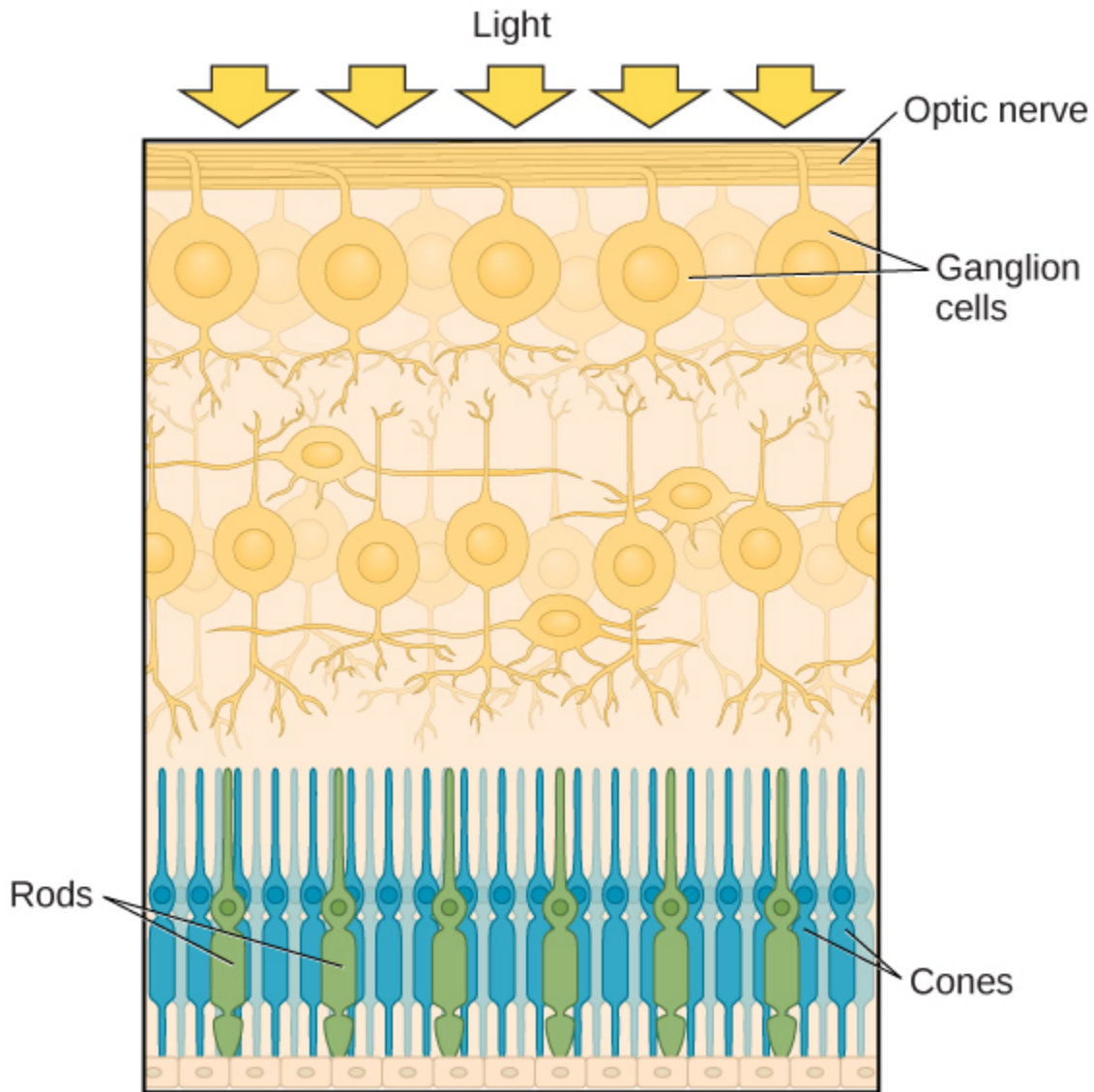
The eye is the major sensory organ involved in vision. Light waves are transmitted across the cornea and enter the eye through the pupil. The cornea is the transparent covering over the eye. It serves as a barrier between the inner eye and the outside world, and it is involved in focusing light waves that enter the eye. The pupil is the small opening in the eye through which light passes, and the size of the pupil can change as a function of light levels as well as emotional arousal. When light levels are low, the pupil will become dilated, or expanded, to allow more light to enter the eye. When light levels are high, the pupil will constrict, or become smaller, to reduce the amount of light that enters the eye. The pupil’s size is controlled by muscles that are connected to the iris, which is the colored portion of the eye.



The anatomy of the eye is illustrated in this diagram.

After passing through the pupil, light crosses the lens, a curved, transparent structure that serves to provide additional focus. The lens is attached to muscles that can change its shape to aid in focusing light that is reflected from near or far objects. In a normal-sighted individual, the lens will focus images perfectly on a small indentation in the back of the eye known as the fovea, which is part of the retina, the light-sensitive lining of the eye. The fovea contains densely packed specialized photoreceptor cells. These photoreceptor cells, known as cones, are light-detecting cells. The cones are specialized types of photoreceptors that work best in bright light conditions. Cones are very sensitive to acute detail and provide tremendous spatial resolution. They also are directly involved in our ability to perceive color.

While cones are concentrated in the fovea, where images tend to be focused, rods, another type of photoreceptor, are located throughout the remainder of the retina. Rods are specialized photoreceptors that work well in low light conditions, and while they lack the spatial resolution and color function of the cones, they are involved in our vision in dimly lit environments as well as in our perception of movement on the periphery of our visual field.



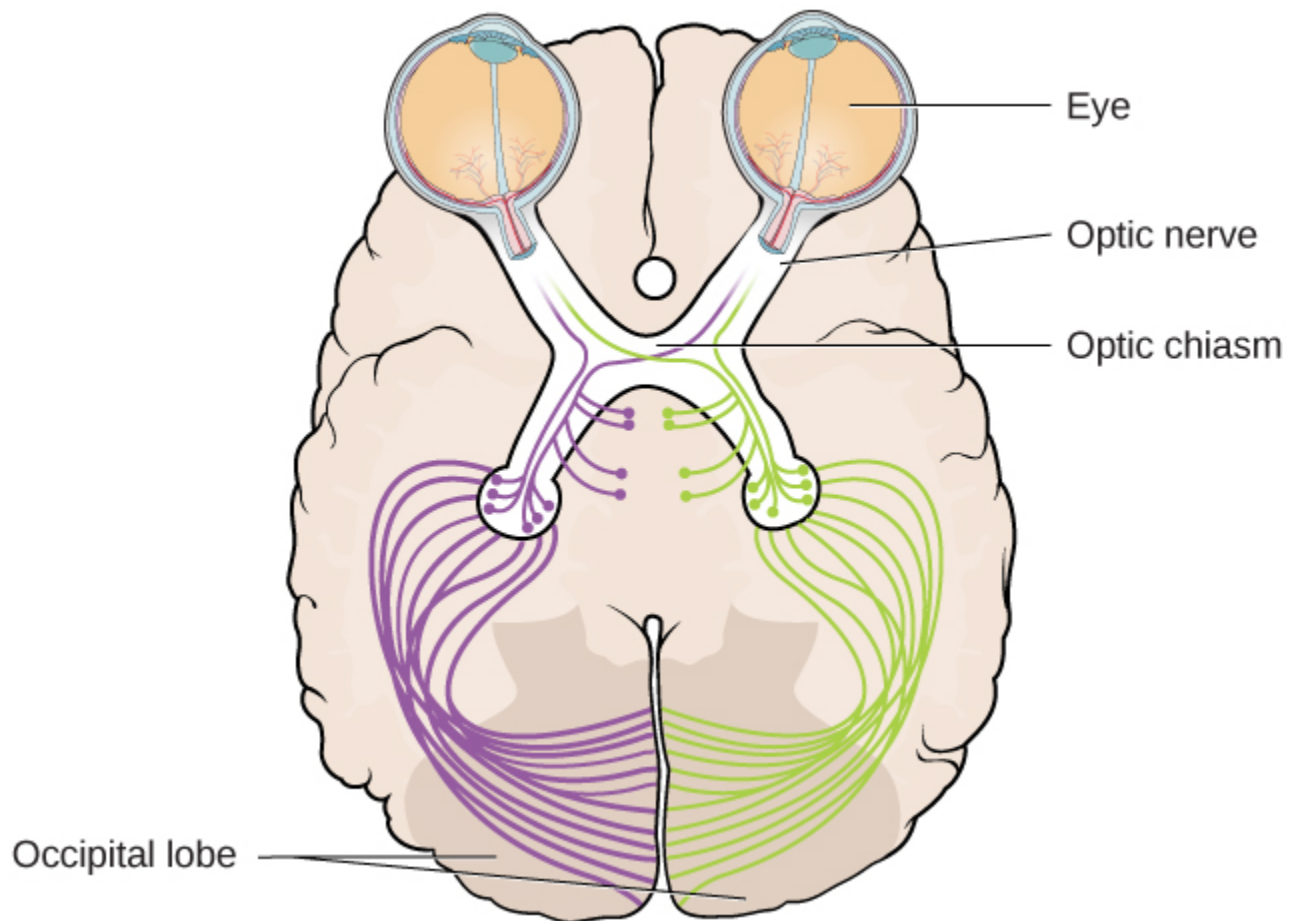
The two types of photoreceptors are shown in this image. Rods are colored green and cones are blue.

We have all experienced the different sensitivities of rods and cones when making the transition from a brightly lit environment to a dimly lit environment. Imagine going to see a blockbuster movie on a clear summer day. As you walk from the brightly lit lobby into the dark theater, you notice that you immediately have difficulty seeing much of anything. After a few minutes, you begin to adjust to the darkness and can see the interior of the theater. In the bright environment, your vision was dominated primarily by cone activity. As you move to the dark environment, rod activity dominates, but there is a delay in transitioning between the phases. If your rods do not transform light into nerve impulses as easily and efficiently as they should, you will have difficulty seeing in dim light, a condition known as night blindness.

Rods and cones are connected (via several interneurons) to retinal ganglion cells. Axons from the retinal ganglion cells converge and exit through the back of the eye to form the optic nerve. The optic nerve carries visual information from the retina to the brain. There is a point in the visual field called the blind spot; even

when light from a small object is focused on the blind spot, we do not see it. We are not consciously aware of our blind spots for two reasons: First, each eye gets a slightly different view of the visual field, therefore, the blind spots do not overlap. Second, our visual system fills in the blind spot so that although we cannot respond to visual information that occurs in that portion of the visual field, we are also not aware that information is missing.

The optic nerve from each eye merges just below the brain at a point called the optic chiasm. As shown, the optic chiasm is an X-shaped structure that sits just below the cerebral cortex at the front of the brain. At the point of the optic chiasm, information from the right visual field (which comes from both eyes) is sent to the left side of the brain, and information from the left visual field is sent to the right side of the brain.



This illustration shows the optic chiasm at the front of the brain and the pathways to the occipital lobe at the back of the brain, where visual sensations are processed into meaningful perceptions.

Once inside the brain, visual information is sent via a number of structures to the occipital lobe at the back of the brain for processing. Visual information might be processed in parallel pathways which can generally be described as the “what pathway” and the “where/how pathway.” The “what pathway” is involved in object recognition and identification, while the “where/how pathway” is involved with location in space and how one might interact with a particular visual stimulus (Milner & Goodale, 2008; Ungerleider & Haxby, 1994). For

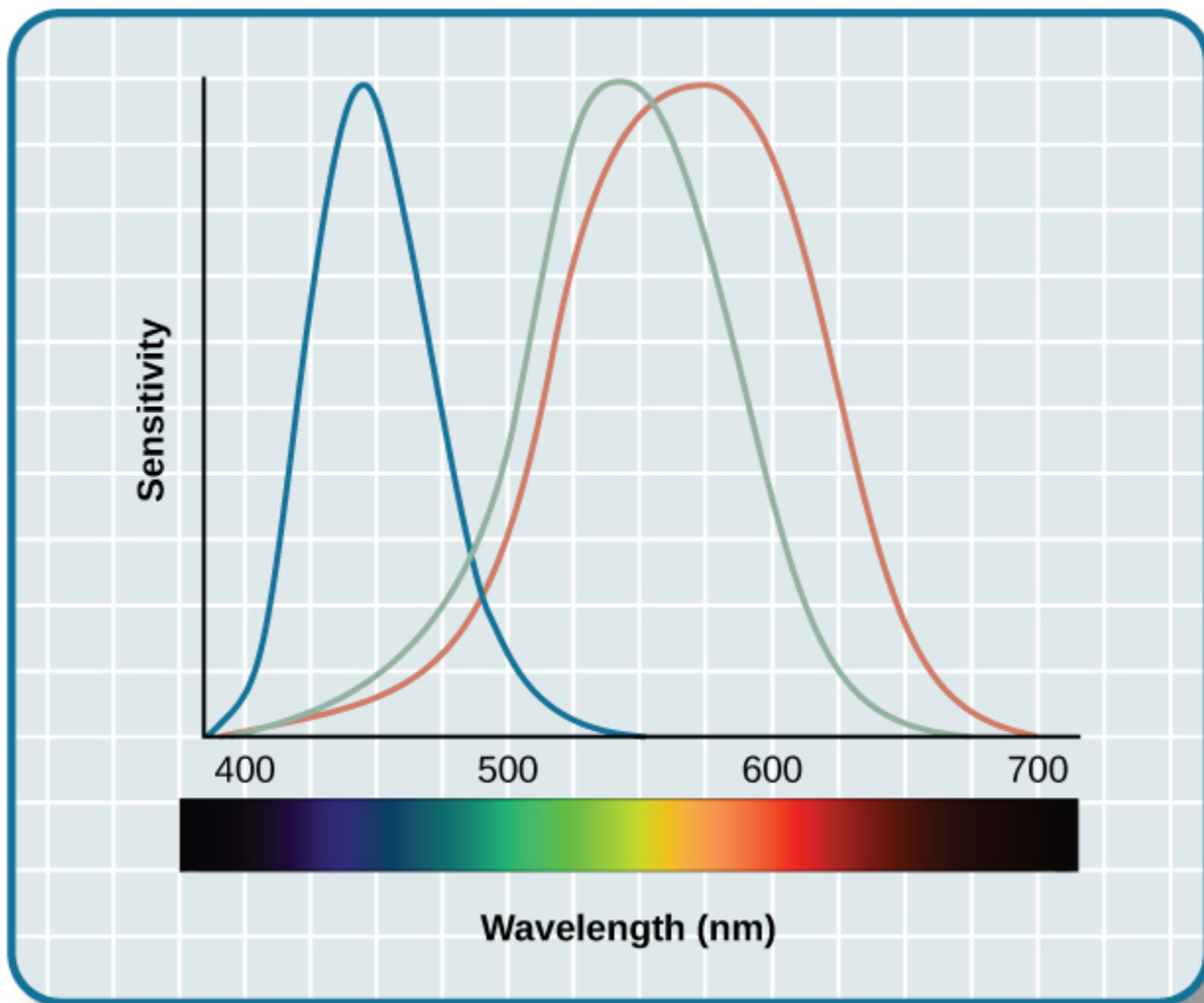
example, when you see a ball rolling down the street, the “what pathway” identifies what the object is, and the “where/how pathway” identifies its location or movement in space.

## Color and Depth Perception

We do not see the world in black and white; neither do we see it as two-dimensional (2-D) or flat (just height and width, no depth). Let’s look at how color vision works and how we perceive three dimensions (height, width, and depth).

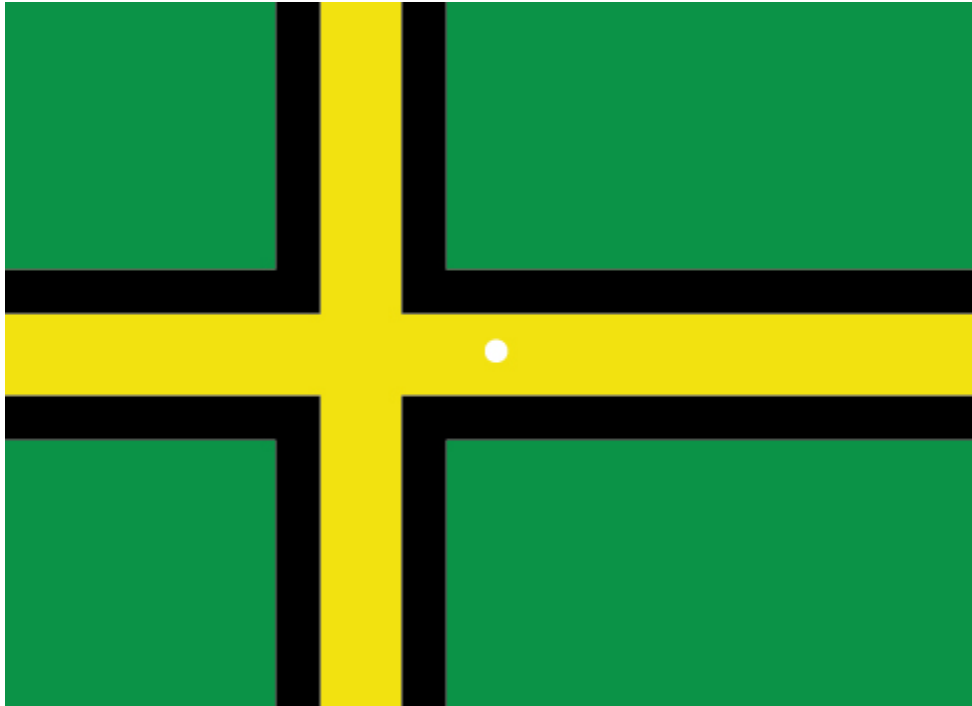
### Color Vision

Normal-sighted individuals have three different types of cones that mediate color vision. Each of these cone types is maximally sensitive to a slightly different wavelength of light. According to the trichromatic theory of color vision all colors in the spectrum can be produced by combining red, green, and blue. The three types of cones are each receptive to one of the colors.



This figure illustrates the different sensitivities for the three cone types found in a normal-sighted individual. (credit: modification of work by Vanessa Ezekowitz)

The trichromatic theory of color vision is not the only theory—another major theory of color vision is known as the opponent-process theory. According to this theory, color is coded in opponent pairs: black-white, yellow-blue, and green-red. The basic idea is that some cells of the visual system are excited by one of the opponent colors and inhibited by the other. So, a cell that was excited by wavelengths associated with green would be inhibited by wavelengths associated with red, and vice versa. One of the implications of opponent processing is that we do not experience greenish-reds or yellowish-blues as colors. Another implication is that this leads to the experience of negative afterimages. An afterimage describes the continuation of a visual sensation after removal of the stimulus. For example, when you stare briefly at the sun and then look away from it, you may still perceive a spot of light although the stimulus (the sun) has been removed. When color is involved in the stimulus, the color pairings identified in the opponent-process theory lead to a negative afterimage. You can test this concept using the flag in the image below.



Stare at the white dot for 30–60 seconds and then move your eyes to a blank piece of white paper. What do you see? This is known as a negative afterimage, and it provides empirical support for the opponent-process theory of color vision.

But these two theories—the trichromatic theory of color vision and the opponent-process theory—are not mutually exclusive. Research has shown that they just apply to different levels of the nervous system. For visual processing on the retina, trichromatic theory applies: the cones are responsive to three different wavelengths that represent red, blue, and green. But once the signal moves past the retina on its way to the brain, the cells respond in a way consistent with opponent-process theory (Land, 1959; Kaiser, 1997).

Watch this video to see the first part of a documentary explaining color vision in more detail:  
[The Science of Color Perception.](#)



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# Test Your Understanding



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## Depth Perception

Our ability to perceive spatial relationships in three-dimensional (3-D) space is known as depth perception. With depth perception, we can describe things as being in front, behind, above, below, or to the side of other things.

Our world is three-dimensional, so it makes sense that our mental representation of the world has three-dimensional properties. We use a variety of cues in a visual scene to establish our sense of depth. Some of these are binocular cues, which means that they rely on the use of both eyes. One example of a binocular depth cue is binocular disparity, the slightly different view of the world that each of our eyes receives. To experience this slightly different view, do this simple exercise: extend your arm fully, then extend one of your fingers and focus on that finger. Now, close your left eye without moving your head, then open your left eye and close your right eye without moving your head. You will notice that your finger seems to shift as you alternate between the two eyes because of the slightly different view each eye has of your finger.

A 3-D movie works on the same principle: the special glasses you wear allow the two slightly different images projected onto the screen to be seen separately by your left and your right eye. As your brain processes these images, you have the illusion that the leaping animal or running person is coming right toward you.

Although we rely on binocular cues to experience depth in our 3-D world, we can also perceive depth in 2-D arrays. Think about all the paintings and photographs you have seen. Generally, you pick up on depth in these images even though the visual stimulus is 2-D. When we do this, we are relying on a number of monocular cues, or cues that require only one eye. If you think you can't see depth with one eye, note that you don't bump into things when using only one eye while walking—and, in fact, we have more monocular cues than binocular cues.

An example of a monocular cue would be what is known as linear perspective. Linear perspective refers to the fact that we perceive depth when we see two parallel lines that seem to converge in an image. Some other

monocular depth cues are interposition, the partial overlap of objects, and the relative size and closeness of images to the horizon.



We perceive depth in a two-dimensional figure like this one through the use of monocular cues like linear perspective, like the parallel lines converging as the road narrows in the distance. (credit: Marc Dalmulder)

## STEREOBLINDNESS

Bruce Bridgeman was born with an extreme case of lazy eye that resulted in him being stereoblind, or unable to respond to binocular cues of depth. He relied heavily on monocular depth cues, but he never had a true appreciation of the 3-D nature of the world around him. This all changed one night in 2012 while Bruce was seeing a movie with his wife.

The movie the couple was going to see was shot in 3-D, and even though he thought it was a waste of money, Bruce paid for the 3-D glasses when he purchased his ticket. As soon as the film began, Bruce put on the glasses and experienced something completely new. For the first time in his life, he appreciated the true depth of the world around him. Remarkably, his ability to perceive depth persisted outside of the movie theater.

There are cells in the nervous system that respond to binocular depth cues. Normally, these cells require activation during early development in order to persist, so experts familiar with Bruce's case (and others like his) assume that at some point in his development, Bruce must have experienced at least a fleeting moment of binocular vision. It was enough to ensure the survival of the cells in the visual system tuned to binocular cues. The mystery now is why it took Bruce nearly 70 years to have these cells activated (Peck, 2012).

## Test Your Understanding



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## Summary

Light waves cross the cornea and enter the eye at the pupil. The eye's lens focuses this light so that the image is focused on a region of the retina known as the fovea. The fovea contains cones that possess high levels of visual acuity and operate best in bright light conditions. Rods are located throughout the retina and operate best under dim light conditions. Visual information leaves the eye via the optic nerve. Information from each visual field is sent to the opposite side of the brain at the optic chiasm. Visual information then moves through a number of brain sites before reaching the occipital lobe, where it is processed.

Two theories explain color perception. The trichromatic theory asserts that three distinct cone groups are tuned to slightly different wavelengths of light, and it is the combination of activity across these cone types that results in our perception of all the colors we see. The opponent-process theory of color vision asserts that color is processed in opponent pairs and accounts for the interesting phenomenon of a negative afterimage. We perceive depth through a combination of monocular and binocular depth cues.

## Review Questions



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## Critical Thinking Question

Compare the two theories of color perception. Are they completely different?

The trichromatic theory of color vision and the opponent-process theory are not mutually exclusive. Research has shown they apply to different levels of the nervous system. For visual processing on the retina, trichromatic theory applies: the cones are responsive to three different wavelengths that represent red, blue, and green. But once the signal moves past the retina on its way to the brain, the cells respond in a way consistent with opponent-process theory.

Color is not a physical property of our environment. What function (if any) do you think color vision serves?

Color vision probably serves multiple adaptive purposes. One popular hypothesis suggests that seeing in color allowed our ancestors to differentiate ripened fruits and vegetables more easily.

## Personal Application Question

Take a look at a few of your photos or personal works of art. Can you find examples of linear perspective as a potential depth cue?

24.

# HEARING

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## Learning Objectives

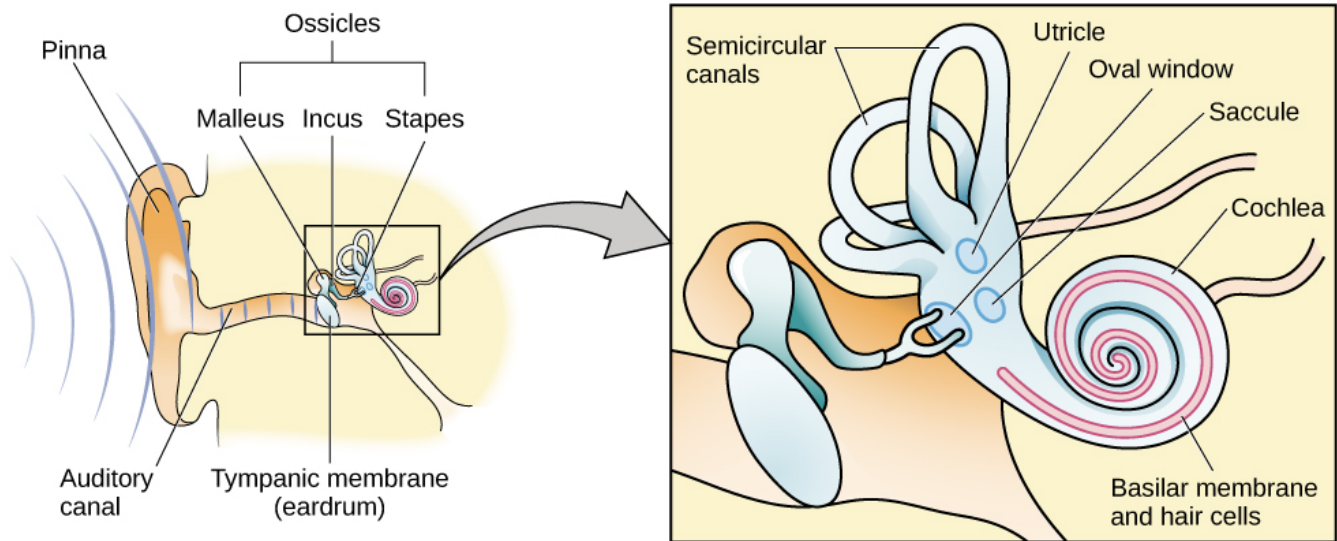
By the end of this section, you will be able to:

- Describe the basic anatomy and function of the auditory system
- Explain how we encode and perceive pitch
- Discuss how we localize sound

Our auditory system converts pressure waves into meaningful sounds. This translates into our ability to hear the sounds of nature, to appreciate the beauty of music, and to communicate with one another through spoken language. This section will provide an overview of the basic anatomy and function of the auditory system. It will include a discussion of how the sensory stimulus is translated into neural impulses, where in the brain that information is processed, how we perceive pitch, and how we know where sound is coming from.

## Anatomy of the Auditory System

The ear can be separated into multiple sections. The outer ear includes the pinna, which is the visible part of the ear that protrudes from our heads, the auditory canal, and the tympanic membrane, or eardrum. The middle ear contains three tiny bones known as the ossicles, which are named the malleus (or hammer), incus (or anvil), and the stapes (or stirrup). The inner ear contains the semi-circular canals, which are involved in balance and movement (the vestibular sense), and the cochlea. The cochlea is a fluid-filled, snail-shaped structure that contains the sensory receptor cells (hair cells) of the auditory system.



The ear is divided into outer (pinna and tympanic membrane), middle (the three ossicles: malleus, incus, and stapes), and inner (cochlea and basilar membrane) divisions.

Sound waves travel along the auditory canal and strike the tympanic membrane, causing it to vibrate. This vibration results in movement of the three ossicles. As the ossicles move, the stapes presses into a thin membrane of the cochlea known as the oval window. As the stapes presses into the oval window, the fluid inside the cochlea begins to move, which in turn stimulates hair cells, which are auditory receptor cells of the inner ear embedded in the basilar membrane. The basilar membrane is a thin strip of tissue within the cochlea.

The activation of hair cells is a mechanical process: the stimulation of the hair cell ultimately leads to the activation of the cell. As hair cells become activated, they generate neural impulses that travel along the auditory nerve to the brain. Auditory information is shuttled to the inferior colliculus, the medial geniculate nucleus of the thalamus, and finally to the auditory cortex in the temporal lobe of the brain for processing. Like the visual system, there is also evidence suggesting that information about auditory recognition and localization is processed in parallel streams (Rauschecker & Tian, 2000; Renier et al., 2009).

## Pitch Perception

Different frequencies of sound waves are associated with differences in our perception of the pitch of those sounds. Low-frequency sounds are lower pitched, and high-frequency sounds are higher pitched. How does the auditory system differentiate among various pitches?

Several theories have been proposed to account for pitch perception. We'll discuss two of them here: temporal theory and place theory. The temporal theory of pitch perception asserts that frequency is coded by the activity level of a sensory neuron. This would mean that a given hair cell would fire action potentials related to the frequency of the sound wave. While this is a very intuitive explanation, we detect such a broad range of

frequencies (20–20,000 Hz) that the frequency of action potentials fired by hair cells cannot account for the entire range. Because of properties related to sodium channels on the neuronal membrane that are involved in action potentials, there is a point at which a cell cannot fire any faster (Shamma, 2001).

The place theory of pitch perception suggests that different portions of the basilar membrane are sensitive to sounds of different frequencies. More specifically, the base of the basilar membrane responds best to high frequencies and the tip of the basilar membrane responds best to low frequencies. Therefore, hair cells that are in the base portion would be labeled as high-pitch receptors, while those in the tip of basilar membrane would be labeled as low-pitch receptors (Shamma, 2001).

In reality, both theories explain different aspects of pitch perception. At frequencies up to about 4000 Hz, it is clear that both the rate of action potentials and place contribute to our perception of pitch. However, much-higher-frequency sounds can only be encoded using place cues (Shamma, 2001).

## Test Your Understanding



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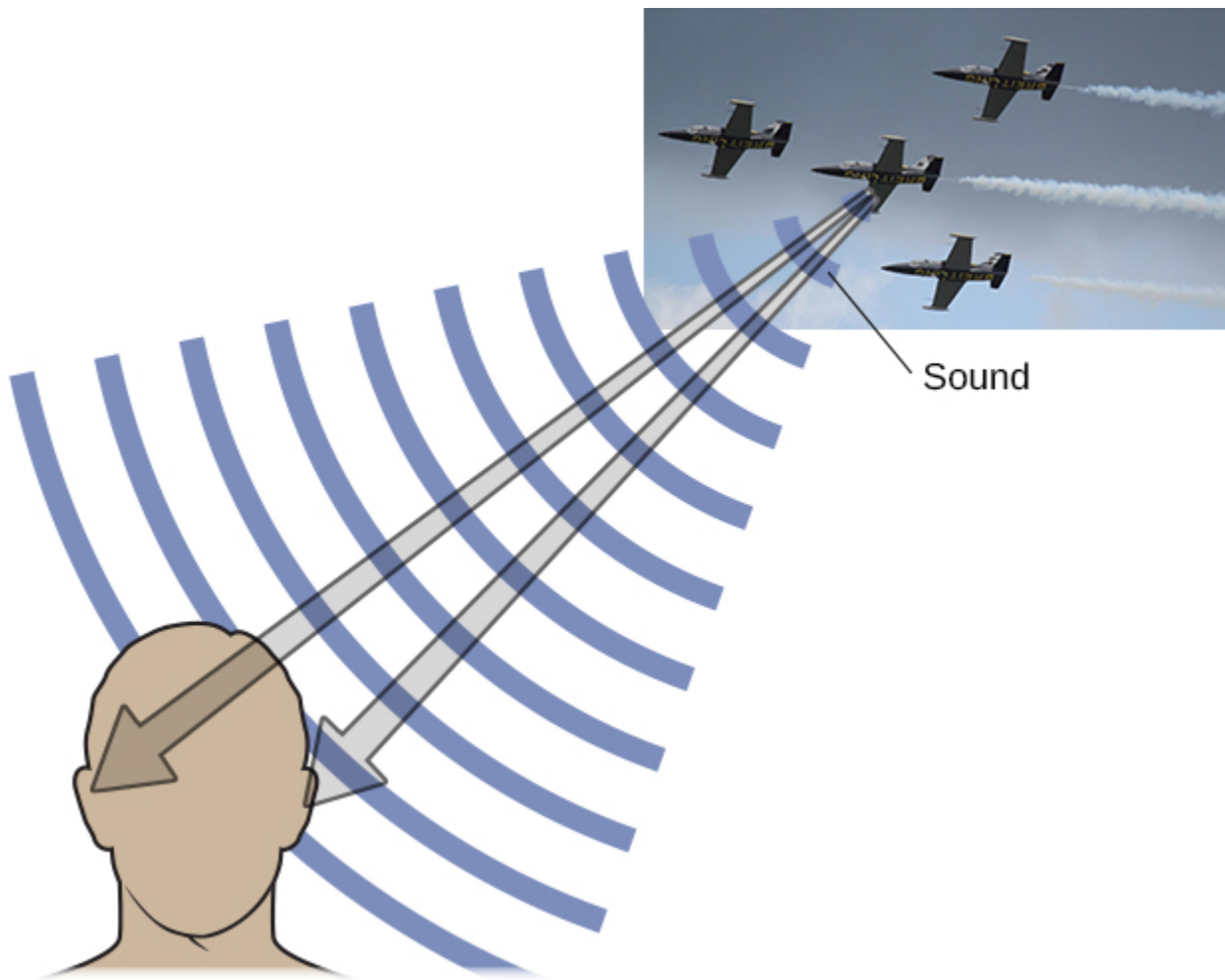
## Sound Localization

The ability to locate sound in our environments is an important part of hearing. Localizing sound could be considered similar to the way that we perceive depth in our visual fields. Like the monocular and binocular cues that provide information about depth, the auditory system uses both monaural (one-eared) and binaural (two-eared) cues to localize sound.

Each pinna interacts with incoming sound waves differently, depending on the sound's source relative to our bodies. This interaction provides a monaural cue that is helpful in locating sounds that occur above or below and in front or behind us. The sound waves received by your two ears from sounds that come from directly

above, below, in front, or behind you would be identical; therefore, monaural cues are essential (Grothe, Pecka, & McAlpine, 2010).

Binaural cues, on the other hand, provide information on the location of a sound along a horizontal axis by relying on differences in patterns of vibration of the eardrum between our two ears. If a sound comes from an off-center location, it creates two types of binaural cues: interaural level differences and interaural timing differences. Interaural level difference refers to the fact that a sound coming from the right side of your body is more intense at your right ear than at your left ear because of the attenuation of the sound wave as it passes through your head. Interaural timing difference refers to the small difference in the time at which a given sound wave arrives at each ear. Certain brain areas monitor these differences to construct where along a horizontal axis a sound originates (Grothe et al., 2010).



Localizing sound involves the use of both monaural and binaural cues. (credit "plane": modification of work by Max Pfandl)

## Hearing Loss

Deafness is the partial or complete inability to hear. Some people are born deaf, which is known as congenital deafness. Many others begin to suffer from conductive hearing loss because of age, genetic predisposition, or environmental effects, including exposure to extreme noise (noise-induced hearing loss), as shown in the images below, certain illnesses (such as measles or mumps), or damage due to toxins (such as those found in certain solvents and metals).



(a)



(b)

Environmental factors that can lead to conductive hearing loss include regular exposure to loud music or construction equipment. (a) Rock musicians and (b) construction workers are at risk for this type of hearing loss. (credit a: modification of work by Kenny Sun; credit b: modification of work by Nick Allen)

Given the mechanical nature by which the sound wave stimulus is transmitted from the eardrum through the ossicles to the oval window of the cochlea, some degree of hearing loss is inevitable. With conductive hearing loss, hearing problems are associated with a failure in the vibration of the eardrum and/or movement of the ossicles. These problems are often dealt with through devices like hearing aids that amplify incoming sound waves to make vibration of the eardrum and movement of the ossicles more likely to occur.

When the hearing problem is associated with a failure to transmit neural signals from the cochlea to the brain, it is called sensorineural hearing loss. One disease that results in sensorineural hearing loss is Ménière's disease. Although not well understood, Ménière's disease results in a degeneration of inner ear structures that can lead to hearing loss, tinnitus (constant ringing or buzzing), vertigo (a sense of spinning), and an increase in pressure within the inner ear (Semaan & Megerian, 2011). This kind of loss cannot be treated with hearing aids, but some individuals might be candidates for a cochlear implant as a treatment option. Cochlear implants

are electronic devices that consist of a microphone, a speech processor, and an electrode array. The device receives incoming sound information and directly stimulates the auditory nerve to transmit information to the brain.

Watch this video describing cochlear implant surgeries and how they work: [Cochlear Implant Surgery](#).

## Deaf Culture

In the United States and other places around the world, deaf people have their own language, schools, and customs. This is called deaf culture. In the United States, deaf individuals often communicate using American Sign Language (ASL); ASL has no verbal component and is based entirely on visual signs and gestures. The primary mode of communication is signing. One of the values of deaf culture is to continue traditions like using sign language rather than teaching deaf children to try to speak, read lips, or have cochlear implant surgery.

When a child is diagnosed as deaf, parents have difficult decisions to make. Should the child be enrolled in mainstream schools and taught to verbalize and read lips? Or should the child be sent to a school for deaf children to learn ASL and have significant exposure to deaf culture? Do you think there might be differences in the way that parents approach these decisions depending on whether or not they are also deaf?

## Summary

Sound waves are funneled into the auditory canal and cause vibrations of the eardrum; these vibrations move the ossicles. As the ossicles move, the stapes presses against the oval window of the cochlea, which causes fluid inside the cochlea to move. As a result, hair cells embedded in the basilar membrane become enlarged, which sends neural impulses to the brain via the auditory nerve.

Pitch perception and sound localization are important aspects of hearing. Our ability to perceive pitch relies on both the firing rate of the hair cells in the basilar membrane as well as their location within the membrane. In terms of sound localization, both monaural and binaural cues are used to locate where sounds originate in our environment.

Individuals can be born deaf, or they can develop deafness as a result of age, genetic predisposition, and/or environmental causes. Hearing loss that results from a failure of the vibration of the eardrum or the

resultant movement of the ossicles is called conductive hearing loss. Hearing loss that involves a failure of the transmission of auditory nerve impulses to the brain is called sensorineural hearing loss.

## Review Questions



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## Critical Thinking Question

Given what you've read about sound localization, from an evolutionary perspective, how does sound localization facilitate survival?

Sound localization would have allowed early humans to locate prey and protect themselves from predators.

How can temporal and place theories both be used to explain our ability to perceive the pitch of sound waves with frequencies up to 4000 Hz?

Pitch of sounds below this threshold could be encoded by the combination of the place and firing rate of stimulated hair cells. So, in general, hair cells located near the tip of the basilar membrane would signal that we're dealing with a lower-pitched sound. However, differences in firing rates of hair cells within this location could allow for fine discrimination between low-, medium-, and high-pitch sounds within the larger low-pitch context.

## Personal Application Question

If you had to choose to lose either your vision or your hearing, which would you choose and why?

25.

## TASTING, SMELLING, AND TOUCHING

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### Learning Objectives

By the end of this section, you will be able to:

- Describe the basic functions of the chemical senses
- Explain the basic functions of the somatosensory, nociceptive, and thermoceptive sensory systems
- Describe the basic functions of the vestibular, proprioceptive, and kinesthetic sensory systems

Vision and hearing have received an incredible amount of attention from researchers over the years. While there is still much to be learned about how these sensory systems work, we have a much better understanding of them than of our other sensory modalities. In this section, we will explore our chemical senses (taste and smell) and our body senses (touch, temperature, pain, balance, and body position).

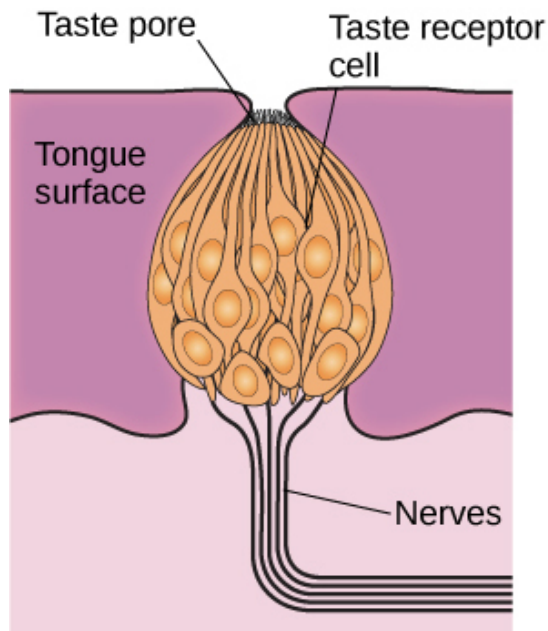
### The Chemical Senses

Taste (gustation) and smell (olfaction) are called chemical senses because both have sensory receptors that respond to molecules in the food we eat or in the air we breathe. There is a pronounced interaction between our chemical senses. For example, when we describe the flavor of a given food, we are really referring to both gustatory and olfactory properties of the food working in combination.

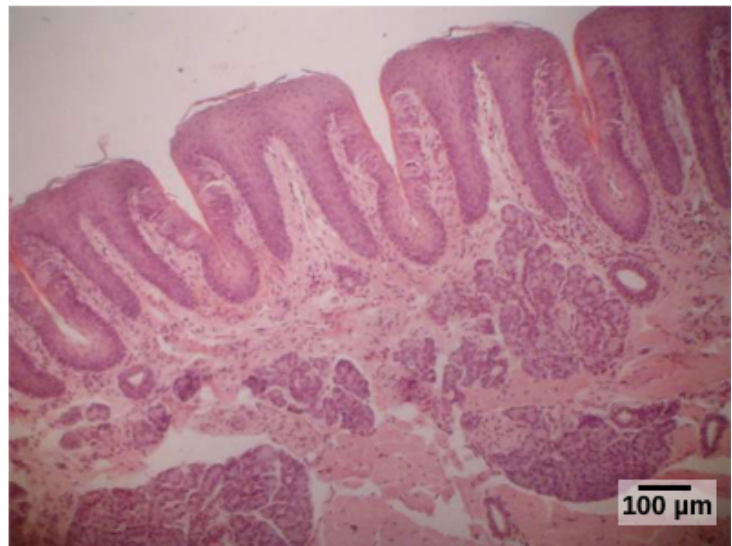
## Taste (Gustation)

You have learned since elementary school that there are four basic groupings of taste: sweet, salty, sour, and bitter. Research demonstrates, however, that we have at least six taste groupings. Umami is our fifth taste. Umami is actually a Japanese word that roughly translates to yummy, and it is associated with a taste for monosodium glutamate (Kinnamon & Vandenbeuch, 2009). There is also a growing body of experimental evidence suggesting that we possess a taste for the fatty content of a given food (Mizushige, Inoue, & Fushiki, 2007).

Molecules from the food and beverages we consume dissolve in our saliva and interact with taste receptors on our tongue and in our mouth and throat. Taste buds are formed by groupings of taste receptor cells with hair-like extensions that protrude into the central pore of the taste bud. Taste buds have a life cycle of ten days to two weeks, so even destroying some by burning your tongue won't have any long-term effect; they just grow right back. Taste molecules bind to receptors on this extension and cause chemical changes within the sensory cell that result in neural impulses being transmitted to the brain via different nerves, depending on where the receptor is located. Taste information is transmitted to the medulla, thalamus, and limbic system, and to the gustatory cortex, which is tucked underneath the overlap between the frontal and temporal lobes (Maffei, Haley, & Fontanini, 2012; Roper, 2013).



(a)

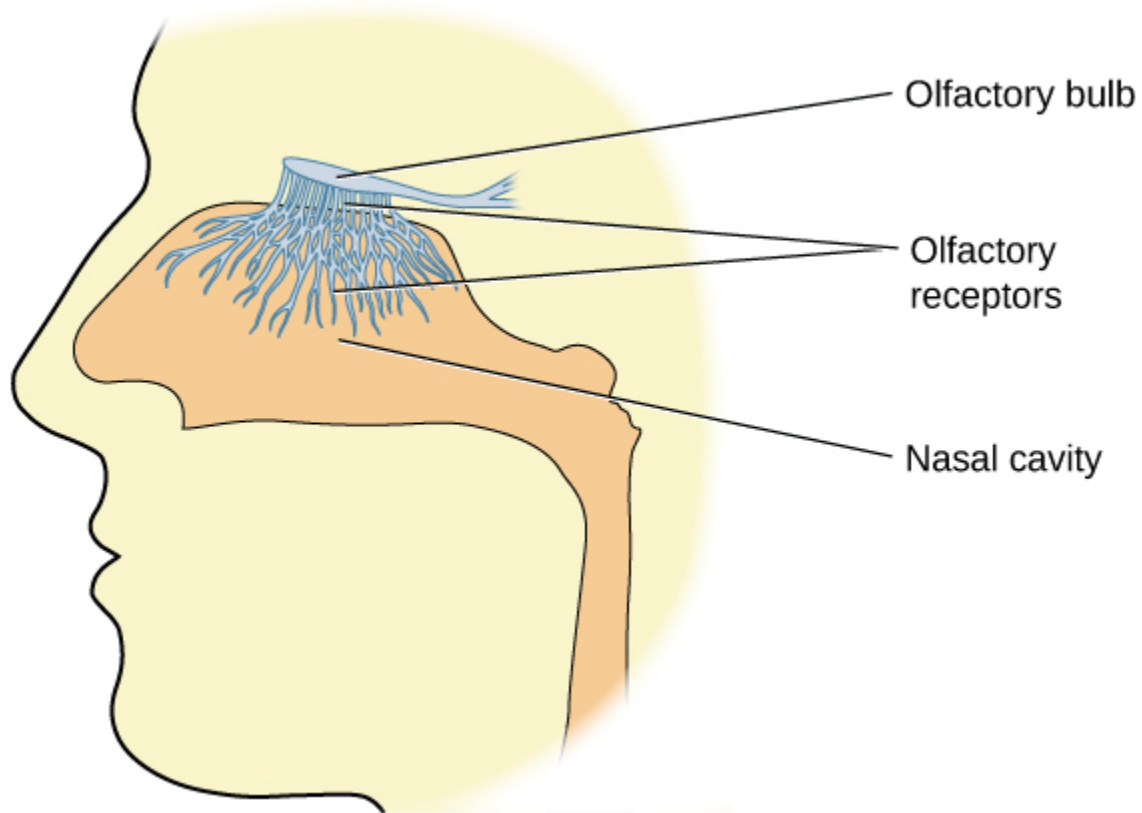


(b)

(a) Taste buds are composed of a number of individual taste receptor cells that transmit information to nerves. (b) This micrograph shows a close-up view of the tongue's surface. (credit a: modification of work by Jonas Töle; credit b: scale-bar data from Matt Russell)

## Smell (Olfaction)

Olfactory receptor cells are located in a mucous membrane at the top of the nose. Small hair-like extensions from these receptors serve as the sites for odor molecules dissolved in the mucus to interact with chemical receptors located on these extensions. Once an odor molecule has bound a given receptor, chemical changes within the cell result in signals being sent to the olfactory bulb: a bulb-like structure at the tip of the frontal lobe where the olfactory nerves begin. From the olfactory bulb, information is sent to regions of the limbic system and to the primary olfactory cortex, which is located very near the gustatory cortex (Lodovichi & Belluscio, 2012; Spors et al., 2013).



Olfactory receptors are the hair-like parts that extend from the olfactory bulb into the mucous membrane of the nasal cavity.

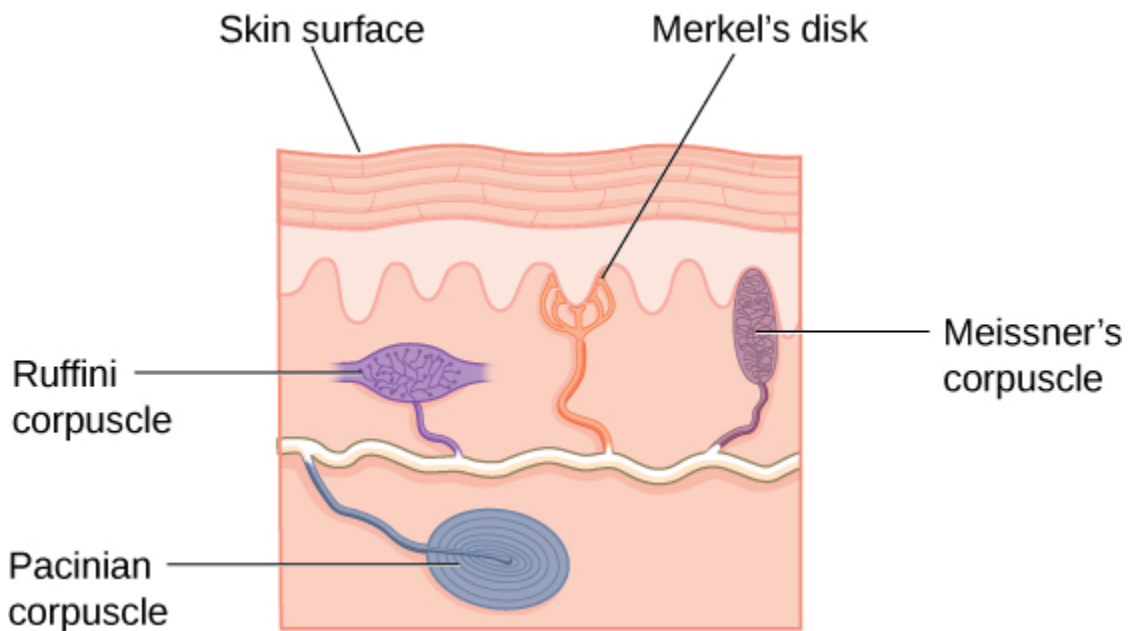
There is tremendous variation in the sensitivity of the olfactory systems of different species. We often think of dogs as having far superior olfactory systems than our own, and indeed, dogs can do some remarkable things with their noses. There is some evidence to suggest that dogs can “smell” dangerous drops in blood glucose levels as well as cancerous tumors (Wells, 2010). Dogs’ extraordinary olfactory abilities may be due to the increased number of functional genes for olfactory receptors (between 800 and 1200), compared to the fewer than 400 observed in humans and other primates (Niimura & Nei, 2007).

Many species respond to chemical messages, known as pheromones, sent by another individual (Wysocki &

Preti, 2004). Pheromonal communication often involves providing information about the reproductive status of a potential mate. So, for example, when a female rat is ready to mate, she secretes pheromonal signals that draw attention from nearby male rats. Pheromonal activation is actually an important component in eliciting sexual behavior in the male rat (Furlow, 1996, 2012; Purvis & Haynes, 1972; Sachs, 1997). There has also been a good deal of research (and controversy) about pheromones in humans (Comfort, 1971; Russell, 1976; Wolfgang-Kimball, 1992; Weller, 1998).

## Touch

A number of receptors are distributed throughout the skin to respond to various touch-related stimuli. These receptors include Meissner's corpuscles, Pacinian corpuscles, Merkel's disks, and Ruffini corpuscles. Meissner's corpuscles respond to pressure and lower frequency vibrations, and Pacinian corpuscles detect transient pressure and higher frequency vibrations. Merkel's disks respond to light pressure, while Ruffini corpuscles detect stretch (Abraira & Ginty, 2013).



There are many types of sensory receptors located in the skin, each attuned to specific touch-related stimuli.

In addition to the receptors located in the skin, there are also a number of free nerve endings that serve sensory functions. These nerve endings respond to a variety of different types of touch-related stimuli and serve as sensory receptors for both thermoception (temperature perception) and nociception (a signal indicating potential harm and maybe pain) (Garland, 2012; Petho & Reeh, 2012; Spray, 1986). Sensory information collected from the receptors and free nerve endings travels up the spinal cord and is transmitted to regions of

the medulla, thalamus, and ultimately to the somatosensory cortex, which is located in the postcentral gyrus of the parietal lobe.

## Pain Perception

Pain is an unpleasant experience that involves both physical and psychological components. Feeling pain is quite adaptive because it makes us aware of an injury, and it motivates us to remove ourselves from the cause of that injury. In addition, pain also makes us less likely to suffer additional injury because we will be gentler with our injured body parts.

Generally speaking, pain can be considered to be neuropathic or inflammatory in nature. Pain that signals some type of tissue damage is known as inflammatory pain. In some situations, pain results from damage to neurons of either the peripheral or central nervous system. As a result, pain signals that are sent to the brain get exaggerated. This type of pain is known as neuropathic pain. Multiple treatment options for pain relief range from relaxation therapy to the use of analgesic medications to deep brain stimulation. The most effective treatment option for a given individual will depend on a number of considerations, including the severity and persistence of the pain and any medical/psychological conditions.

Some individuals are born without the ability to feel pain. This very rare genetic disorder is known as congenital insensitivity to pain (or congenital analgesia). While those with congenital analgesia can detect differences in temperature and pressure, they cannot experience pain. As a result, they often suffer significant injuries. Young children have serious mouth and tongue injuries because they have bitten themselves repeatedly. Not surprisingly, individuals suffering from this disorder have much shorter life expectancies due to their injuries and secondary infections of injured sites (U.S. National Library of Medicine, 2013).

Watch this video to learn more about congenital insensitivity to pain: [People who feel no pain but suffer enormously | 60 Minutes Australia](#).



*One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://louis.pressbooks.pub/intropsychology/?p=370#oembed-1>*

## Test Your Understanding



*An interactive H5P element has been excluded from this version of the text. You can view it online here:*

<https://louis.pressbooks.pub/intropsychology/?p=370#h5p-117>

## Summary

Taste (gustation) and smell (olfaction) are chemical senses that employ receptors on the tongue and in the nose that bind directly with taste and odor molecules in order to transmit information to the brain for processing. Our ability to perceive touch, temperature, and pain is mediated by a number of receptors and free nerve endings that are distributed throughout the skin and various tissues of the body. The vestibular sense helps us maintain a sense of balance through the response of hair cells in the utricle, saccule, and semi-circular canals that respond to changes in head position and gravity. Our proprioceptive and kinesthetic systems provide information about body position and body movement through receptors that detect stretch and tension in the muscles, joints, tendons, and skin of the body.

## Review Questions



*An interactive H5P element has been excluded from this version of the text. You can view it online here:*

<https://louis.pressbooks.pub/intropsychology/?p=370#h5p-118>

## Critical Thinking Questions

Many people experience nausea while traveling in a car, plane, or boat. How might you explain this as a function of sensory interaction?

When traveling by car, we often have visual information that suggests that we are in motion while our vestibular sense indicates that we're not moving (assuming we're traveling at a relatively constant speed). Normally, these two sensory modalities provide congruent information, but the discrepancy might lead to confusion and nausea. The converse would be true when traveling by plane or boat.

If you heard someone say that they would do anything not to feel the pain associated with significant injury, how would you respond given what you've just read?

Pain serves important functions that are critical to our survival. As noxious as pain stimuli may be, the experiences of individuals who suffer from congenital insensitivity to pain makes the consequences of a lack of pain all too apparent.

Do you think women experience pain differently than men? Why do you think this is? Research has shown that women and men do differ in their experience of and tolerance for pain: Women tend to handle pain better than men. Perhaps this is due to women's labor and childbirth experience. Men tend to be stoic about their pain and do not seek help. Research also shows that gender differences in pain tolerance can vary across cultures. .

## Personal Application Question

As mentioned earlier, a food's flavor represents an interaction of both gustatory and olfactory information. Think about the last time you were seriously congested due to a cold or the flu. What changes did you notice in the flavors of the foods that you ate during this time?

## 26.

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## PART VI

## GROWTH AND DEVELOPMENT



How have you changed since childhood? How are you the same? What will your life be like twenty-five years from now? Fifty years from now? Lifespan development studies how you change as well as how you remain the same over the course of your life. (credit: modification of work by Giles Cook)

Welcome to the story of your life. In this chapter we explore the fascinating tale of how you have grown and developed into the person you are today. We also look at some ideas about who you will grow into tomorrow. Yours is a story of **lifespan development**, *from the start of life to the end*.

The process of human growth and development is more obvious in infancy and childhood, yet your development is happening at this moment and will continue, minute by minute, for the rest of your life. Who you are today and who you will be in the future depends on a blend of genetics, environment, culture, relationships, and more, as you continue through each phase of life. You have experienced firsthand much of what is discussed in this chapter. Now consider what psychological science has to say about your physical, cognitive, and psychosocial development, from the womb to the tomb.



27.

## WHAT IS GROWTH AND DEVELOPMENT?

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### Learning Objectives

By the end of this section, you will be able to:

- Define and distinguish between the three domains of development: physical, cognitive, and psychosocial
- Discuss the normative approach to development
- Understand the three major issues in development: continuity and discontinuity, one common course of development or many unique courses of development, and nature versus nurture

My heart leaps up when I behold

A rainbow in the sky:

So was it when my life began;

So is it now I am a man;

So be it when I shall grow old,

Or let me die!

The Child is father of the Man;

I could wish my days to be

Bound each to each by natural piety. (Wordsworth, 1802)

In this poem, William Wordsworth writes, “The child is father of the man.” What does this seemingly

incongruous statement mean, and what does it have to do with lifespan development? Wordsworth might be suggesting that the person he is as an adult depends largely on the experiences he had in childhood. Consider the following questions: To what extent is the adult you are today influenced by the child you once were? To what extent is a child fundamentally different from the adult he grows up to be?

These are the types of questions **developmental psychologists** *try to answer, by studying how humans change and grow from conception through childhood, adolescence, adulthood, and death*. They view development as a lifelong process that can be studied scientifically across three developmental domains—physical, cognitive, and psychosocial development. **Physical development** *involves growth and changes in the body and brain, the senses, motor skills, and health and wellness*. **Cognitive development** *involves learning, attention, memory, language, thinking, reasoning, and creativity*. **Psychosocial development** *involves emotions, personality, and social relationships*. We refer to these domains throughout the chapter.

## Research Methods in Developmental Psychology

You've learned about a variety of research methods used by psychologists. Developmental psychologists use many of these approaches in order to better understand how individuals change mentally and physically over time. These methods include naturalistic observations, case studies, surveys, and experiments, among others.

**Naturalistic observations** involve *observing behavior in its natural context*. A developmental psychologist might observe how children behave on a playground, at a daycare center, or in the child's own home. While this research approach provides a glimpse into how children behave in their natural settings, researchers have very little control over the types and/or frequencies of displayed behavior.

In a **case study**, *developmental psychologists collect a great deal of information from one individual in order to better understand physical and psychological changes over the lifespan*. This particular approach is an excellent way to better understand individuals, who are exceptional in some way, but it is especially prone to researcher bias in interpretation, and it is difficult to generalize conclusions to the larger population.

In one classic example of this research method being applied to a study of lifespan development, Sigmund Freud analyzed the development of a child known as “Little Hans” (Freud, 1909/1949). Freud's findings helped inform his theories of psychosexual development in children, which you will learn about later in this chapter. Little Genie, the subject of a case study discussed in the chapter on thinking and intelligence, provides another example of how psychologists examine developmental milestones through detailed research on a single individual. In Genie's case, her neglectful and abusive upbringing led to her being unable to speak until, at age 13, she was removed from that harmful environment. As she learned to use language, psychologists were able to compare how her language acquisition abilities differed when occurring in her late-stage development compared to the typical acquisition of those skills during the ages of infancy through early childhood (Fromkin, Krashen, Curtiss, Rigler, & Rigler, 1974; Curtiss, 1981).

The **survey method** *asks individuals to self-report important information about their thoughts, experiences,*

*and beliefs*. This particular method can provide large amounts of information in relatively short amounts of time; however, the validity of data collected in this way relies on honest self-reporting, and the data is relatively shallow when compared to the depth of information collected in a case study.

Experiments involve significant control over extraneous variables and manipulation of the independent variable. As such, **experimental research** *allows developmental psychologists to make causal statements about certain variables that are important for the developmental process*. Because experimental research must occur in a controlled environment, researchers must be cautious about whether behaviors observed in the laboratory translate to an individual's natural environment.

Later in this chapter, you will learn about several experiments in which toddlers and young children observe scenes or actions so that researchers can determine at what age specific cognitive abilities develop. For example, children may observe a quantity of liquid poured from a short, fat glass into a tall, skinny glass. As the experimenters question the children about what occurred, the subjects' answers help psychologists understand at what age a child begins to comprehend that the volume of liquid remained the same although the shapes of the containers differ.

Across these three domains—physical, cognitive, and psychosocial—the **normative approach** to development is also discussed. This approach asks, “*What is normal development?*” In the early decades of the 20th century, normative psychologists studied large numbers of children at various ages to determine norms (i.e., average ages) of when most children reach specific developmental milestones in each of the three domains (Gesell, 1933, 1939, 1940; Gesell & Ilg, 1946; Hall, 1904). Although children develop at slightly different rates, we can use these age-related averages as general guidelines to compare children with same-age peers to determine the approximate ages they should reach specific normative events called developmental milestones (e.g., crawling, walking, writing, dressing, naming colors, speaking in sentences, and starting puberty).

Not all normative events are universal, meaning they are not experienced by all individuals across all cultures. Biological milestones, such as puberty, tend to be universal, but social milestones, such as the age when children begin formal schooling, are not necessarily universal; instead, they affect most individuals in a particular culture (Gesell & Ilg, 1946). For example, in developed countries children begin school around 5 or 6 years old, but in developing countries, like Nigeria, children often enter school at an advanced age, if at all (Huebler, 2005; United Nations Educational, Scientific, and Cultural Organization [UNESCO], 2013).

To better understand the normative approach, imagine two new mothers, Louisa and Kimberly, who are close friends and have children around the same age. Louisa's daughter is 14 months old, and Kimberly's son is 12 months old. According to the normative approach, the average age a child starts to walk is 12 months. However, at 14 months Louisa's daughter still isn't walking. She tells Kimberly she is worried that something might be wrong with her baby. Kimberly is surprised because her son started walking when he was only 10 months old. Should Louisa be worried? Should she be concerned if her daughter is not walking by 15 months or 18 months?

The Centers for Disease Control and Prevention (CDC) describes the developmental milestones for children from 2 months through 5 years old. After reviewing the information, take this quiz to see how well you recall what you've learned. If you are a parent with concerns about your child's development, contact your pediatrician: [CDC's Developmental Milestones](#).

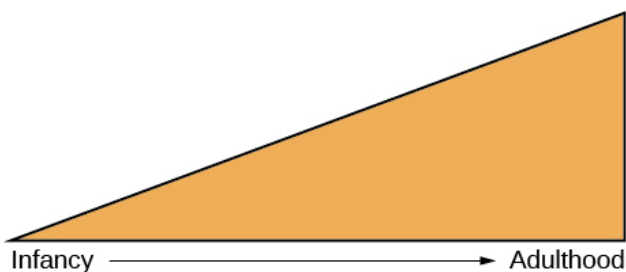
## Issues in Developmental Psychology

There are many different theoretical approaches regarding human development. As we evaluate them in this chapter, recall that **developmental psychology** *focuses on how people change, and keep in mind that all the approaches that we present in this chapter address questions of change*: Is the change smooth or uneven (continuous versus discontinuous)? Is this pattern of change the same for everyone, or are there many different patterns of change (one course of development versus many courses)? How do genetics and environment interact to influence development (nature versus nurture)?

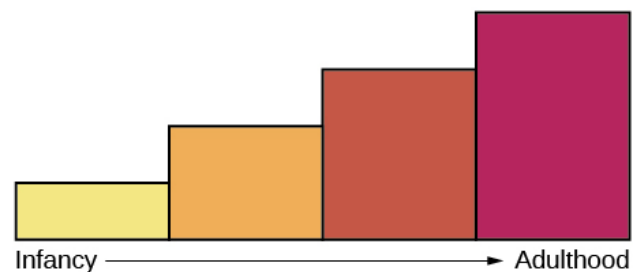
### Is Development Continuous or Discontinuous?

**Continuous development** *views development as a cumulative process, gradually improving on existing skills*. With this type of development, there is gradual change. Consider, for example, a child's physical growth: adding inches to her height year by year. In contrast, theorists who view development as **discontinuous (development)** believe that *development takes place in unique stages; it occurs at specific times or ages*. With this type of development, the change is more sudden, such as an infant's ability to conceive object permanence. The concept of continuous development can be visualized as a smooth slope of progression, whereas discontinuous development sees growth in more discrete stages.

**Continuous Development**



**Discontinuous Development**



The concept of continuous development can be visualized as a smooth slope of progression from infancy to adulthood, whereas discontinuous development sees growth in more discrete stages.

## Is There One Course of Development or Many?

Is development essentially the same, or universal, for all children (i.e., there is one course of development) or does development follow a different course for each child, depending on the child's specific genetics and environment (i.e., there are many courses of development)? Do people across the world share more similarities or more differences in their development? How much do culture and genetics influence a child's behavior?

Stage theories hold that the sequence of development is universal. For example, in cross-cultural studies of language development, children from around the world reach language milestones in a similar sequence (Gleitman & Newport, 1995). Infants in all cultures coo before they babble. They begin babbling at about the same age and utter their first word around 12 months old. Yet we live in diverse contexts that have a unique effect on each of us. For example, researchers once believed that motor development follows one course for all children regardless of culture. However, child care practices vary by culture, and different practices have been found to accelerate or inhibit the achievement of developmental milestones such as sitting, crawling, and walking (Karasik, Adolph, Tamis-LeMonda, & Bornstein, 2010).

For instance, let's look at the Aché society in Paraguay. They spend a significant amount of time foraging in forests. While foraging, Aché mothers carry their young children, rarely putting them down in order to protect them from getting hurt in the forest. Consequently, their children walk much later; they walk around 23–25 months old, in comparison to infants in Western cultures who begin to walk around 12 months old. However, as Aché children become older, they are allowed more freedom to move about, and by about age 9, their motor skills surpass those of U.S. children of the same age; Aché children are able to climb trees up to 25 feet tall and use machetes to chop their way through the forest (Kaplan & Dove, 1987). As you can see, our development is influenced by multiple contexts, so the timing of basic motor functions may vary across cultures. However, the functions themselves are present in all societies.



(a)



(b)

All children across the world love to play. Whether in (a) Florida or (b) South Africa, children enjoy exploring sand, sunshine, and the sea. (credit a: modification of work by "Visit St. Pete/Clearwater"/Flickr; credit b: modification of work by "stringer\_bel"/Flickr)

## How Do Nature and Nurture Influence Development?

Are we who we are because of **nature** (*biology and genetics*), or are we who we are because of **nurture** (*our environment and culture*)? This longstanding question is known in psychology as the **nature versus nurture debate**. *It seeks to understand how our personalities and traits are the product of our genetic makeup and biological factors, and how they are shaped by our environment, including our parents, peers, and culture.* For instance, why do biological children sometimes act like their parents—is it because of genetics or because of early childhood environment and what the child has learned from the parents? What about children who are adopted—are they more like their biological families or more like their adoptive families? And how can siblings from the same family be so different?

We are all born with specific genetic traits inherited from our parents, such as eye color, height, and certain personality traits. Beyond our basic genotype, however, there is a deep interaction between our genes and our environment: Our unique experiences in our environment influence whether and how particular traits are expressed, and at the same time, our genes influence how we interact with our environment (Diamond, 2009; Lobo, 2008). This chapter will show that there is a reciprocal interaction between nature and nurture as they both shape who we become, but the debate continues as to the relative contributions of each.

## The Achievement Gap: How Does Socioeconomic Status Affect Development?

The **achievement gap** refers to *the persistent difference in grades, test scores, and graduation rates that exist among students of different ethnicities, races, and—in certain subjects—sexes* (Winerman, 2011). Research suggests that these achievement gaps are strongly influenced by differences in socioeconomic factors that exist among the families of these children. While the researchers acknowledge that programs aimed at reducing such socioeconomic discrepancies would likely aid in equalizing the aptitude and performance of children from different backgrounds, they recognize that such large-scale interventions would be difficult to achieve. Therefore, it is recommended that programs aimed at fostering aptitude and achievement among disadvantaged children may be the best option for dealing with issues related to academic achievement gaps (Duncan & Magnuson, 2005).

Low-income children perform significantly more poorly than their middle- and high-income peers on a number of educational variables: They have significantly lower standardized test scores, graduation rates, and college entrance rates, and they have much higher school dropout rates. There have been attempts to correct the achievement gap through state and federal legislation, but what if the problems start before the children even enter school?

Psychologists Betty Hart and Todd Risley (2006) spent their careers looking at early language ability and progression of children in various income levels. In one longitudinal study, they found that although all the

parents in the study engaged and interacted with their children, middle- and high-income parents interacted with their children differently than low-income parents. After analyzing 1,300 hours of parent-child interactions, the researchers found that middle- and high-income parents talk to their children significantly more, starting when the children are infants. By 3 years old, high-income children knew almost double the number of words known by their low-income counterparts, and they had heard an estimated total of 30 million more words than their low-income counterparts (Hart & Risley, 2003). And the gaps only become more pronounced. Before entering kindergarten, high-income children score 60% higher on achievement tests than their low-income peers (Lee & Burkam, 2002).

There are solutions to this problem. At the University of Chicago, experts are working with low-income families, visiting them at their homes, and encouraging them to speak more to their children on a daily and hourly basis. Other experts are designing preschools in which students from diverse economic backgrounds are placed in the same classroom. In this research, low-income children made significant gains in their language development, likely as a result of attending the specialized preschool (Schechter & Byeb, 2007). What other methods or interventions could be used to decrease the achievement gap? What types of activities could be implemented to help the children of your community or a neighboring community?

## Summary

Lifespan development explores how we change and grow from conception to death. This field of psychology is studied by developmental psychologists. They view development as a lifelong process that can be studied scientifically across three developmental domains: physical, cognitive development, and psychosocial. There are several theories of development that focus on the following issues: whether development is continuous or discontinuous, whether development follows one course or many, and the relative influence of nature versus nurture on development.

## Review Questions



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online here:

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## Critical Thinking Questions

Describe the nature versus nurture controversy, and give an example of a trait and how it might be influenced by each.

The nature versus nurture controversy seeks to understand whether our personalities and traits are the product of our genetic makeup and biological factors, or whether they are shaped by our environment, which includes such things as our parents, peers, and culture. Today, psychologists agree that both nature and nurture interact to shape who we become, but the debate over the relative contributions of each continues. An example would be a child learning to walk: Nature influences when the physical ability occurs, but culture can influence when a child masters this skill, as in Aché culture.

Compare and contrast continuous and discontinuous development.

Continuous development sees our development as a cumulative process: Changes are gradual. On the other hand, discontinuous development sees our development as taking place in specific steps or stages: Changes are sudden.

Why should developmental milestones only be used as a general guideline for normal child development?

Children develop at different rates. For example, some children may walk and talk as early as 8 months old, while others may not do so until well after their first birthday. Each child's unique contexts will influence when he reaches these milestones.

## Personal Application Questions

How are you different today from the person you were at 6 years old? What about at 16 years old? How are you the same as the person you were at those ages?

Your 3-year-old daughter is not yet potty trained. Based on what you know about the normative approach, should you be concerned? Why or why not?

28.

## LIFESPAN THEORIES

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### Learning Objectives

By the end of this section, you will be able to:

- Discuss Freud's theory of psychosexual development
- Describe the major tasks of child and adult psychosocial development according to Erikson
- Discuss Piaget's view of cognitive development and apply the stages to understanding childhood cognition
- Describe Kohlberg's theory of moral development

There are many theories regarding how babies and children grow and develop into happy, healthy adults. We explore several of these theories in this section.

## Psychosexual Theory of Development

**Sigmund Freud (1856–1939)** believed that personality develops during early childhood. For Freud, childhood experiences shape our personalities and behavior as adults. Freud viewed development as discontinuous; he believed that each of us must pass through a series of stages during childhood, and that if we lack proper nurturance and parenting during a stage, we may become stuck, or fixated, in that stage. Freud's stages are called the stages of psychosexual development. According to Freud, children's pleasure-seeking urges are focused on a different area of the body, called an erogenous zone, at each of the five stages of development: oral, anal, phallic, latency, and genital.

While most of Freud's ideas have not found support in modern research, we cannot discount the contributions that Freud has made to the field of psychology. Psychologists today dispute Freud's psychosexual stages as a legitimate explanation for how one's personality develops, but what we can take away from Freud's

theory is that personality is shaped, in some part, by experiences we have in childhood. These stages are discussed in detail in the chapter on personality.

## Psychosocial Theory of Development

**Erik Erikson (1902–1994)**, another *stage theorist*, took Freud's theory and modified it as *psychosocial theory*. Erikson's psychosocial development theory emphasizes the social nature of our development rather than its sexual nature. While Freud believed that personality is shaped only in childhood, Erikson proposed that personality development takes place all through the lifespan. Erikson suggested that how we interact with others is what affects our sense of self, or what he called the ego identity.



Erik Erikson proposed the psychosocial theory of development. In each stage of Erikson's theory, there is a psychosocial task that we must master in order to feel a sense of competence.

Erikson proposed that we are motivated by a need to achieve competence in certain areas of our lives. According to **psychosocial theory**, *we experience eight stages of development over our lifespan, from infancy through late adulthood*. At each stage there is a conflict, or task, that we need to resolve. Successful completion of each developmental task results in a sense of competence and a healthy personality. Failure to master these tasks leads to feelings of inadequacy.

According to Erikson (1963), trust is the basis of our development during infancy (birth to 12 months). Therefore, the primary task of this stage is trust versus mistrust. Infants are dependent upon their caregivers, so caregivers who are responsive and sensitive to their infant's needs help their baby to develop a sense of trust;

their baby will see the world as a safe, predictable place. Unresponsive caregivers who do not meet their baby's needs can engender feelings of anxiety, fear, and mistrust; their baby may see the world as unpredictable.

As toddlers (ages 1–3 years) begin to explore their world, they learn that they can control their actions and act on the environment to get results. They begin to show clear preferences for certain elements of the environment, such as food, toys, and clothing. A toddler's main task is to resolve the issue of autonomy versus shame and doubt, by working to establish independence. This is the “me do it” stage. For example, we might observe a budding sense of autonomy in a 2-year-old child who wants to choose her clothes and dress herself. Although her outfits might not be appropriate for the situation, her input in such basic decisions has an effect on her sense of independence. If denied the opportunity to act on her environment, she may begin to doubt her abilities, which could lead to low self-esteem and feelings of shame.

Once children reach the preschool stage (ages 3–6 years), they are capable of initiating activities and asserting control over their world through social interactions and play. According to Erikson, preschool children must resolve the task of initiative versus guilt. By learning to plan and achieve goals while interacting with others, preschool children can master this task. Those who do will develop self-confidence and feel a sense of purpose. Those who are unsuccessful at this stage—with their initiative misfiring or stifled—may develop feelings of guilt. How might over-controlling parents stifle a child's initiative?

During the elementary school stage (ages 6–12), children face the task of industry versus inferiority. Children begin to compare themselves to their peers to see how they measure up. They either develop a sense of pride and accomplishment in their schoolwork, sports, social activities, and family life, or they feel inferior and inadequate when they don't measure up. What are some things parents and teachers can do to help children develop a sense of competence and a belief in themselves and their abilities?

In adolescence (ages 12–18), children face the task of identity versus role confusion. According to Erikson, an adolescent's main task is developing a sense of self. Adolescents struggle with questions such as “Who am I?” and “What do I want to do with my life?” Along the way, most adolescents try on many different selves to see which ones fit. Adolescents who are successful at this stage have a strong sense of identity and are able to remain true to their beliefs and values in the face of problems and other people's perspectives. What happens to apathetic adolescents, who do not make a conscious search for identity, or those who are pressured to conform to their parents' ideas for the future? These teens will have a weak sense of self and experience role confusion. They are unsure of their identity and confused about the future.

People in early adulthood (i.e., 20s through early 40s) are concerned with intimacy versus isolation. After we have developed a sense of self in adolescence, we are ready to share our life with others. Erikson said that we must have a strong sense of self before developing intimate relationships with others. Adults who do not develop a positive self-concept in adolescence may experience feelings of loneliness and emotional isolation.

When people reach their 40s, they enter the time known as middle adulthood, which extends to the mid-60s. The social task of middle adulthood is generativity versus stagnation. Generativity involves finding your life's work and contributing to the development of others, through activities such as volunteering, mentoring, and

raising children. Those who do not master this task may experience stagnation, having little connection with others and little interest in productivity and self-improvement.

From the mid-60s to the end of life, we are in the period of development known as late adulthood. Erikson's task at this stage is called integrity versus despair. He said that people in late adulthood reflect on their lives and feel either a sense of satisfaction or a sense of failure. People who feel proud of their accomplishments feel a sense of integrity, and they can look back on their lives with few regrets. However, people who are not successful at this stage may feel as if their life has been wasted. They focus on what "would have," "should have," and "could have" been. They face the end of their lives with feelings of bitterness, depression, and despair.

**Erikson's Psychosocial Stages of Development**

Stage	Age (years)	Developmental Task	Description
1	0–1	Trust vs. mistrust	Trust (or mistrust) that basic needs, such as nourishment and affection, will be met
2	1–3	Autonomy vs. shame/doubt	Develop a sense of independence in many tasks
3	3–6	Initiative vs. guilt	Take initiative on some activities—may develop guilt when unsuccessful or boundaries overstepped
4	7–11	Industry vs. inferiority	Develop self-confidence in abilities when competent or a sense of inferiority when not
5	12–18	Identity vs. confusion	Experiment with and develop identity and roles
6	19–29	Intimacy vs. isolation	Establish intimacy and relationships with others
7	30–64	Generativity vs. stagnation	Contribute to society and be part of a family
8	65+	Integrity vs. despair	Assess and make sense of life and the meaning of contributions

## Cognitive Theory of Development

**Jean Piaget (1896–1980)** is another stage theorist who studied childhood development. Instead of approaching development from a psychoanalytical or psychosocial perspective, Piaget focused on children's cognitive growth. He believed that thinking is a central aspect of development and that children are naturally inquisitive. However, he said that children do not think and reason like adults (Piaget, 1930, 1932). His theory of cognitive development holds that our cognitive abilities develop through specific stages, which exemplifies the discontinuity approach to development. As we progress to a new stage, there is a distinct shift in how we think and reason.



Jean Piaget spent over 50 years studying children and how their minds develop.

Piaget said that children develop schemata to help them understand the world. **Schemata** are concepts (mental models) that are used to help us categorize and interpret information. By the time children have reached adulthood, they have created schemata for almost everything. When children learn new information, they adjust their schemata through two processes: assimilation and accommodation. First, they assimilate new information or experiences in terms of their current schemata: **assimilation** is when they take in information that is comparable to what they already know. **Accommodation** describes when they change their schemata based on new information. This process continues as children interact with their environment.

For example, 2-year-old Blake learned the schema for dogs because his family has a Labrador retriever. When Blake sees other dogs in his picture books, he says, “Look mommy, dog!” Thus, he has assimilated them into his schema for dogs. One day, Blake sees a sheep for the first time and says, “Look mommy, dog!” Having a basic schema that a dog is an animal with four legs and fur, Blake thinks all furry, four-legged creatures are dogs. When Blake’s mom tells him that the animal he sees is a sheep, not a dog, Blake must accommodate his schema for dogs to include more information based on his new experiences. Blake’s schema for dog was too broad, since not all furry, four-legged creatures are dogs. He now modifies his schema for dogs and forms a new one for sheep.

Like Freud and Erikson, Piaget thought development unfolds in a series of stages approximately associated

with age ranges. He proposed a theory of cognitive development that unfolds in four stages: sensorimotor, preoperational, concrete operational, and formal operational.

### Piaget's Stages of Cognitive Development

Age (years)	Stage	Description	Developmental issues
0–2	Sensorimotor	World experienced through senses and actions	Object permanence Stranger anxiety Pretend play
2–6	Preoperational	Use words and images to represent things, but lack logical reasoning	Egocentrism Language development Conservation
7–11	Concrete operational	Understand concrete events and analogies logically; perform arithmetical operations	Mathematical transformations
12+	Formal operational	Formal operations Utilize abstract reasoning	Abstract logic Moral reasoning

The first stage is the **sensorimotor stage**, a stage of development which lasts from birth to about 2 years old. During this stage, children learn about the world through their senses and motor behavior. Young children put objects in their mouths to see if the items are edible, and once they can grasp objects, they may shake or bang them to see if they make sounds. Between 5 and 8 months old, the child develops **object permanence**, which is *the understanding that even if something is out of sight, it still exists* (Bogartz, Shinsky, & Schilling, 2000). According to Piaget, young infants do not remember an object after it has been removed from sight. Piaget studied infants' reactions when a toy was first shown to an infant and then hidden under a blanket. Infants who had already developed object permanence would reach for the hidden toy, indicating that they knew it still existed, whereas infants who had not developed object permanence would appear confused.

Please take a few minutes to view this brief video demonstrating different children's ability to understand object permanence: [Piaget – Stage 1 – Sensorimotor stage : Object Permanence](#).




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In Piaget's view, around the same time children develop object permanence, they also begin to exhibit **stranger anxiety**, which is *a fear of unfamiliar people*. Babies may demonstrate this by crying and turning away from a stranger, by clinging to a caregiver, or by attempting to reach their arms toward familiar faces such as parents. Stranger anxiety results when a child is unable to assimilate the stranger into an existing schema; therefore, she can't predict what her experience with that stranger will be like, which results in a fear response.

Piaget's second stage is the **preoperational stage**, which is *from approximately 2 to 7 years old*. In this stage, children can use symbols to represent words, images, and ideas, which is why children in this stage engage in pretend play. A child's arms might become airplane wings as he zooms around the room, or a child with a stick might become a brave knight with a sword. Children also begin to use language in the preoperational stage, but they cannot understand adult logic or mentally manipulate information (the term *operational* refers to logical manipulation of information, so children at this stage are considered to be *pre-operational*). Children's logic is based on their own personal knowledge of the world so far, rather than on conventional knowledge. For example, Dad gave a slice of pizza to 10-year-old Keiko and another slice to her 3-year-old brother, Kenny. Kenny's pizza slice was cut into 5 pieces, so Kenny told his sister that he got more pizza than she did. Children in this stage cannot perform mental operations because they have not developed an understanding of conservation, which is the idea that even if you change the appearance of something, it is still equal in size as long as nothing has been removed or added.


This video shows a 4.5-year-old boy in the preoperational stage as he responds to Piaget's conservation tasks: [A typical child on Piaget's conservation tasks](#).



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During this stage, we also expect children to display egocentrism, which means that the child is not able to take the perspective of others. A child at this stage thinks that everyone sees, thinks, and feels just as they do. Let's look at Kenny and Keiko again. Keiko's birthday is coming up, so their mom takes Kenny to the toy store to choose a present for his sister. He selects an Iron Man action figure for her, thinking that if he likes the toy, his sister will too. An egocentric child is not able to infer the perspective of other people and instead attributes his own perspective.

Piaget developed the Three-Mountain Task to determine the level of egocentrism displayed by children. Children view a three-dimensional mountain scene from one viewpoint and are asked what another person at a different viewpoint would see in the same scene. Watch the Three-Mountain Task in action in this short video from the University of Minnesota and the Science Museum of Minnesota: [Piaget's Mountains Task](#).

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Piaget's third stage is the **concrete operational stage**, which occurs from about 7 to 11 years old. In this stage, children can think logically about real (concrete) events; they have a firm grasp on the use of numbers and start to employ memory strategies. They can perform mathematical operations and understand transformations, such as addition is the opposite of subtraction, and multiplication is the opposite of division. In this stage, children also master the concept of conservation: Even if something changes shape, its mass, volume, and number stay the same. For example, if you pour water from a tall, thin glass to a short, fat glass, you still have the same

amount of water. Remember Keiko and Kenny and the pizza? How did Keiko know that Kenny was wrong when he said that he had more pizza?

Children in the concrete operational stage also understand the principle of reversibility, which means that objects can be changed and then returned back to their original form or condition. Take, for example, water that you poured into the short, fat glass: You can pour water from the fat glass back into the thin glass and still have the same amount (minus a couple of drops).

The fourth, and last, stage in Piaget's theory is the **formal operational stage**, which is *from about age 11 to adulthood*. Whereas children in the concrete operational stage are able to think logically only about concrete events, children in the formal operational stage can also deal with abstract ideas and hypothetical situations. *Children in this stage can use abstract thinking to problem solve, look at alternative solutions, and test these solutions. In adolescence, a renewed egocentrism occurs.* For example, a 15-year-old with a very small pimple on her face might think it is huge and incredibly visible, under the mistaken impression that others must share her perceptions.

## Beyond Formal Operational Thought

As with other major contributors to theories of development, several of Piaget's ideas have come under criticism based on the results of further research. For example, several contemporary studies support a model of development that is more continuous than Piaget's discrete stages (Courage & Howe, 2002; Siegler, 2005, 2006). Many others suggest that children reach cognitive milestones earlier than Piaget describes (Baillargeon, 2004; de Hevia & Spelke, 2010).

According to Piaget, the *highest level of cognitive development* is **formal operational thought**, which develops between 11 and 20 years old. However, many developmental psychologists disagree with Piaget, suggesting a fifth stage of cognitive development, known as the postformal stage (Basseches, 1984; Commons & Bressette, 2006; Sinnott, 1998). In postformal thinking, decisions are made based on situations and circumstances, and logic is integrated with emotion as adults develop principles that depend on contexts. One way that we can see the difference between an adult in postformal thought and an adolescent in formal operations is in terms of how they handle emotionally charged issues.

It seems that once we reach adulthood our problem-solving abilities change. As we attempt to solve problems, we tend to think more deeply about many areas of our lives, such as relationships, work, and politics (Labouvie-Vief & Diehl, 1999). Because of this, postformal thinkers are able to draw on past experiences to help them solve new problems. Problem-solving strategies using postformal thought vary, depending on the situation. What does this mean? Adults can recognize, for example, that what seems to be an ideal solution to a problem at work involving a disagreement with a colleague may not be the best solution to a disagreement with a significant other.

## Test Your Understanding



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## Theory of Moral Development

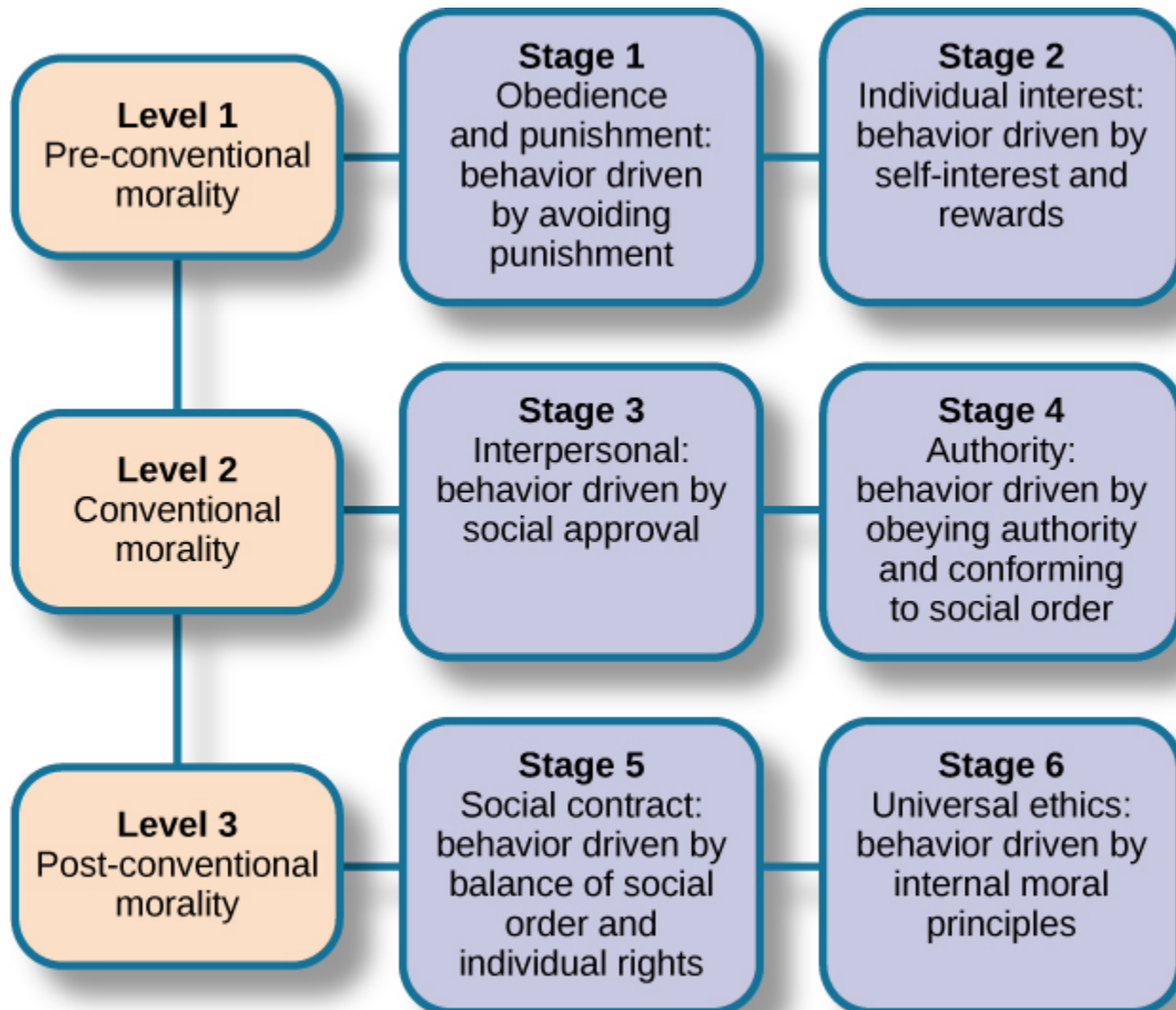
A major task beginning in childhood and continuing into adolescence is discerning right from wrong. Psychologist **Lawrence Kohlberg (1927–1987)** extended upon the foundation that Piaget built regarding cognitive development. Kohlberg *believed that moral development, like cognitive development, follows a series of stages*. To develop this theory, Kohlberg posed moral dilemmas to people of all ages, and then he analyzed their answers to find evidence of their particular stage of moral development. Before reading about the stages, take a minute to consider how you would answer one of Kohlberg’s best-known moral dilemmas, commonly known as the Heinz dilemma:

In Europe, a woman was near death from a special kind of cancer. There was one drug that the doctors thought might save her. It was a form of radium that a druggist in the same town had recently discovered. The drug was expensive to make, but the druggist was charging ten times what the drug cost him to make. He paid \$200 for the radium and charged \$2,000 for a small dose of the drug. The sick woman’s husband, Heinz, went to everyone he knew to borrow the money, but he could only get together about \$1,000, which is half of what it cost. He told the druggist that his wife was dying and asked him to sell it cheaper or let him pay later. But the druggist said: “No, I discovered the drug and I’m going to make money from it.” So Heinz got desperate and broke into the man’s store to steal the drug for his wife. Should the husband have done that? (Kohlberg, 1969, p. 379)

How would you answer this dilemma? Kohlberg was not interested in whether you answer yes or no to the dilemma: Instead, he was interested in the reasoning behind your answer.

After presenting people with this and various other moral dilemmas, Kohlberg reviewed people’s responses and placed them in different stages of moral reasoning. According to Kohlberg, an individual progresses from the capacity for pre-conventional morality (before age 9) to the capacity for conventional morality (early adolescence), and toward attaining post-conventional morality (once formal operational thought is attained),

which only a few fully achieve. Kohlberg placed in the highest stage responses that reflected the reasoning that Heinz should steal the drug because his wife's life is more important than the pharmacist making money. The value of a human life overrides the pharmacist's greed.



Kohlberg identified three levels of moral reasoning: pre-conventional, conventional, and post-conventional: Each level is associated with increasingly complex stages of moral development.

It is important to realize that even those people who have the most sophisticated, post-conventional reasons for some choices may make other choices for the simplest of pre-conventional reasons. Many psychologists agree with Kohlberg's theory of moral development but point out that moral reasoning is very different from moral behavior. Sometimes what we say we would do in a situation is not what we actually do in that situation. In other words, we might "talk the talk," but not "walk the walk."

How does this theory apply to males and females? Kohlberg (1969) felt that more males than females move past stage four in their moral development. He went on to note that women seem to be deficient in their moral

reasoning abilities. These ideas were not well received by Carol Gilligan, a research assistant of Kohlberg's, who consequently developed her own ideas of moral development. In her groundbreaking book *In a Different Voice: Psychological Theory and Women's Development*, Gilligan (1982) criticized her former mentor's theory because it was based only on upper-class White men and boys. She argued that women are not deficient in their moral reasoning—she proposed that males and females reason differently. Girls and women focus more on staying connected and the importance of interpersonal relationships. Therefore, in the Heinz dilemma, many girls and women respond that Heinz should not steal the medicine. Their reasoning is that if he steals the medicine, is arrested, and is put in jail, then he and his wife will be separated, and she could die while he is still in prison.

## Test Your Understanding



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## Summary

There are many theories regarding how babies and children grow and develop into happy, healthy adults. Sigmund Freud suggested that we pass through a series of psychosexual stages in which our energy is focused on certain erogenous zones on the body. Eric Erikson modified Freud's ideas and suggested a theory of psychosocial development. Erikson said that our social interactions and successful completion of social tasks shape our sense of self. Jean Piaget proposed a theory of cognitive development that explains how children think and reason as they move through various stages. Finally, Lawrence Kohlberg turned his attention to moral development. He said that we pass through three levels of moral thinking that build on our cognitive development.

## Review Questions



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## Critical Thinking Questions

What is the difference between assimilation and accommodation? Provide examples of each. Assimilation is when we take in information that is comparable to what we already know. Accommodation is when we change our schemata based on new information. An example of assimilation is a child's schema of "dog" based on the family's golden retriever being expanded to include two newly adopted golden retrievers. An example of accommodation is that same child's schema of "dog" being adjusted to exclude other four-legged furry animals such as sheep and foxes.

Why was Carol Gilligan critical of Kohlberg's theory of moral development? Gilligan criticized Kohlberg because his theory was based on the responses of upper class White men and boys, arguing that it was biased against women. While Kohlberg concluded that women must be deficient in their moral reasoning abilities, Gilligan disagreed, suggesting that female moral reasoning is not deficient, just different.

What is egocentrism? Provide an original example. Egocentrism is the inability to take the perspective of another person. This type of thinking is common in young children in the preoperational stage of cognitive development. An example

might be that upon seeing his mother crying, a young child gives her his favorite stuffed animal to make her feel better.

## Personal Application Questions

Explain how you would use your understanding of one of the major developmental theories to deal with each of the difficulties listed below:

1. Your infant daughter puts everything in her mouth, including the dog's food.
2. Your 8-year-old son is failing math; all he cares about is baseball.
3. Your 2-year-old daughter refuses to wear the clothes you pick for her every morning, which makes getting dressed a 20-minute battle.
4. Your 68-year-old neighbor is chronically depressed and feels she has wasted her life.
5. Your 18-year-old daughter has decided not to go to college. Instead she's moving to Colorado to become a ski instructor.
6. Your 11-year-old son is the class bully.

29.

# STAGES OF HUMAN DEVELOPMENT

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## Learning Objectives

By the end of this section, you will be able to:

- Describe the stages of prenatal development and recognize the importance of prenatal care
- Discuss physical, cognitive, and emotional development that occurs from infancy through childhood
- Discuss physical, cognitive, and emotional development that occurs during adolescence
- Discuss physical, cognitive, and emotional development that occurs in adulthood

From the moment we are born until the moment we die, we continue to develop.

As discussed at the beginning of this chapter, developmental psychologists often divide our development into three areas: physical development, cognitive development, and psychosocial development. Mirroring Erikson's stages, lifespan development is divided into different stages that are based on age. We will discuss prenatal, infant, child, adolescent, and adult development.

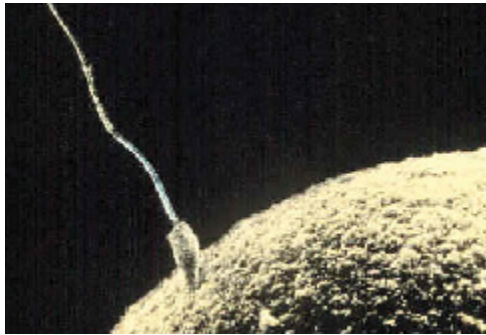
## Prenatal Development

How did you come to be who you are? From beginning as a one-cell structure to your birth, your prenatal development occurred in an orderly and delicate sequence.

There are three stages of prenatal development: germinal, embryonic, and fetal. Let's take a look at what happens to the developing baby in each of these stages.

## Germinal Stage (Weeks 1–2)

In the discussion of biopsychology earlier in the book, you learned about genetics and DNA. A mother and father’s DNA is passed on to the child at the moment of conception. **Conception** occurs when sperm fertilizes an egg and forms a zygote. A **zygote** begins as a one-cell structure that is created when a sperm and egg merge. The genetic makeup and sex of the baby are set at this point. During the first week after conception, the zygote divides and multiplies, going from a one-cell structure to two cells, then four cells, then eight cells, and so on. This *process of cell division* is called **mitosis**. Mitosis is a fragile process, and fewer than one-half of all zygotes survive beyond the first two weeks (Hall, 2004). After five days of mitosis there are one hundred cells, and after nine months there are billions of cells. As the cells divide, they become more specialized, forming different organs and body parts. In the **germinal stage**, *the mass of cells has yet to attach itself to the lining of the mother’s uterus*. Once it does, the next stage begins.



Sperm and ovum fuse at the point of conception.

## Embryonic Stage (Weeks 3–8)

After the zygote divides for about 7–10 days and has 150 cells, it travels down the fallopian tubes and implants itself in the lining of the uterus. Upon implantation, this multi-cellular organism is called an embryo. Now blood vessels grow, forming the placenta. The **placenta** is *a structure connected to the uterus that provides nourishment and oxygen from the mother to the developing embryo via the umbilical cord*. Basic structures of the embryo start to develop into areas that will become the head, chest, and abdomen. During the **embryonic stage**, *the heart begins to beat and organs form and begin to function*. The neural tube forms along the back of the embryo, developing into the spinal cord and brain.

## Fetal Stage (Weeks 9–40)

*When the organism is about 9 weeks old*, the embryo is called a **fetus**. At this stage, the fetus is about the size of a kidney bean and begins to take on the recognizable form of a human being as the “tail” begins to disappear.

From 9–12 weeks, the sex organs begin to differentiate. At about 16 weeks, the fetus is approximately 4.5 inches long. Fingers and toes are fully developed, and fingerprints are visible. By the time the fetus reaches the sixth month of development (24 weeks), it weighs up to 1.4 pounds. Hearing has developed, so the fetus can respond to sounds. The internal organs, such as the lungs, heart, stomach, and intestines, have formed enough that a fetus born prematurely at this point has a chance to survive outside of the mother’s womb. Throughout the fetal stage the brain continues to grow and develop, nearly doubling in size from weeks 16 to 28. Around 36 weeks, the fetus is almost ready for birth. It weighs about 6 pounds and is about 18.5 inches long, and by week 37 all of the fetus’s organ systems are developed enough that it could survive outside the mother’s uterus without many of the risks associated with premature birth. The fetus continues to gain weight and grow in length until approximately 40 weeks. By then, the fetus has very little room to move around and birth becomes imminent.



**9 weeks**  
Fetal stage begins



**12 weeks**  
Sex organs differentiate



**16 weeks**  
Fingers and toes develop



**20 weeks**  
Hearing begins



**24 weeks**  
Lungs begin to develop



**28 weeks**  
Brain grows rapidly



**32 weeks**  
Bones fully develop



**36 weeks**  
Muscles fully develop



**40 weeks**  
Full-term development

During the fetal stage, the baby's brain develops and the body adds size and weight until the fetus reaches full-term development.

For an amazing look at prenatal development and the process of birth, view the video *Life's Greatest Miracle* from Nova and PBS: [Life's Greatest Miracle](#).

## Prenatal Influences

During each prenatal stage, genetic and environmental factors can affect development. The developing fetus is completely dependent on the mother for life. It is important that the mother takes good care of herself and receives prenatal care, which is medical care during pregnancy that monitors the health of both the mother and the fetus. According to the National Institutes of Health ([NIH], 2013), routine prenatal care is important because it can reduce the risk of complications for the mother and fetus during pregnancy. In fact, women who are trying to become pregnant or who may become pregnant should discuss pregnancy planning with their doctor. They may be advised, for example, to take a vitamin containing folic acid, which helps prevent certain birth defects, or to monitor aspects of their diet or exercise routines.



A pregnant woman receives an ultrasound as part of her prenatal care. (credit: United States Agency for International Development)

Recall that when the zygote attaches to the wall of the mother's uterus, the placenta is formed. The placenta provides nourishment and oxygen to the fetus. Most everything the mother ingests, including food, liquid, and even medication, travels through the placenta to the fetus, hence the common phrase "eating for two." Anything the mother is exposed to in the environment affects the fetus; if the mother is exposed to something harmful, the child can show life-long effects.

A **teratogen** is *any environmental agent—biological, chemical, or physical—that causes damage to the developing embryo or fetus*. There are different types of teratogens. Alcohol and most drugs cross the placenta and affect the fetus. Alcohol is not safe to drink in any amount during pregnancy. Alcohol use during pregnancy has been found to be the leading preventable cause of intellectual disabilities in children in the United States (Maier & West, 2001). Excessive maternal drinking while pregnant can cause fetal alcohol spectrum disorders with life-long consequences for the child ranging in severity from minor to major. **Fetal alcohol spectrum disorders (FASD)** are *a collection of birth defects associated with heavy consumption of alcohol during pregnancy. Physically, children with FASD may have a small head size and abnormal facial features. Cognitively, these children may have poor judgment, poor impulse control, higher rates of ADHD,*

*learning issues, and lower IQ scores.* These developmental problems and delays persist into adulthood (Streissguth et al., 2004). Based on studies conducted on animals, it also has been suggested that a mother's alcohol consumption during pregnancy may predispose her child to like alcohol (Youngentob et al., 2007).

#### **Fetal Alcohol Syndrome Facial Features**

<b>Facial Feature</b>	<b>Potential Effect of Fetal Alcohol Syndrome</b>
Head size	Below-average head circumference
Eyes	Smaller than average eye opening, skin folds at corners of eyes
Nose	Low nasal bridge, short nose
Midface	Smaller than average midface size
Lip and philtrum	Thin upper lip, indistinct philtrum

Smoking is also considered a teratogen because nicotine travels through the placenta to the fetus. When the mother smokes, the developing baby experiences a reduction in blood oxygen levels. According to the Centers for Disease Control and Prevention (2013), smoking while pregnant can result in premature birth, low-birth-weight infants, stillbirth, and sudden infant death syndrome (SIDS).

Heroin, cocaine, methamphetamine, almost all prescription medicines, and most over-the-counter medications are also considered teratogens. Babies born with a heroin addiction need heroin just like an adult addict. The child will need to be gradually weaned from the heroin under medical supervision; otherwise, the child could have seizures and die. Other teratogens include radiation, viruses such as HIV and herpes, and rubella (German measles). Women in the United States are much less likely to be afflicted with rubella because most women receive childhood immunizations or vaccinations that protect the body from disease.

Each organ of the fetus develops during a specific period in the pregnancy, called the critical or sensitive period. For example, research with primate models of FASD has demonstrated that the time during which a developing fetus is exposed to alcohol can dramatically affect the appearance of facial characteristics associated with fetal alcohol syndrome. Specifically, this research suggests that alcohol exposure that is limited to day 19 or 20 of gestation can lead to significant facial abnormalities in the offspring (Ashley, Magnuson, Omnell, & Clarren, 1999). Given regions of the brain also show sensitive periods during which they are most susceptible to the teratogenic effects of alcohol (Tran & Kelly, 2003).

## **Should Women Who Use Drugs During Pregnancy Be Arrested and Jailed?**

As you now know, women who use drugs or alcohol during pregnancy can cause serious lifelong harm to their children. Some people have advocated mandatory screenings for women who are pregnant and have a history of drug abuse, and if the women continue using, to arrest, prosecute, and incarcerate them (Figdor & Kaeser,

1998). This policy was tried in Charleston, South Carolina, as recently as 20 years ago. The policy was called the Interagency Policy on Management of Substance Abuse During Pregnancy and had disastrous results.

The Interagency Policy applied to patients attending the obstetrics clinic at MUSC, which primarily serves patients who are indigent or on Medicaid. It did not apply to private obstetrical patients. The policy required patient education about the harmful effects of substance abuse during pregnancy. . . . [A] statement also warned patients that protection of unborn and newborn children from the harms of illegal drug abuse could involve the Charleston police, the Solicitor of the Ninth Judicial Court, and the Protective Services Division of the Department of Social Services (DSS). (Jos, Marshall, & Perlmutter, 1995, pp. 120–121)

This policy seemed to deter women from seeking prenatal care, deterred them from seeking other social services, and was applied solely to low-income women, resulting in lawsuits. The program was canceled after 5 years, during which 42 women were arrested. A federal agency later determined that the program involved human experimentation without the approval and oversight of an institutional review board (IRB). What were the flaws in the program and how would you correct them? What are the ethical implications of charging pregnant women with child abuse?

## Test Your Understanding



*An interactive H5P element has been excluded from this version of the text. You can view it online here:*

<https://louis.pressbooks.pub/intropsychology/?p=599#h5p-160>

## Infancy through Childhood

The average newborn weighs approximately 7.5 pounds. Although small, a newborn is not completely helpless because his reflexes and sensory capacities help him interact with the environment from the moment of birth. All healthy babies are born with newborn reflexes: inborn automatic responses to particular forms of stimulation. Reflexes help the newborn survive until it is capable of more complex behaviors—these reflexes are crucial to survival. They are present in babies whose brains are developing normally and usually disappear around 4–5 months old. Let’s take a look at some of these newborn reflexes. The rooting reflex is the newborn’s

response to anything that touches her cheek: When you stroke a baby's cheek, she naturally turns her head in that direction and begins to suck. The sucking reflex is the automatic, unlearned sucking motions that infants do with their mouths. Several other interesting newborn reflexes can be observed. For instance, if you put your finger into a newborn's hand, you will witness the grasping reflex, in which a baby automatically grasps anything that touches his palms. The Moro reflex is the newborn's response when she feels like she is falling. The baby spreads her arms, pulls them back in, and then (usually) cries. How do you think these reflexes promote survival in the first months of life?

Take a few minutes to view this brief video clip illustrating several newborn reflexes: [Reflexes in newborn babies](#).



*One or more interactive elements has been excluded from this version of the text. You can view them online here: <https://louis.pressbooks.pub/intropsychology/?p=599#oembed-1>*

What can young infants see, hear, and smell? Newborn infants' sensory abilities are significant, but their senses are not yet fully developed. Many of a newborn's innate preferences facilitate interaction with caregivers and other humans. Although vision is their least developed sense, newborns already show a preference for faces. Babies who are just a few days old also prefer human voices, they will listen to voices longer than sounds that do not involve speech (Vouloumanos & Werker, 2004), and they seem to prefer their mother's voice over a stranger's voice (Mills & Melhuish, 1974). In an interesting experiment, 3-week-old babies were given pacifiers that played a recording of the infant's mother's voice and of a stranger's voice. When the infants heard their mother's voice, they sucked more strongly at the pacifier (Mills & Melhuish, 1974). Newborns also have a strong sense of smell. For instance, newborn babies can distinguish the smell of their own mother from that of others. In a study by MacFarlane (1978), 1-week-old babies who were being breastfed were placed between two gauze pads. One gauze pad was from the bra of a nursing mother who was a stranger, and the other gauze pad was from the bra of the infant's own mother. More than two-thirds of the week-old babies turned toward the gauze pad with their mother's scent.

## Physical Development

In infancy, toddlerhood, and early childhood, the body's physical development is rapid. On average, newborns

weigh between 5 and 10 pounds, and a newborn's weight typically doubles in 6 months and triples in 1 year. By 2 years old the weight will have quadrupled, so we can expect that a 2-year-old should weigh between 20 and 40 pounds. The average length of a newborn is 19.5 inches, increasing to 29.5 inches by 12 months and 34.4 inches by 2 years old (WHO Multicentre Growth Reference Study Group, 2006).



Children experience rapid physical changes through infancy and early childhood. (credit “left”: modification of work by Kerry Ceszyk; credit “middle-left”: modification of work by Kristi Fausel; credit “middle-right”: modification of work by “devinf”/Flickr; credit “right”: modification of work by Rose Spielman)

During infancy and childhood, growth does not occur at a steady rate (Carel, Lahlou, Roger, & Chaussain, 2004). Growth slows between 4 and 6 years old: During this time children gain 5–7 pounds and grow about 2–3 inches per year. Once girls reach 8–9 years old, their growth rate outpaces that of boys due to a pubertal growth spurt. This growth spurt continues until around 12 years old, coinciding with the start of the menstrual cycle. By 10 years old, the average girl weighs 88 pounds, and the average boy weighs 85 pounds.

We are born with all of the brain cells that we will ever have—about 100–200 billion neurons (nerve cells) whose function is to store and transmit information (Huttenlocher & Dabholkar, 1997). However, the nervous system continues to grow and develop. Each neural pathway forms thousands of new connections during infancy and toddlerhood. This *period of rapid neural growth* is called **blooming**. Neural pathways continue to develop through puberty. The blooming period of neural growth is then followed by a period of pruning, where neural connections are reduced. It is thought that pruning causes the brain to function more efficiently, allowing for mastery of more complex skills (Hutchinson, 2011). Blooming occurs during the first few years of life, and pruning continues through childhood and into adolescence in various areas of the brain.

The size of our brains increases rapidly. For example, the brain of a 2-year-old is 55% of its adult size, and by 6 years old the brain is about 90% of its adult size (Tanner, 1978). During early childhood (ages 3–6), the frontal lobes grow rapidly. Recalling our discussion of the 4 lobes of the brain earlier in this book, the frontal lobes are associated with planning, reasoning, memory, and impulse control. Therefore, by the time children reach school age, they are developmentally capable of controlling their attention and behavior. Through the elementary school years, the frontal, temporal, occipital, and parietal lobes all grow in size. The brain growth spurts experienced in childhood tend to follow Piaget’s sequence of cognitive development so that significant changes in neural functioning account for cognitive advances (Kolb & Whishaw, 2009; Overman, Bachevalier, Turner, & Peuster, 1992).

Motor development occurs in an orderly sequence as infants move from reflexive reactions (e.g., sucking and rooting) to more advanced motor functioning. For instance, babies first learn to hold their heads up, then to sit with assistance, and then to sit unassisted, followed later by crawling and then walking.

**Motor skills** refer to our ability to move our bodies and manipulate objects. **Fine motor skills** focus on the muscles in our fingers, toes, and eyes, and enable coordination of small actions (e.g., grasping a toy, writing with a pencil, and using a spoon). **Gross motor skills** focus on large muscle groups that control our arms and legs and involve larger movements (e.g., balancing, running, and jumping).

As motor skills develop, there are certain developmental milestones that young children should achieve. For each milestone there is an average age, as well as a range of ages in which the milestone should be reached. An example of a developmental milestone is sitting. On average, most babies sit alone at 7 months old. Sitting involves both coordination and muscle strength, and 90% of babies achieve this milestone between 5 and 9 months old. In another example, babies on average are able to hold up their head at 6 weeks old, and 90% of babies achieve this between 3 weeks and 4 months old. If a baby is not holding up his head by 4 months old, he is showing a delay. If the child is displaying delays on several milestones, that is reason for concern, and the parent or caregiver should discuss this with the child's pediatrician. Some developmental delays can be identified and addressed through early intervention.

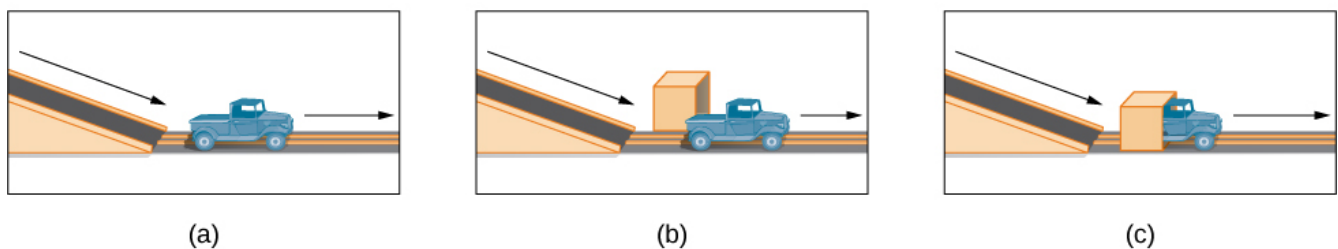
**Developmental Milestones, Ages 2–5 Years**

Age (years)	Physical	Personal/Social	Language	Cognitive
2	Kicks a ball; walks up and down stairs	Plays alongside other children; copies adults	Points to objects when named; puts 2–4 words together in a sentence	Sorts shapes and colors; follows 2-step instructions
3	Climbs and runs; pedals tricycle	Takes turns; expresses many emotions; dresses self	Names familiar things; uses pronouns	Plays make believe; works toys with parts (levers, handles)
4	Catches balls; uses scissors	Prefers social play to solo play; knows likes and interests	Knows songs and rhymes by memory	Names colors and numbers; begins writing letters
5	Hops and swings; uses fork and spoon	Distinguishes real from pretend; likes to please friends	Speaks clearly; uses full sentences	Counts to 10 or higher; prints some letters and copies basic shapes

## Cognitive Development

In addition to rapid physical growth, young children also exhibit significant development of their cognitive abilities. Piaget thought that children's ability to understand objects—such as learning that a rattle makes a noise when shaken—was a cognitive skill that develops slowly as a child matures and interacts with the environment. Today, developmental psychologists think Piaget was incorrect. Researchers have found that

even very young children understand objects and how they work long before they have experience with those objects (Baillargeon, 1987; Baillargeon, Li, Gertner, & Wu, 2011). For example, children as young as 3 months old demonstrated knowledge of the properties of objects that they had only viewed and did not have prior experience with them. In one study, 3-month-old infants were shown a truck rolling down a track and behind a screen. The box, which appeared solid but was actually hollow, was placed next to the track. The truck rolled past the box as would be expected. Then the box was placed on the track to block the path of the truck. When the truck was rolled down the track this time, it continued unimpeded. The infants spent significantly more time looking at this impossible event. Baillargeon (1987) concluded that they knew solid objects could not pass through each other. Baillargeon's findings suggest that very young children have an understanding of objects and how they work, which Piaget (1954) would have said is beyond their cognitive abilities due to their limited experiences in the world.



In Baillargeon's study, infants observed a truck (a) roll down an unobstructed track, (b) roll down an unobstructed track with an obstruction (box) beside it, and (c) roll down and pass through what appeared to be an obstruction.

Just as there are physical milestones that we expect children to reach, there are also cognitive milestones. It is helpful to be aware of these milestones as children gain new abilities to think, problem-solve, and communicate. For example, infants shake their head “no” around 6–9 months, and they respond to verbal requests to do things like “wave bye-bye” or “blow a kiss” around 9–12 months. Remember Piaget's ideas about object permanence? We can expect children to grasp the concept that objects continue to exist even when they are not in sight by around 8 months old. Because toddlers (i.e., 12–24 months old) have mastered object permanence, they enjoy games like hide and seek, and they realize that when someone leaves the room they will come back (Loop, 2013). Toddlers also point to pictures in books and look in appropriate places when you ask them to find objects.

Preschool-age children (i.e., 3–5 years old) also make steady progress in cognitive development. Not only can they count, name colors, and tell you their name and age, but they can also make some decisions on their own, such as choosing an outfit to wear. Preschool-age children understand basic time concepts and sequencing (e.g., before and after), and they can predict what will happen next in a story. They also begin to enjoy the use of humor in stories. Because they can think symbolically, they enjoy pretend play and inventing elaborate characters and scenarios. One of the most common examples of their cognitive growth is their blossoming curiosity. Preschool-age children love to ask “Why?”

An important cognitive change occurs in children this age. Recall that Piaget described 2-to-3-year-olds as egocentric, meaning that they do not have an awareness of others' points of view. Between 3 and 5 years old, children come to understand that people have thoughts, feelings, and beliefs that are different from their own. This is known as theory-of-mind (TOM). Children can use this skill to tease others, persuade their parents to purchase a candy bar, or understand why a sibling might be angry. When children develop TOM, they can recognize that others have false beliefs (Dennett, 1987; Callaghan et al., 2005).

False-belief tasks are useful in determining a child's acquisition of theory-of-mind (TOM). Take a look at this video clip showing a false-belief task involving a box of crayons: [The "False Belief" Test: Theory of Mind](#).



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Cognitive skills continue to expand in middle and late childhood (6–11 years old). Thought processes become more logical and organized when dealing with concrete information. Children at this age understand concepts such as the past, present, and future, giving them the ability to plan and work toward goals. Additionally, they can process complex ideas such as addition and subtraction and cause-and-effect relationships. However, children's attention spans tend to be very limited until they are around 11 years old. After that point, it begins to improve through adulthood.



Because they understand luck and fairness, children in middle and late childhood (6–11 years old) are able to follow rules for games. (credit: Edwin Martinez)

One well-researched aspect of cognitive development is language acquisition. As mentioned earlier, the order in which children learn language structures is consistent across children and cultures (Hatch, 1983). You’ve also learned that some psychological researchers have proposed that children possess a biological predisposition for language acquisition.

Starting before birth, babies begin to develop language and communication skills. At birth, babies apparently recognize their mother’s voice and can discriminate between the language(s) spoken by their mothers and foreign languages, and they show preferences for faces that are moving in synchrony with audible language (Blossom & Morgan, 2006; Pickens, 1994; Spelke & Cortelou, 1981).

Children communicate information through gesturing long before they speak, and there is some evidence that gesture usage predicts subsequent language development (Iverson & Goldin-Meadow, 2005). In terms of producing spoken language, babies begin to coo almost immediately. Cooing is a one-syllable combination of a consonant and a vowel sound (e.g., coo or ba). Interestingly, babies replicate sounds from their own languages. A baby whose parents speak French will coo in a different tone than a baby whose parents speak Spanish or Urdu. After cooing, the baby starts to babble. Babbling begins with repeating a syllable, such as ma-ma, da-da, or ba-ba. When a baby is about 12 months old, we expect her to say her first word for meaning and to start combining words for meaning at about 18 months.

At about 2 years old, a toddler uses between 50 and 200 words; by 3 years old they have a vocabulary of up to 1,000 words and can speak in sentences. During the early childhood years, children’s vocabulary increases at a rapid pace. This is sometimes referred to as the “vocabulary spurt” and has been claimed to involve an expansion in vocabulary at a rate of 10–20 new words per week. Recent research may indicate that while some children experience these spurts, it is far from universal (as discussed in Ganger & Brent, 2004). It has been estimated that 5-year-olds understand about 6,000 words, speak 2,000 words, and can define words and question their meanings. They can rhyme and name the days of the week. Seven-year-olds speak fluently and use slang and clichés (Stork & Widdowson, 1974).

What accounts for such dramatic language learning by children? Behaviorist B. F. Skinner thought that we learn language in response to reinforcement or feedback, such as through parental approval or through being understood. For example, when a 2-year-old child asks for juice, he might say, “Me juice,” to which his mother might respond by giving him a cup of apple juice. Noam Chomsky (1957) criticized Skinner’s theory and proposed that we are all born with an innate capacity to learn language. Chomsky called this mechanism a language acquisition device (LAD). Who is correct? Both Chomsky and Skinner are right. Remember that we are a product of both nature and nurture. Researchers now believe that language acquisition is partially inborn and partially learned through our interactions with our linguistic environment (Gleitman & Newport, 1995; Stork & Widdowson, 1974).

## Attachment

**Psychosocial development** *occurs as children form relationships, interact with others, and understand and manage their feelings.* In social and emotional development, forming healthy attachments is very important and is the major social milestone of infancy. Attachment is a long-standing connection or bond with others. Developmental psychologists are interested in how infants reach this milestone. They ask such questions as: How do parent and infant attachment bonds form? How does neglect affect these bonds? What accounts for children’s attachment differences?

Researchers Harry Harlow, John Bowlby, and Mary Ainsworth conducted studies designed to answer these questions. In the 1950s, Harlow conducted a series of experiments on monkeys. He separated newborn monkeys from their mothers. Each monkey was presented with two surrogate mothers. One surrogate monkey was made out of wire mesh, and she could dispense milk. The other monkey was softer and made from cloth: This monkey did not dispense milk. Research shows that the monkeys preferred the soft, cuddly cloth monkey, even though she did not provide any nourishment. The baby monkeys spent their time clinging to the cloth monkey and only went to the wire monkey when they needed to be fed. Prior to this study, the medical and scientific communities generally thought that babies become attached to the people who provide their nourishment. However, Harlow (1958) concluded that there was more to the mother-child bond than nourishment. Feelings of comfort and security are the critical components of maternal-infant bonding, which leads to healthy psychosocial development.

Harlow’s studies of monkeys were performed before modern ethics guidelines were in place, and today his experiments are widely considered to be unethical and even cruel. Watch this

video to see actual footage of Harlow's monkey studies: [Harlow's Studies on Dependency in Monkeys](#).



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Building on the work of Harlow and others, John Bowlby developed the concept of attachment theory. He defined **attachment** as *the affectional bond or tie that an infant forms with the mother* (Bowlby, 1969). An infant must form this bond with a primary caregiver in order to have normal social and emotional development. In addition, Bowlby proposed that this attachment bond is very powerful and continues throughout life. He used the concept of secure base to define a healthy attachment between parent and child (1988). A secure base is a parental presence that gives the child a sense of safety as he explores his surroundings. Bowlby said that two things are needed for a healthy attachment: The caregiver must be responsive to the child's physical, social, and emotional needs; and the caregiver and child must engage in mutually enjoyable interactions (Bowlby, 1969).



Mutually enjoyable interactions promote the mother-infant bond. (credit: Peter Shanks)

While Bowlby thought attachment was an all-or-nothing process, Mary Ainsworth's (1970) research showed otherwise. Ainsworth wanted to know if children differ in the ways they bond, and if so, why. To find the

answers, she used the Strange Situation procedure to study attachment between mothers and their infants (1970). In the Strange Situation, the mother (or primary caregiver) and the infant (age 12-18 months) are placed in a room together. There are toys in the room, and the caregiver and child spend some time alone in the room. After the child has had time to explore her surroundings, a stranger enters the room. The mother then leaves her baby with the stranger. After a few minutes, she returns to comfort her child.

Based on how the infants/toddlers responded to the separation and reunion, Ainsworth identified three types of **parent-child attachments**: *secure*, *avoidant*, and *resistant* (Ainsworth & Bell, 1970). A fourth style, known as disorganized attachment, was later described (Main & Solomon, 1990). The most common type of attachment—also considered the healthiest—is called **secure attachment**. In this type of attachment, *the toddler prefers his parent over a stranger*. The attachment figure is used as a secure base to explore the environment and is sought out in times of stress. Securely attached children were distressed when their caregivers left the room in the Strange Situation experiment, but when their caregivers returned, the securely attached children were happy to see them. Securely attached children have caregivers who are sensitive and responsive to their needs.



In secure attachment, the parent provides a secure base for the toddler, allowing him to securely explore his environment. (credit: Kerry Ceszyk)

With **avoidant attachment**, *the child is unresponsive to the parent, does not use the parent as a secure base, and does not care if the parent leaves*. The toddler reacts to the parent the same way she reacts to a stranger. When the parent does return, the child is slow to show a positive reaction. Ainsworth theorized that these children were