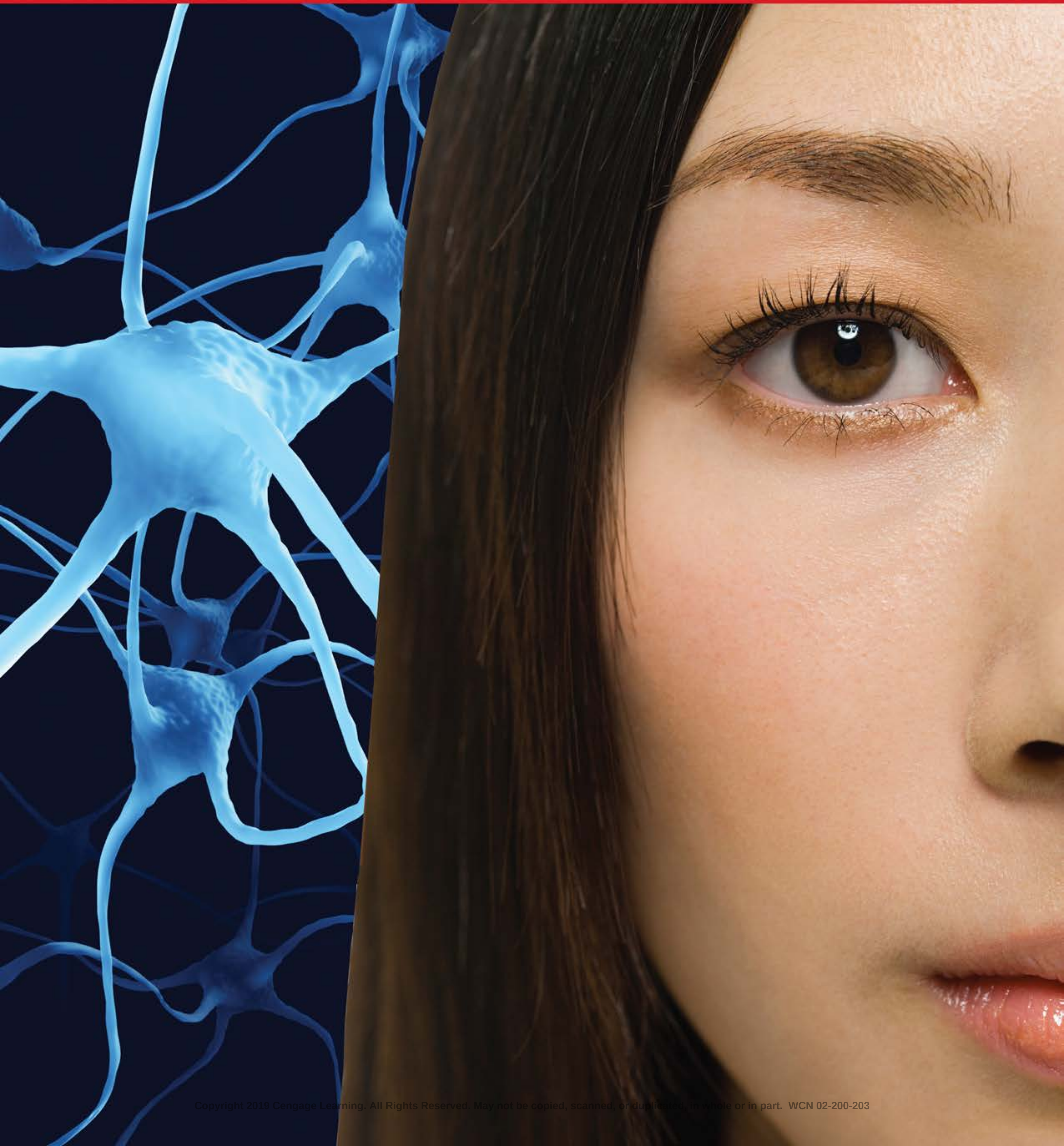
Biological PSYCHOLOGY

James W. Kalat

13e



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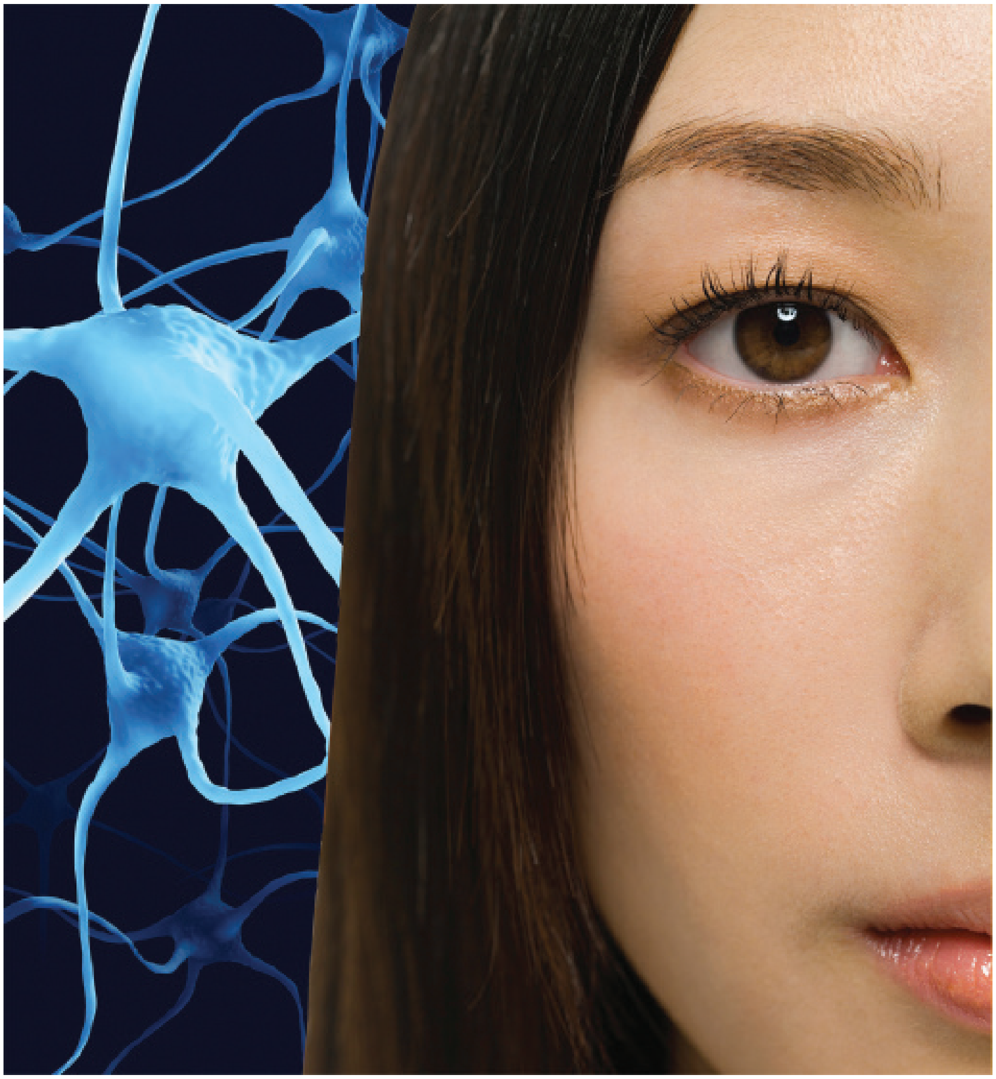
Biological Psychology

13th Edition



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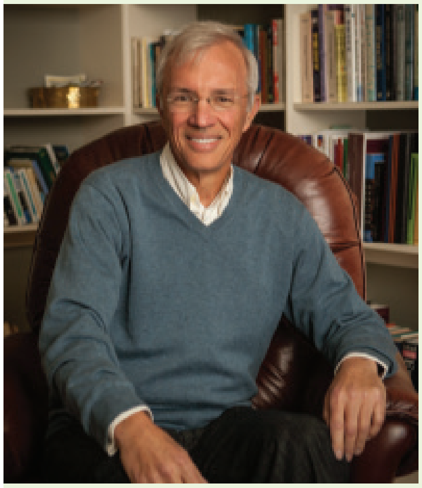

James W. Kalat (rhymes with ballot) is professor emeritus of psychology at North Carolina State University, where he taught courses in introduction to psychology and biological psychology from 1977 through 2012. Born in 1946, he received a BA summa cum laude from Duke University in 1968, and a PhD in psychology from the University of Pennsylvania in 1971. He is also the author of *Introduction to Psychology* (11th edition) and co-author with Michelle Shiota of *Emotion* (3rd edition). In addition to textbooks, he has written journal articles on taste-aversion learning, the teaching of psychology, and other topics. He was twice the program chair for the annual convention of the American Psychological Society, now named the Association for Psychological Science. A remarried widower, he has three children, two stepsons, and four grandchildren.

To my grandchildren.

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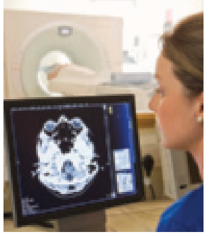

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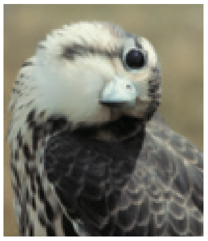

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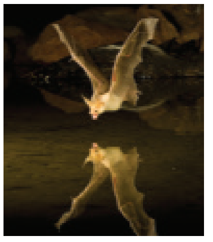

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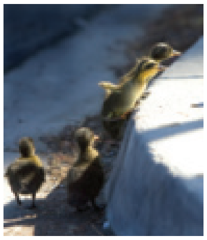

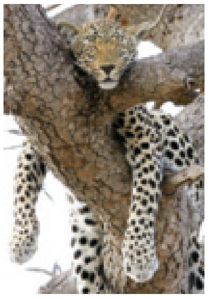

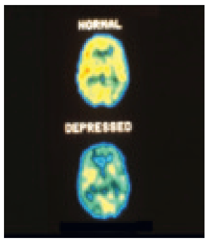
NORMAL
DEPRESSED

Preface

In the first edition of this text, published in 1981, I remarked, "I almost wish I could get parts of this text . . . printed in disappearing ink, programmed to fade within 10 years of publication, so that I will not be embarrassed by statements that will look primitive from some future perspective." I would say the same thing today, except that I would like for the ink to fade faster. Biological psychology progresses rapidly, and much that we thought we knew becomes obsolete.

Biological psychology is the most interesting topic in the world. No doubt many people in other fields think their topic is the most interesting, but they are wrong. This really is the most interesting. Unfortunately, it is easy to get so bogged down in memorizing facts that one loses the big picture. The big picture here is fascinating and profound: Your brain activity *is* your mind. I hope that readers of this book will remember that message even after they forget many of the details.

Each chapter is divided into modules that begin with an introduction and end with a summary, a list of key terms, and some review questions. This organization makes it easy for instructors to assign part of a chapter per day instead of a whole chapter per week. Modules can also be covered in a different order, or of course omitted.

I assume that readers have a basic background in psychology and biology, and understand such terms as *classical conditioning, reinforcement, vertebrate, mammal, gene, chromosome, cell,* and *mitochondrion.* I also assume at least a high school chemistry course. Those with a weak background in chemistry or a fading memory of it may consult Appendix A.

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Changes in This Edition

Reflecting the rapid changes in biological psychology, this edition includes revised content throughout, with almost 700 new references, including more than 550 from 2014 or later. Some of the figures are new or revised, and most of the review questions at the end of modules are new. The most extensive changes are in the later chapters. These organizational changes are worth notice: Chapter 9 ("Internal Regulation") includes a new section about anorexia nervosa. Chapter 12 ("Learning, Memory, and Intelligence") now has four modules instead of two. What used to be the first module has been split into two, and a new module has been added about intelligence. That module includes some material previously in the anatomy chapter, plus more, and all of it reorganized. In Chapter 13 ("Cognitive Functions"), the previous modules on lateralization and language have been shortened and combined into one module. The previous module on social neuroscience has been expanded with the addition of a section on the neurobiology of making decisions. In Chapter 14 ("Psychological Disorders"), the first module ("Substance Abuse") has been reorganized and reordered.

With regard to new or revised content, here are some of the highlights:

- This edition continues the tradition of including photographs and quotes of some prominent researchers, now adding Karl Deisseroth, Margaret McCarthy, May-Britt Moser and Edvard Moser, and Stanislas Dehaene. Students can name hundreds of singers, actors, and athletes. I think they should be able to identify some important researchers too, especially in the field in which they chose to major.
- Neuroscientists no longer believe that glia outnumber neurons in the human brain.
- Although many psychologists and others have explained risky adolescent behavior in terms of an

immature prefrontal cortex, that explanation looks less plausible. Between early adolescence and age 20, most risky behaviors *increase,* even while the prefrontal cortex is approaching maturity. Risky behavior more likely reflects increased drive for excitement.

- Current research indicates that astrocytes and scar tissue are more helpful than harmful for regrowth of axons.
- A new study found that people who lose a sensation as a result of brain damage also have trouble thinking about concepts related to that sensation. For example, someone with damage to the auditory cortex might regard "thunder" as a nonword.
- Previous data showed that acetaminophen decreases emotional pain. New data say that it also decreases pleasant experiences.
- The text includes updated information about the genetic basis of Parkinson's disease, substance abuse, depression, schizophrenia, and autism.
- Certain bird species sleep while they are flying over great distances. Frigate birds, which are large enough for researchers to monitor in the air, sometimes sleep in one hemisphere at a time, sometimes sleep briefly in both hemispheres at once, but overall get very little sleep on days when they are at sea.
- Thirst anticipates needs, and so does satiation of thirst. We stop drinking long before the water we have drunk reaches the cells that need it.
- New research sheds important light on male–female differences in brain anatomy. Because the mechanisms controlling male–female differences vary from one brain area to another, it is common for someone to have a patchwork of male-typical, female-typical, and approximately neutral anatomy in different brain areas.
- A new hypothesis holds that the rapid formation of new neurons in an infant hippocampus is responsible for both the ease of new learning and the phenomenon of infant amnesia. That is, infants learn rapidly, but also tend to forget episodic memories.
- Chapter 12 includes a new section about the role of the hippocampus and surrounding areas in control of navigation.
- Accumulating data cast doubt on the central role of dopamine in addictive behaviors.
- The previous belief that later episodes of depression get shorter and shorter was based on a methodological artifact. Many people have only one episode, possibly a very long one. Only people with short episodes get as far as, say, a 10th episode. Therefore, the mean duration of all first episodes is not comparable to the mean delay of later episodes.

I would also like to mention certain points about my writing style. You would not have noticed these points, and I know that you don't care either, but I shall mention them anyway: I avoid the term *incredible,* which has been so overused that it has lost its original meaning of "not believable." I also avoid the terms *intriguing, involved,* and *outrageous,* which are also overused and misused. Finally, I avoid the term *different* after a quantifier. For example, I would not say, "They offered four different explanations." If they offered four explanations, we can take it for granted that the explanations were different!

Instructor Ancillaries

***Biological Psychology,* 13th edition,** is accompanied by an array of supplements developed to facilitate both instructors' and students' best experience inside as well as outside the classroom. All of the supplements continuing from the 12th edition have been revised and updated. Cengage invites you to take full advantage of the teaching and learning tools available to you and has prepared the following descriptions of each.

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James W. Kalat

Overview and Major Issues

Introduction

Outline

Learning Objectives

After studying this introduction, you should be able to:

1. State the mind–brain problem and contrast monism with dualism.
2. List three general points that are important to remember from this text.
3. Give examples of physiological, ontogenetic, evolutionary, and functional explanations of behavior.
4. Discuss the ethical issues of research with laboratory animals.

It is often said that Man is unique among animals. It is worth looking at this term *unique* before we discuss our subject proper. The word may in this context have two slightly different meanings. It may mean: Man is strikingly different—he is not identical with any animal. This is of course true. It is true also of all other animals: Each species, even each individual, is unique in this sense. But the term is also often used in a more absolute sense: Man is so different, so "essentially different" (whatever that means) that the gap between him and animals cannot possibly be bridged—he is something altogether new. Used in this absolute sense, the term is scientifically meaningless. Its use also reveals and may reinforce conceit, and it leads to complacency and defeatism because it assumes that it will be futile even to search for animal roots. It is prejudging the issue.

Niko Tinbergen (1973, p. 161)

What is meant by the term *biological psychology*? In a sense, all psychology is biological. You are a biological organism, and everything you do or think is part of your biology. However, it is helpful to distinguish among levels of explanation. All of biology is chemical, and all of chemistry is physics, but we do not try to explain every biological observation in terms of protons and electrons. Similarly, much of psychology is best described in terms of cultural, social, and cognitive influences. Nevertheless, much of psychology is also best understood in terms of genetics, evolution, hormones, body physiology, and brain mechanisms. This textbook concentrates mostly on brain mechanisms, but also discusses the other biological influences. In this chapter, we consider three major issues: the relationship between mind and brain, the roles of nature and nurture, and the ethics of research. We also briefly consider career opportunities in this and related fields.

Opposite:

It is tempting to try to "get inside the mind" of people and other animals, to imagine what they are thinking or feeling. In contrast, biological psychologists try to explain behavior in terms of its physiology, development, evolution, and function. (© Renee Lynn/Corbis/VCG/Getty Images)

The Biological Approach to Behavior

Of all the questions that people ask, two stand out as the most profound and the most difficult. One of those questions deals with physics. The other pertains to the relationship between physics and psychology.

Gottfried Leibniz (1714/1989) posed the first of these questions: "Why is there something rather than nothing?" It would seem that nothingness would be the default state. Evidently, the universe—or whoever or whatever created the universe—had to be self-created.

So . . . how did that happen?

That question is supremely baffling, but a subordinate question is more amenable to discussion: Given the existence of a universe, why this particular kind of universe? Could the universe have been fundamentally different? Our universe has protons, neutrons, and electrons with particular dimensions of mass and charge. It has four fundamental forces—gravity, electromagnetism, the strong nuclear force, and the weak nuclear force. What would happen to the universe if any of these properties had been different?

Beginning in the 1980s, specialists in a branch of physics known as *string theory* set out to prove mathematically that this is the only possible way the universe could be. Succeeding in that effort would have been theoretically satisfying, but alas, as string theorists worked through their equations, they concluded that this is not the only possible universe. The universe could have taken a vast number of forms with different laws of physics. How vast a number? Imagine the number 1 followed by about 500 zeros. And that's the *low* estimate.

Of all those possible universes, how many could have supported life? Very few. Consider the following (Davies, 2006):

- If gravity were weaker, matter would not condense into stars and planets. If it were stronger, stars would burn brighter and use up their fuel too quickly for life to evolve.
- If the electromagnetic force were stronger, the protons within an atom would repel one another so strongly that atoms would burst apart.
- In the beginning was hydrogen. The other elements formed by fusion within stars. The only way to get those elements out of stars and into planets is for a star to explode as a supernova and send its contents out into the galaxy. If the weak nuclear force were *either* a bit stronger *or* a bit weaker, a star could not explode.
- Because of the exact ratio of the electromagnetic force to the strong nuclear force, helium (element 2 on the periodic table) and beryllium (element 4) go into resonance within a star, enabling them to fuse easily into carbon (element 6), which is essential to life as we know it. (It's hard to talk about life as we don't know it.) If either the electromagnetic force or the strong nuclear force changed slightly (less than one percent), the universe would have almost no carbon.
- The electromagnetic force is 10^{40} times stronger than gravity. If gravity were a bit stronger relative to the electromagnetic force, planets would not form. If it were a bit weaker, planets would consist of only gases.

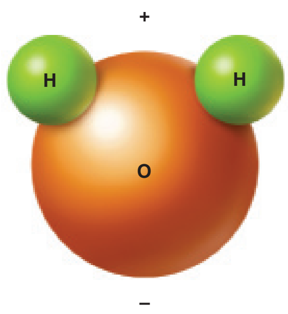

Figure Intro.1 A water molecule
Because of the hydrogen-oxygen-hydrogen angle, one end of a water molecule is more positive and the other negative. The exact difference in charge causes water molecules to attract one another just enough to be a liquid.

- The mass of a neutron is 0.14 percent greater than that of a proton. If the difference had been a little larger, all the hydrogen would have fused into helium, but the helium would not have fused into any of the heavier elements (Wilczek, 2015).
- Why is water (H_2O) a liquid? Similar molecules such as carbon dioxide, nitric oxide, ozone, and methane are gases except at extremely low temperatures. In a water molecule, the two hydrogen ions form a 104.5° angle (see Figure Intro.1). As a result, one end of the water molecule has a slight positive charge and the other has a slight negative charge. The difference is enough for water molecules to attract one another electrically. If they attracted one another a bit less, all water would be a gas (steam). But if water molecules attracted one another a bit more strongly, water would always be a solid (ice).

In short, the universe could have been different in many ways, nearly all of which would have made life impossible. Why is the universe the way it is? Maybe it's just a coincidence. (Lucky for us, huh?) Or maybe intelligence of some sort guided the formation of the universe. That hypothesis clearly goes beyond the reach of empirical science. A third possibility that many physicists favor is that a huge number of other universes (perhaps an infinite number) really *do* exist, and we of course know about only the kind of universe in which we could evolve. That hypothesis, too, goes beyond the reach of empirical science, as we cannot know about other universes. Will we ever know why the universe is the way it is? Maybe or maybe not, but the question is fascinating.

At the start I mentioned two profound and difficult questions. The second one is called the **mind–brain problem** or the **mind–body problem**, the question of how mind relates to brain activity. Put another way: Given a universe composed of matter and energy, why is there such a thing as consciousness? We can imagine how matter came together to form molecules, and how certain kinds of carbon compounds came together to form a primitive type of life, which then evolved into animals with brains and complex behaviors. But why are certain types of brain activity conscious?

So far, no one has offered a convincing explanation of consciousness. A few scholars have suggested that we abandon the concept of consciousness altogether (Churchland, 1986; Dennett, 1991). That proposal avoids the question, rather than answering it. Consciousness is something we experience, and it calls for an explanation, even if we do not yet see how to explain it. Chalmers (2007) and Rensch (1977) proposed,

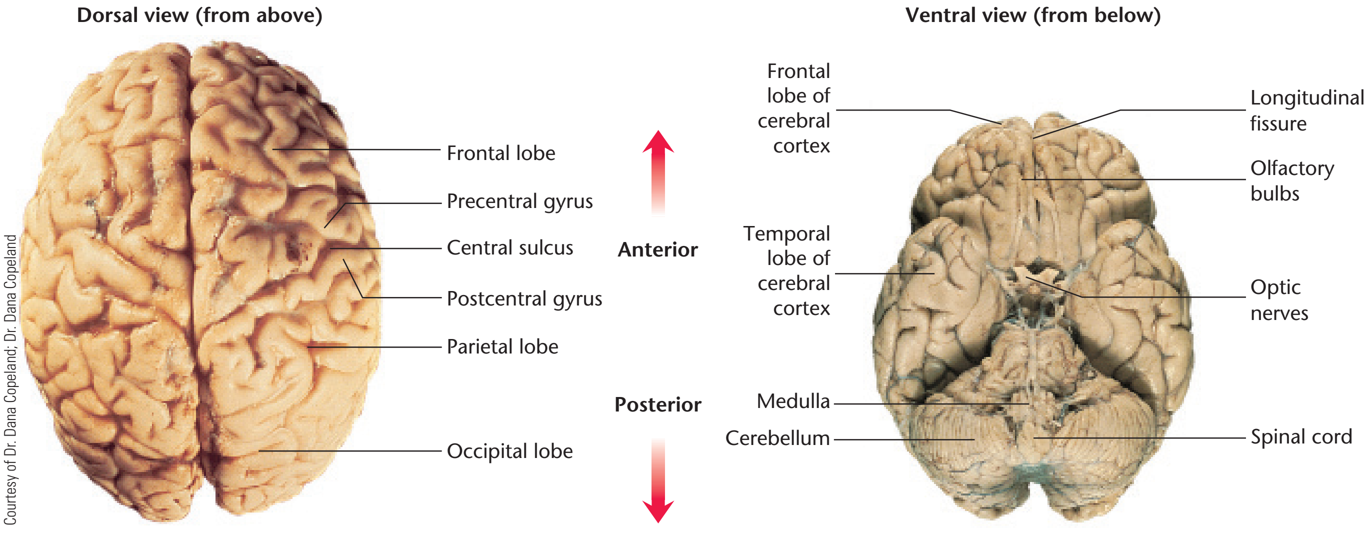

Figure Intro.2 Two views of the human brain
The brain has an enormous number of divisions and subareas; the labels point to a few of the main ones on the surface of the brain.

instead, that we regard consciousness as a fundamental property of matter. A fundamental property is one that cannot be reduced to something else. For example, mass and electrical charge are fundamental properties. Maybe consciousness is like that.

However, that is an unsatisfying answer. First, consciousness isn't like other fundamental properties. Matter has mass all the time, and protons and electrons have charge all the time. So far as we can tell, consciousness occurs only in certain parts of a nervous system, just some of the time—not when you are in a dreamless sleep, and not when you are in a coma. Besides, it's unsatisfying to call *anything* a fundamental property, even mass or charge. To say that mass is a fundamental property doesn't mean that there is no reason. It means that we have given up on finding a reason. And, in fact, contemporary physicists have not given up. They are trying to explain mass and charge in terms of the Higgs boson and other principles of the universe. To say that consciousness is a fundamental property would mean that we have given up on explaining it. Certainly it is too soon to give up. After we learn as much as possible about the nervous system, perhaps we shall understand what consciousness is all about. Even if not, the research will teach us much that is important and interesting.

The Field of Biological Psychology

Biological psychology is the study of the physiological, evolutionary, and developmental mechanisms of behavior and experience. It is approximately synonymous with the terms *biopsychology, psychobiology, physiological psychology,* and *behavioral neuroscience.* The term *biological psychology* emphasizes that the goal is to relate biology to issues of psychology. *Neuroscience* includes much that is relevant to behavior but also includes more detail about anatomy and chemistry.

Biological psychology is not only a field of study, but also a point of view. It holds that we think and act as we do because of brain mechanisms, and that we evolved those brain mechanisms because ancient animals built this way survived and reproduced.

Biological psychology deals mostly with brain activity. Figure Intro.2 offers a view of the human brain from the top (what anatomists call a *dorsal* view) and from the bottom (a *ventral* view). The labels point to a few important areas that will become more familiar as you proceed through this text. An inspection of a brain reveals distinct subareas. At the microscopic level, we find two kinds of cells: the *neurons* (Figure Intro.3)

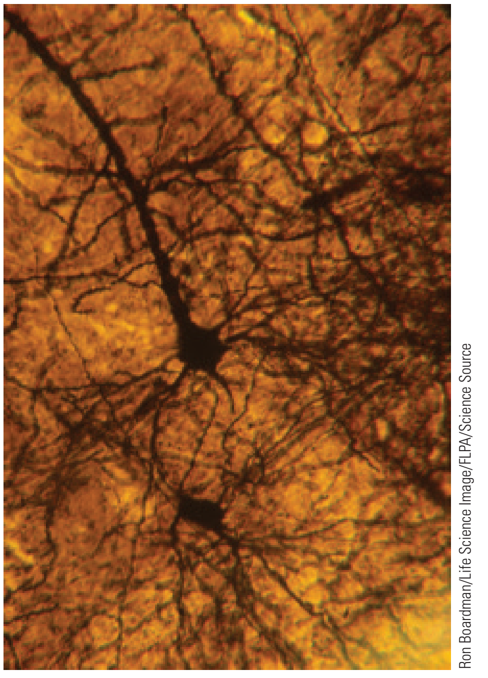

Figure Intro.3 Neurons, magnified
The brain is composed of cells called neurons and glia.

and the *glia*. Neurons, which convey messages to one another and to muscles and glands, vary enormously in size, shape, and functions. The glia, generally smaller than neurons, have many functions but do not convey information over great distances. The activities of neurons and glia somehow produce an enormous wealth of behavior and experience. This book is about researchers' attempts to elaborate on that word *somehow.*

Three Main Points to Remember from This Book

This book presents a great deal of factual information. How much of it will you remember a few years from now? If you enter a career in psychology, biology, or medicine, you might continue using a great deal of the information. Otherwise, you will inevitably forget many of the facts, although you will occasionally read about a new research study that refreshes your memory. Regardless of how many details you remember, at least three general points should stick with you forever:

1. Perception occurs in your brain. When something contacts your hand, the hand sends a message to your brain. You feel it in your brain, not your hand. (Electrical stimulation of your brain could produce a hand experience even if you had no hand. A hand disconnected from your brain has no experience.) Similarly, you see when light comes into your eyes. The experience is in your head, not "out there." You do NOT send "sight rays" out of your eyes, and even if you did, they wouldn't do you any good. The chapter on vision elaborates on this point.
2. Mental activity and certain types of brain activity are, so far as we can tell, inseparable. This position is known as **monism**, the idea that the universe consists of only one type of being. (The opposite is **dualism**, the idea that minds are one type of substance and matter is another.) Nearly all neuroscientists and philosophers support the position of monism. You should understand monism and the evidence behind it. The chapter on consciousness considers this issue directly, but nearly everything in the book pertains to the mind–brain relationship in one way or another.

   It is not easy to get used to the concept of monism. According to monism, your thoughts or experiences are the same thing as your brain activity. People sometimes ask whether brain activity causes thoughts, or whether thoughts direct the brain activity (e.g., Miller, 2010). According to monism, that question is like asking whether temperature causes the movement of molecules, or whether the movement of molecules causes temperature. Neither causes the other; they are just different ways of describing the same thing.
3. We should be cautious about what is an explanation and what is not. For example, people with depression have less than usual activity in certain brain areas. Does that evidence tell us *why* people became depressed? No, it does not. To illustrate, consider that people with depression also have less activity than normal in their legs. (They don't move around as much as other people do.) Clearly, the inactive legs did not cause depression. Suppose we also find that certain genes are less common than average among people with depression. Does that genetic difference explain depression? Again, it does not. It might be a useful step toward explaining depression, after we understand what those genes do, but the genetic difference itself does not explain anything. In short, we should avoid overstating the conclusions from any research study.

Biological Explanations of Behavior

Commonsense explanations of behavior often refer to intentional goals such as, "He did this because he was trying to . . ." or "She did that because she wanted to. . . ." But often, we have

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Researchers continue to debate the function of yawning. Brain mechanisms produce many behaviors that we engage in without necessarily knowing why.

no reason to assume intentions. A 4-month-old bird migrating south for the first time presumably does not know why. The next spring, when she lays an egg, sits on it, and defends it from predators, again she doesn't know why. Even humans don't always know the reasons for their own behaviors. Yawning and laughter are two examples. You do them, but can you explain what they accomplish? Intentions are, at best, a weak form of explanation.

In contrast to commonsense explanations, biological explanations of behavior fall into four categories: physiological, ontogenetic, evolutionary, and functional (Tinbergen, 1951). A **physiological explanation** relates a behavior to the activity of the brain and other organs. It deals with the machinery of the body—for example, the chemical reactions that enable hormones to influence brain activity and the routes by which brain activity controls muscle contractions.

The term *ontogenetic* comes from Greek roots meaning the origin (or genesis) of being. An **ontogenetic explanation** describes how a structure or behavior develops, including the influences of genes, nutrition, experiences, and their interactions. For example, males and females differ on average in several ways. Some of those differences can be traced to the effects of genes or prenatal hormones, some relate to cultural influences, many relate partly to both, and some await further research.

An **evolutionary explanation** reconstructs the evolutionary history of a structure or behavior. The characteristic features of an animal are almost always modifications of something found in ancestral species. For example, bat wings are modified arms, and porcupine quills are modified hairs. In behavior, monkeys use tools occasionally, and humans evolved elaborations on those abilities that enable us to use tools even better (Peeters et al., 2009). Evolutionary explanations call attention to behavioral similarities among related species.

A **functional explanation** describes *why* a structure or behavior evolved as it did. Within a small, isolated population, a gene can spread by accident through a process called *genetic drift.* For example, a dominant male with many offspring spreads all his genes, including some that may have been irrelevant to his success or even disadvantageous. However, a gene that is prevalent in a large population probably provided some advantage—at least in the past, though not necessarily today. A functional explanation identifies that advantage. For example, many species have an appearance that matches their background (see Figure Intro.4). A functional explanation is that camouflaged appearance makes the animal inconspicuous to predators. Some species use their behavior as part of the camouflage. For example, zone-tailed hawks, native to Mexico and the southwestern United States, fly among vultures and hold their wings in the same posture as vultures. Small mammals and birds run for cover when they see a hawk, but they learn to ignore vultures, which pose no threat to healthy animals. Because the zone-tailed hawks resemble vultures in both appearance and flight behavior, their prey disregard them, enabling the hawks to pick up easy meals (Clark, 2004).

To contrast the four types of biological explanation, consider how they all apply to one example, birdsong (Catchpole & Slater, 1995):

Steve Maslowski/Science Source

Unlike other birds, doves and pigeons can drink with their heads down. Others fill their mouths and then raise their heads. A physiological explanation would describe these birds' nerves and throat muscles. An evolutionary explanation states that all doves and pigeons share this behavioral capacity because they inherited their genes from a common ancestor.

Kris Wiktor/Shutterstock.com

Figure Intro.4 A seadragon, an Australian fish related to the seahorse, lives among kelp plants, looks like kelp, and usually drifts slowly, *acting* like kelp.
A functional explanation is that potential predators overlook a fish that resembles inedible plants. An evolutionary explanation is that genetic modifications expanded smaller appendages that were present in these fish's ancestors.

Type of Explanation	Example from Birdsong
Physiological	A particular area of a songbird brain grows under the influence of testosterone; hence, it is larger in breeding males than in females or immature birds. That brain area enables a mature male to sing.
Ontogenetic	In certain species, a young male bird learns its song by listening to adult males. Development of the song requires certain genes and the opportunity to hear the appropriate song during a sensitive period early in life.
Evolutionary	Certain pairs of species have similar songs. For example, dunlins and Baird's sandpipers, two shorebird species, give their calls in distinct pulses, unlike other shorebirds. The similarity suggests that the two evolved from a single ancestor.
Functional	In most bird species, only the male sings. He sings only during the reproductive season and only in his territory. The functions of the song are to attract females and warn away other males.

STOP & CHECK

1. How does an evolutionary explanation differ from a functional explanation?

ANSWER

1. An evolutionary explanation states what evolved from what. For example, humans evolved from earlier primates and therefore have certain features that we inherited from those ancestors, even if the features are not useful to us today. A functional explanation states why something was advantageous and therefore favored by natural selection.

Career Opportunities

If you want to consider a career related to biological psychology, you have a range of options relating to research and therapy. Table Intro.1 describes some of the major fields.

A research position ordinarily requires a PhD in psychology, biology, neuroscience, or other related field. People with a master's or bachelor's degree might work in a research laboratory but would not direct it. Many people with a PhD hold college or university positions, where they perform some combination of teaching and

Table Intro.1 | Fields of Specialization

Specialization	Description
Research Fields	**Research positions ordinarily require a PhD. Researchers are employed by universities, hospitals, pharmaceutical firms, and research institutes.**
Neuroscientist	Studies the anatomy, biochemistry, or physiology of the nervous system. (This broad term includes any of the next five, as well as other specialties not listed.)
Behavioral neuroscientist (almost synonyms: psychobiologist, biopsychologist, or physiological psychologist)	Investigates how functioning of the brain and other organs influences behavior.
Cognitive neuroscientist	Uses brain research, such as scans of brain anatomy or activity, to analyze and explore people's knowledge, thinking, and problem solving.
Neuropsychologist	Conducts behavioral tests to determine the abilities and disabilities of people with various kinds of brain damage, and changes in their condition over time. Most neuropsychologists have a mixture of psychological and medical training; they work in hospitals and clinics.
Psychophysiologist	Measures heart rate, breathing rate, brain waves, and other body processes and how they vary from one person to another or one situation to another.
Neurochemist	Investigates the chemical reactions in the brain.
Comparative psychologist (almost synonyms: ethologist, animal behaviorist)	Compares the behaviors of different species and tries to relate them to their ways of life.
Evolutionary psychologist (almost synonym: sociobiologist)	Relates behaviors, especially social behaviors, including those of humans, to the functions they have served and, therefore, the presumed selective pressures that caused them to evolve.
Practitioner Fields of Psychology	**Require a PhD, PsyD, or master's degree. In most cases, their work is not directly related to neuroscience. However, practitioners often need to understand it enough to communicate with a client's physician.**
Clinical psychologist	Employed by hospital, clinic, private practice, or college; helps people with emotional problems.
Counseling psychologist	Employed by hospital, clinic, private practice, or college. Helps people make educational, vocational, and other decisions.

Table Intro.1 | Fields of Specialization (*Continued*)

Specialization	Description
School psychologist	Most are employed by a school system. Identifies educational needs of schoolchildren, devises a plan to meet the needs, and then helps teachers implement it.
Medical Fields	**Require an MD plus about four years of additional specialized study and practice. Physicians are employed by hospitals, clinics, medical schools, and in private practice. Some conduct research in addition to seeing patients.**
Neurologist	Treats people with brain damage or diseases of the brain.
Neurosurgeon	Performs brain surgery.
Psychiatrist	Helps people with emotional distress or troublesome behaviors, sometimes using drugs or other medical procedures.
Allied Medical Field	**Ordinarily require a master's degree or more. Practitioners are employed by hospitals, clinics, private practice, and medical schools.**
Physical therapist	Provides exercise and other treatments to help people with muscle or nerve problems, pain, or anything else that impairs movement.
Occupational therapist	Helps people improve their ability to perform functions of daily life, for example, after a stroke.
Social worker	Helps people deal with personal and family problems. The activities of a social worker overlap those of a clinical psychologist.

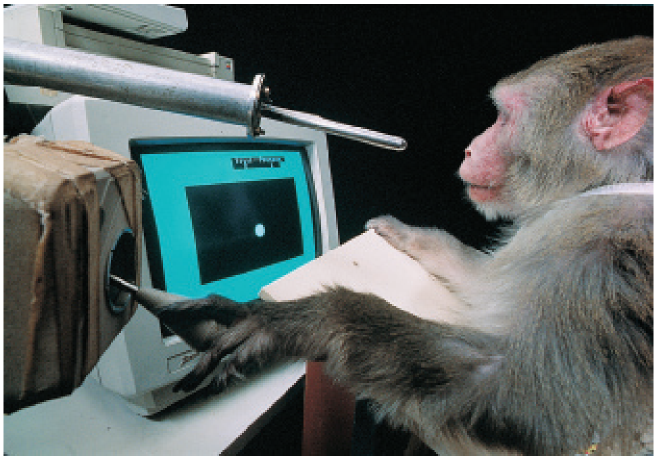
research. Others have pure research positions in laboratories sponsored by the government, drug companies, or other industries.

Fields of therapy include clinical psychology, counseling psychology, school psychology, medicine, and allied medical practice such as physical therapy. These fields range from neurologists (who deal exclusively with brain disorders) to social workers and clinical psychologists, who need to recognize possible signs of brain disorder so they can refer a client to a proper specialist.

Anyone who pursues a career in research needs to stay up to date on new developments by attending conventions, consulting with colleagues, and reading research journals, such as *The Journal of Neuroscience, Neurology, Behavioral Neuroscience, Brain Research,* and *Nature Neuroscience.* But what if you are entering a field on the outskirts of neuroscience, such as clinical psychology, school psychology, social work, or physical therapy? In that case, you probably don't want to wade through technical journal articles, but you do want to stay current on major developments, at least enough to converse intelligently with medical colleagues. You can find much information in the magazine *Scientific American Mind* or at websites such as the Dana Foundation at www.dana.org.

The Use of Animals in Research

Certain ethical disputes resist agreement. One is abortion. Another is the use of animals in research. In both cases, well-meaning people on each side of the issue insist that their position is proper and ethical. The dispute is not a matter of the good guys against the bad guys. It is between two views of what is good.


Explorer/Science Source


Oxygen Group/David M. Barron

Animals are used in many kinds of research studies, some dealing with behavior and others with the functions of the nervous system.