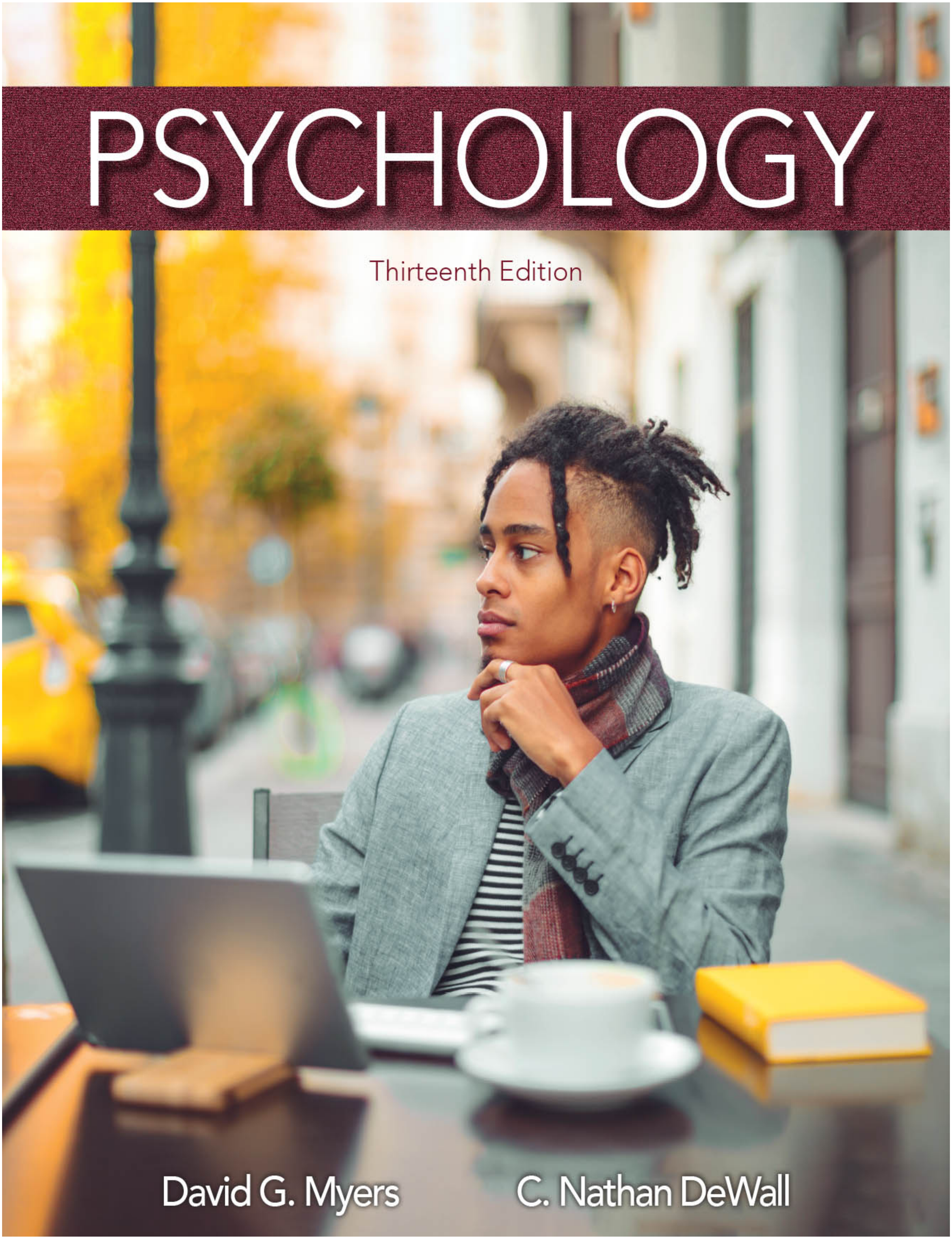
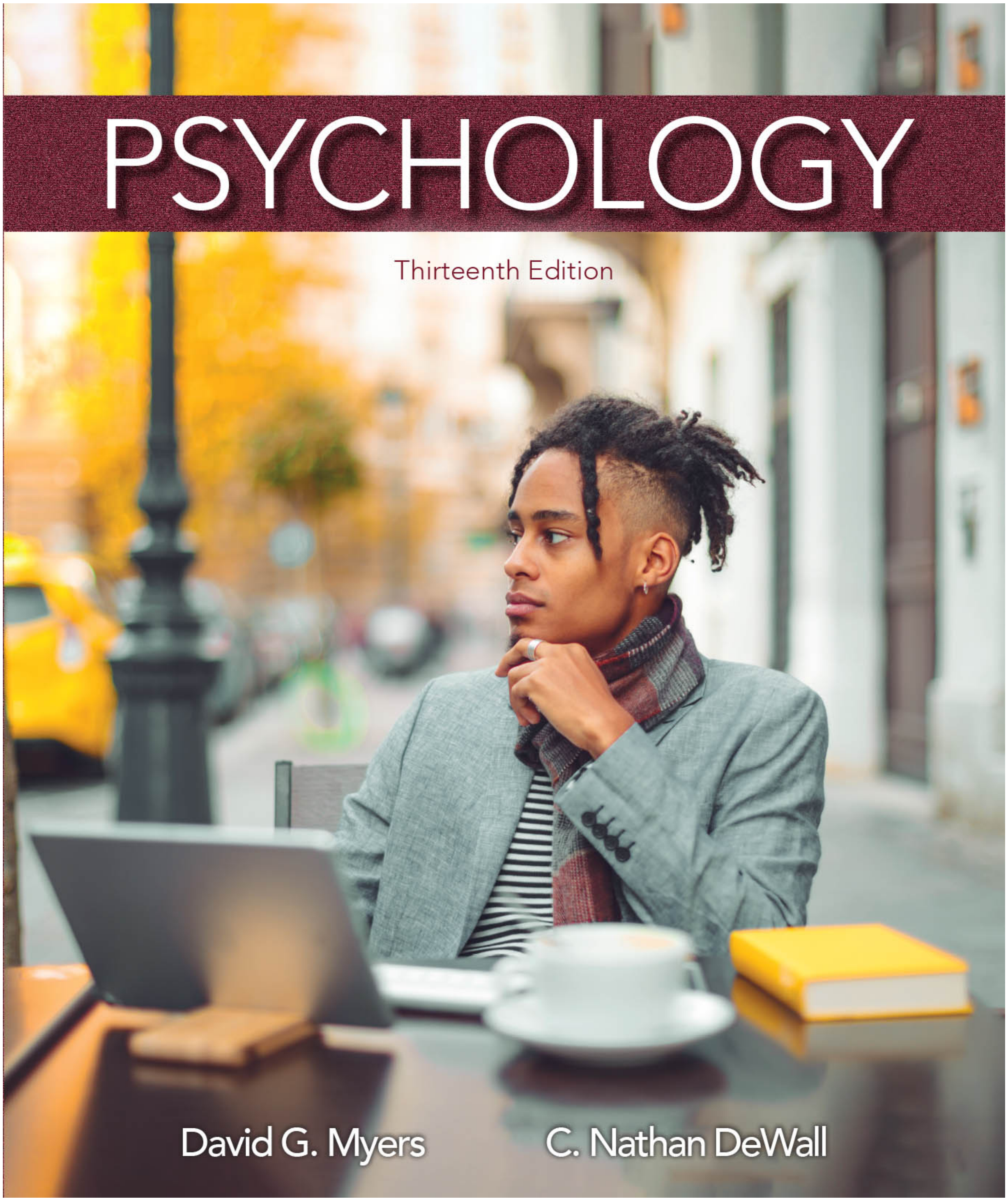
PSYCHOLOGY

Thirteenth Edition



David G. Myers C. Nathan DeWall



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Thirteenth Edition

David G. Myers

C. Nathan DeWall

Psychology

THIRTEENTH EDITION

David G. Myers
Hope College
Holland, Michigan

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University of Kentucky
Lexington, Kentucky

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To John Sargent, with gratitude for his enduring friendship and support, and his example of progressive corporate leadership.

DM

•

To Barb Gillilan: A loving aunt, skilled nurse, and inspiration to many.

ND

About the Authors

Photographer Steven Herppich, courtesy of Hope College Public Affairs and Marketing

David Myers received his B.A. in chemistry from Whitworth University, and his psychology Ph.D. from the University of Iowa. He has spent his career at Michigan's Hope College, where he has taught dozens of introductory psychology sections. Hope College students have invited him to be their commencement speaker and voted him "outstanding professor." His research and writings have been recognized by the Gordon Allport Intergroup Relations Prize, an Honored Scientist award from the Federation of Associations in

Behavioral & Brain Sciences, an Award for Distinguished Service on Behalf of Social-Personality Psychology, a Presidential Citation from APA Division 2, election as an American Association for the Advancement of Science Fellow, and three honorary doctorates.

With support from National Science Foundation grants, Myers' scientific articles have appeared in three dozen scientific periodicals, including *Science, American Scientist, Psychological Science,* and *American Psychologist.* In addition to his scholarly and textbook writing, he digests psychological science for the general public. His writings have appeared in four dozen magazines, from *Today's Education* to *Scientific American.* He has authored five general audience books, including *The Pursuit of Happiness* and *Intuition: Its Powers and Perils.* And he blogs about psychology and life at TalkPsych.com.

David Myers has chaired his city's Human Relations Commission, helped found a thriving assistance center for families in poverty, and spoken to hundreds of college, community, and professional groups worldwide.

Drawing on his experience, he also has written articles and a book *(A Quiet World)* about hearing loss, and he is advocating a transformation in American assistive listening technology (see HearingLoop.org). For his leadership, he has received awards from the American Academy of Audiology, the hearing industry, and the Hearing Loss Association of America.

David and Carol Myers met and married while undergraduates, and have raised sons Peter and Andrew, and a daughter, Laura. They have one grandchild, Allie (see p. 177).

J.A. Laub Photography, LLC

Nathan DeWall is professor of psychology at the University of Kentucky. He received his bachelor's degree from St. Olaf College, a master's degree in social science from the University of Chicago, and a master's degree and Ph.D. in social psychology from Florida State University. DeWall received the College of Arts and Sciences Outstanding Teaching Award, which recognizes excellence in undergraduate and graduate teaching. The Association for

Psychological Science identified DeWall as a “Rising Star” early in his career for “making significant contributions to the field of psychological science.” He is in the top 1 percent of all cited scientists in psychology and psychiatry on the Institute for Scientific Information list, according to the Web of Science.

DeWall conducts research on close relationships, self-control, and aggression. With funding from the National Institutes of Health, the National Science Foundation, and the John Templeton Foundation, he has published over 200 scientific articles and chapters. DeWall’s research awards include the SAGE Young Scholars Award from the Foundation for Personality and Social Psychology, the Young Investigator Award from the International Society for Research on Aggression, and the Early Career Award from the International Society for Self and Identity. His research has been covered by numerous media outlets, including *Good Morning America, The Wall Street Journal, Newsweek, The Atlantic Monthly, The New York Times, The Los Angeles Times, Harvard Business Review, USA Today,* National Public Radio, the BBC, and *The Guardian*. He has lectured nationally and internationally, including in Hong Kong, China, the Netherlands, England, Greece, Hungary, Sweden, Australia, and France.

Nathan is happily married to Alice DeWall and is the proud father of Beverly “Bevy” and Ellis. He enjoys playing with his two golden retrievers, Finnegan and Atticus. As an ultramarathon runner, he completed numerous races, including the Badwater 135 in 2017 (dubbed “the World’s toughest foot race”). In his spare time now, he writes novels, watches sports, and plays guitar and sings in a rock band called *Roar Shock*.

Brief Contents

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Instructor Preface

From its first edition, this text has focused on teaching ***critical thinking,*** and helping students understand the ***research*** underlying psychological discoveries. We've expanded that focus in this new edition. (See p. xii to learn more about the Myers/DeWall research and critical thinking story.) This new edition offers 2100 research citations dated 2015–2020, making these ***the most up-to-date introductory psychology course resources available.*** With so many exciting new findings, and every chapter updated with current new examples and ideas, students will see the importance and value of psychological research, and how psychology can help them make sense of the world around them. For example, we discuss new research on how the COVID-19 pandemic may affect: our need to belong (Chapter 11), the social responsibility norm and prejudice (Chapter 13), and suicidal behavior (Chapter 15). The abundant, high quality teaching and learning resources in ***LaunchPad*** and in ***Achieve Read & Practice***, carefully matched to the text content, help students succeed, and help make life easier and more enjoyable for instructors. Our integrated resources help bring students to class better prepared, and offer instructors more ways to engage them.

APA Introductory Psychology Initiative, and Learning Goals and Outcomes for the Psychology Major

As of our press date, the American Psychological Association (APA) was scheduled to release the results of its **Introductory Psychology Initiative (IPI)** in August, 2020 in hopes of improving "the quality of the introductory psychology experience" (APA.org/Ed/Precollege/Undergrad/Introductory-Psychology-Initiative). The APA IPI, with its five "Integrative Themes" and six "Student Learning Outcomes," encourages instructors to integrate these themes throughout the course, with regular opportunities for practicing, thinking, and communicating about them, and regular assessment of student understanding.

In summary, the APA IPI encourages instructors to use the ***five Integrative Themes*** to help students (1) adapt their thinking in response to empirical evidence; (2) recognize general principles but individual differences; (3) acknowledge biological, psychological, and social-cultural influences; (4) be aware of perceptual and thinking errors; and (5) apply psychology's principles to improve their own lives.

The ***six Learning Outcomes*** charge students to (1) fully understand the five themes; (2) apply psychology in their daily lives; (3) use empirical evidence in judgments and decision making; (4) evaluate claims using psychological science; (5) design, carry out, and evaluate research studies; and (6) know ethical principles for research and therapy.

Psychology, Thirteenth Edition, and its resources offer a perfect match for those interested in following these new guidelines, with full text coverage of relevant content, and abundant student and classroom activities and assessment opportunities (see **TABLE 1** and **TABLE 2**).

TABLE 1 APA 2020 Introductory Psychology Initiative's *Expected *Integrative Themes*

APA's Five "Integrative Themes"	APA's "Sample Concepts or Ideas"
a. Psychological science relies on empirical evidence, adapts as new data develop.	• Experimental methods • Statistics • Memory models • Subliminal perception • Therapy interventions
b. Psychology explains general principles that govern behavior, while recognizing individual differences.	• Intelligence • Resilience • Personality testing • Supertasters • Synesthesia
c. Psychological, biological, social, and cultural factors influence mental processes and behavior.	• Psychological disorders • Aging • Health and wellness • Attachment • Personality theories
d. Our perceptions filter experience of the world through an imperfect personal lens.	• Perceptual illusions • Schemas • Cognitive errors

	• Self-serving bias • Ingroup bias
e. Applying psychological principles can change our lives in positive ways.	• Psychotherapy • Study skills • Coping • Conflict resolution • Behavioral change

*NOTE that these are the *expected* integrative themes—from the July 2019 APA Summit on Introductory Psychology. As of our press date, final recommendations were scheduled to be released in August, 2020. ***For final Integrative Themes, please see APA.org/Ed/Precollege/Undergrad/Introductory-Psychology-Initiative.***

TABLE 2 *Psychology,* Thirteenth Edition, Corresponds to APA 2020 Introductory Psychology Initiative's *Expected *Student Learning Outcomes*

APA's Six Student Learning Outcomes	*Psychology,* Thirteenth Edition, Coverage
1. Identify basic concepts and research findings, and give examples of psychology's integrative themes.	This first outcome is content-based, challenging students to demonstrate the five "Integrative Themes" outlined in Table 1. *Psychology,* Thirteenth Edition, offers a compelling and complete survey of the field, including all of the "Sample Concepts or Ideas" outlined in Table 1.
1. a. Psychological science relies on empirical evidence and adapts as new data develop.	• The ***empirical approach*** is introduced as a key term on p. 2, and the reality that psychology is a science and that research matters is emphasized throughout the text. See Preface section ***"Myers/DeWall Research and Critical Thinking Story"*** (p. xii). • In addition, David Myers regularly blogs at ***TalkPsych,*** where he shares the most exciting new psychological science discoveries, how the field is adapting in response, and how psychology helps explain the rapidly changing world around us.
	• Since the first edition of this text, one of Myers and DeWall's "Eight

1. b. Psychology explains general principles that govern behavior, while recognizing individual differences.	Guiding Principles" has been ***"to convey respect for human unity and diversity."*** Readers will learn about human kinship in our shared biology and need for affiliation; our shared mechanisms for learning and remembering, emotional expression, and the stress response; and our shared vulnerability to perceptual and thinking errors. Yet they will learn much about our individual diversity—in development and aptitudes, temperament and characteristics, sexual orientation and gender identity, attitudes and motivations, disorder and health—and about cultural and other group variations.
1. c. Psychological, biological, social, and cultural factors influence mental processes and behavior.	• The ***biopsychosocial approach*** is introduced in the Prologue and carried through the rest of the book, with regular narrative reflections on the biological, psychological, and social/cultural factors influencing our understanding of behavior and mental processes. The text includes flow charts outlining the biopsychosocial influences on key topics, including development, aging, disordered drug use, learning, sexual motivation, aggressive behavior, personality, and psychological disorder.
1. d. Our perceptions filter our experiences of the world through an imperfect personal lens.	• The Chapter 6 discussion of ***"Processing Sensations and Perceptions"*** outlines the impressive strengths and numerous weaknesses in our ability to detect and interpret incoming stimuli. Other coverage of our "imperfect personal lens" includes: cognitive errors (Chapter 9), ingroup bias (Chapter 13), and self-serving bias (Chapter 14).
1. e. Applying psychological principles can change our lives in positive ways.	• This edition has a new student preface—***Student Success: How to Apply Psychology to Live Your Best Life.*** This preface offers brief discussions of "Thinking Critically and Scientifically," "Self-Control and Self-Improvement," "Time Management and Study Tips," "Social Life," and "Finding Meaning and Pursuing Goals." • New ***"Ask Yourself"*** questions appear throughout each chapter to help students apply what they are learning to improve their own lives. This helps make the material more meaningful and memorable. • ***Self-applications*** are built into the narrative throughout the text, including "Use Psychology to Become a Stronger Person—and a Better Student" in the Prologue, tips for getting a "Better Night's Sleep" in

	Chapter 3, goal-setting to “Change Your Own Behavior” in Chapter 7, “Goal-Setting” strategies in Chapter 11, “Improving Memory” in Chapter 8, ways to “boost the creative process” in Chapter 9, building a “Growth Mindset” in Chapter 10, “Tips for Weight Management” in Chapter 11, “Connecting and Social Networking” in Chapter 11, “Evidence-Based Suggestions for a Happier Life” in Chapter 12, guidance for coping with stress in Chapter 12, “How to Be Persuasive” in Chapter 13, “Cognitive Therapy Techniques” in Chapter 16, “When should a person seek therapy and what should people look for when selecting a therapist?” in Chapter 16, “Therapeutic Lifestyle Change” in Chapter 16, and tips for finding “flow” in Appendix C. • In the ***“Assess Your Strengths” activities*** in LaunchPad, students apply what they are learning from the text to their own lives and experiences by considering key “strengths.” Students assess themselves on the strength (critical thinking, quality of sleep, self-control, relationship strength, and more), then get guidance for nurturing that strength in their own lives. • The value of ***community psychology*** and preventive mental health work is discussed in the Prologue, Chapter 16, and Appendix B. Related discussions include: the social toxicity of extreme income inequality (Chapter 12), the importance of community communication (Chapter 13), and the relationship of poverty and empowering communities to mental disorders (Chapter 15).
2. Apply psychological principles to everyday life.	• Since the first edition of the text, one of the “eight guiding principles” has been “to provide applications of principles.” The authors strive throughout to make psychology meaningful and memorable to students by showing how it relates to their lives. (See above examples.)
3. Draw appropriate, logical, and objective conclusions about behavior and mental processes from empirical evidence.	• There are ***“Thinking Critically About…” infographics,*** with associated activities in LaunchPad, for every chapter to guide students to consider available empirical evidence before drawing conclusions. Topics include parenting styles, gender bias, sexual aggression, effects of violence-viewing, lie detection, and introversion. • Chapter 9 outlines the obstacles to effective decision making, judgment, and problem solving, including confirmation bias, fixation, mental set, representativeness and availability heuristics, overconfidence, belief perseverance, and framing.
4. Evaluate	• “To teach critical thinking” has been the first of the “Eight Guiding

misconceptions or erroneous behavioral claims based on evidence from psychological science.	Principles" that have guided Myers and DeWall's work on this text since the first edition. • Table 4 in the Preface (p. xiv) outlines coverage of "Critical Examinations of Pop Psychology," "Thinking Critically With Psychological Science," and "Scientific Detective Stories." • Chapter 1 offers a new section on "Psychological Science in a Post-Truth World," which is accompanied by Myers' new tutorial animation "Thinking Critically in Our Post-Truth World" in LaunchPad, and also at tinyurl.com/PostTruthMyers. • There is coverage integrated throughout of misconceptions related to diversity, including prejudice toward various "outgroups," and the value in embracing diverse perspectives (see p. xii).
5. Design, conduct, or evaluate basic psychological research.	• "How Would You Know?" ***research activities for each chapter*** in LaunchPad allow students to play the role of researcher as they design and interpret studies. Students consider possible confounding factors and other issues that affect interpretation of results. Students learn about how key decision points can alter the meaning and value of a psychological study, and they develop scientific literacy skills in the process. Topics include "How Would You Know If a Cup of Coffee Can Warm Up Relationships?," "How Would You Know If People Can Learn to Reduce Anxiety?", and "How Would You Know If Schizophrenia Is Inherited?" • ***New research-oriented iClicker questions,*** based on research presented in the text, are available for each chapter, helping build student understanding of research design and interpretation.
6. Describe ethical principles that guide psychologists in research and therapy.	• The Chapter 1 section "Research Strategies: How Psychologists Ask and Answer Questions" includes discussion of "Psychology's Research Ethics," with a ***new section on "Ensuring Scientific Integrity"*** as well as coverage of "Studying and Protecting Animals," "Studying and Protecting Humans," and "Values in Psychology." • Chapter 16, Therapy, has new coverage of ***Ethical Principles in Psychotherapy*** and the ***Ethics of Research on Mental Illness.***

*NOTE that these are the *expected* Student Learning Outcomes—from the July 2019 APA Summit on Introductory Psychology. As of our press date, final recommendations were scheduled to be released in August, 2020. ***For final Student Learning Outcomes, please see APA.org/Ed/Precollege/Undergrad/Introductory-Psychology-Initiative.***

In addition, **APA's 2013 Learning Goals and Outcomes,** from their *Guidelines for the Undergraduate Psychology Major,* Version 2.0, were designed to gauge progress in students graduating with psychology majors. (See apa.org/ed/precollege/about/psymajor-guidelines.pdf.) Many psychology departments use these goals and outcomes to help establish their own benchmarks for departmental assessment purposes. **TABLE 3** outlines the way *Psychology,* Thirteenth Edition, can help you and your department to address the APA's Learning Goals and Outcomes. There is a detailed APA Correlation Guide in LaunchPad's Instructor Resources for this thirteenth edition. In addition, ***all of the Test Bank items for this text are coded for the APA Outcomes.***

TABLE 3 ***Psychology,*** **Thirteenth Edition, Corresponds to APA Learning Goals**

Relevant Feature from *Psychology,* Thirteenth Edition	APA Learning Goals				
	Knowledge Base in Psychology	Scientific Inquiry and Critical Thinking	Ethical and Social Responsibility in a Diverse World	Communication	Professional Development
Text content	•	•	•	•	•
Myers/DeWall research and critical thinking story	•	•	•		
"Thinking Critically About…" infographics and their new	•	•	•		

LaunchPad activities					
“Learning Objective Questions” previewing main sections	•	•			
“Retrieval Practice” self-tests throughout	•	•	•		
New “Ask Yourself” questions integrated throughout	•	•	•	•	•
“Try this” style activities integrated throughout the text and LaunchPad resources	•	•		•	•
“Mastering the Material” self-tests	•	•		•	
“Psychology at Work” appendix	•	•	•	•	•
“The Story of Psychology” timeline (Appendix A)	•		•		•
“Career Fields in Psychology”	•		•		•

appendix, with “Pursuing a Psychology Career” online appendix					
LearningCurve adaptive quizzing	•	•	•	•	•
“Assess Your Strengths” activities in LaunchPad	•	•	•	•	•
“How Would You Know?” research activities in LaunchPad	•	•	•	•	•
New research-oriented iClicker questions	•	•	•		

Myers/DeWall Research and Critical Thinking Story

2100 References Dated 2015–2020

The most important task for us as your authors is to report the current state of psychology, including each sub-discipline’s latest research insights. Thus, you will find 2100 references in this edition dated 2015–2020. A lot has changed since 2014: Barack Obama is no longer the U.S. president, #MeToo and the COVID-19 pandemic have happened, a little-known app called Instagram now has over a billion users, and efforts to improve replicability in psychological science have ramped up dramatically.

The end-of-book ***References*** section highlights these 2100 recent citations in blue. The work of writing this text is mostly reading: With thousands of studies published each year, it takes a daily effort to keep up with all that is happening in our exciting field. In winnowing new research findings, we consider:

- *Reliability*: Does either replication or the inherent scale of the finding make it trustworthy?
- *Importance*: Is this, for psychology, a significant new finding? And is this something an educated person needs to know?
- *Clarity*: Is this something our readers could understand and remember?

The new findings met these high standards for inclusion. Each confirms key concepts or informs the way we present them. The remaining thousands of reference citations include important classic studies that have formed the structure of our discipline.

We all want students to walk away with the most accurate, current understandings of psychology to apply in their own lives and work. Having the latest research engages students so much more effectively. Here are two examples of new research areas—from just the last couple of years—that are important for students' understanding of psychological science and its application in their lives.

1. *People often spurn those with differing worldviews, yet the recent scientific evidence we share in this new edition demonstrates value in embracing diverse perspectives:*
    - Diverse scientific teams make more scientific breakthroughs (AlShebli et al., 2018; see Chapter 13, under Antisocial Relations).
    - Children raised with competent, secure, and nurturing care can flourish regardless of parents' gender and sexual orientation (Calzo et al., 2019; see Chapter 5, under Infancy and Childhood).
    - People who identify as transgender have a more positive therapeutic experience when therapists affirm them (Bettergarcia & Israel, 2018; see Chapter 16, under Evaluating Psychotherapies).
    - Politically conservative and liberal people are similarly biased against those who hold differing political views (Ditto et al., 2019a,b; see Chapter 1, under Research Strategies: How Psychologists Ask and Answer Questions).
    - Social media communication often occurs in an ideological vacuum, in which we surround ourselves with mostly like-minded individuals (Hills, 2019; see Chapter 13, under Social Influence).

2. *Social media use has soared, and the new research we present in Chapters 1 and 11 explores correlational, longitudinal, and*

experimental studies of its possible effects, such as on depression and suicidal thoughts in teen girls.

Other new, student-relevant research explores

- navigating our "post-truth" world,
- understanding how gene–environment interactions affect us,
- distinguishing substance use from abuse,
- weighing parent/peer influences on our development,
- appreciating our unique sensory and perceptual windows on the world,
- figuring out how to learn and remember most effectively,
- successfully connecting socially with others to build our health and well-being,
- understanding gender identity and sexual orientation,
- learning about our hunger and sexual motivations,
- coping with stress and determining how to thrive,
- recognizing inborn personality variations,
- dealing with the challenges of mental illness,
- appreciating *neurodiversity* (including those on the autism spectrum, and those challenged by ADHD, a learning disorder, or brain injury),
- finding hope in psychological and biomedical therapies, and
- seeking "flow" in our daily lives and work.

Expanded Focus on Critical Thinking and Research

Throughout the text, we help students ***think critically.*** By examining sources and evidence, students can apply psychology's concepts to their own lives and to their studies—using evidence-based principles to boost their relationships, academic success, stress-management, and so much more (see **TABLE 4**). "To teach critical thinking" has been the first of the "Eight Guiding Principles" that have guided our work on this text since the first edition. (See p. xxvii.) The first subsection in the text's Prologue is headed *"Psychology Is a Science,"* and Chapter 1 takes a critical-thinking approach to introducing students to psychology's research methods. "Critical thinking" is a key term on p. 3 and is encouraged throughout the text and its resources.

New resources include:

- a new ***Student Preface,*** "Student Success: How to Apply Psychology to Live Your Best Life," which includes discussion of "Thinking Critically and Scientifically."
- a new Chapter 1 section on ***"Psychological Science in a Post-Truth World"*** (accompanied by my [DM's] new tutorial animation, "Thinking Critically in Our Post-Truth World" in LaunchPad, and also at tinyurl.com/PostTruthMyers),
- new Chapter 1 coverage of ***"Ensuring Scientific Integrity,"***
- new Chapter 16 coverage of ***Ethical Principles in Psychotherapy*** and the ***Ethics of Research on Mental Illness,***
- new ***research-oriented iClicker questions*** for each chapter, contributed by Jennifer Zwolinski (University of San Diego), and
- new ***"Thinking Critically About…" infographic activities*** (along with our popular "How Would You Know" research design activities) for every chapter in LaunchPad.

TABLE 4 Critical Thinking and Scientific Inquiry

Critical thinking* coverage and in-depth stories of psychology's process of *scientific inquiry

can be found on the following pages:

Critical Examinations of Pop Psychology:
The need for psychological science, pp. 22–24
Perceiving order in random events, pp. 23–24
Do we use only 10 percent of our brain?, p. 80
Near-death experiences, p. 118
Critiquing the evolutionary perspective, pp. 139–140

Independent and dependent variables, pp. 36–37
Choosing the right research design, p. 38
Statistical reasoning, pp. 44–48
Describing data, pp. 44–46
Making inferences, pp. 47–48
The evolutionary perspective on human sexuality, pp. 138–140

Scientific Detective Stories:
Superforecasters avoid overconfidence, p. 23
Big data enables naturalistic observation, p. 28
Girls' social media use and risk of depression and self-harm, pp. 35–36

What causes depressive disorders and bipolar disorders?, pp. 574–578
Do prenatal viral infections increase the risk of schizophrenia?, p. 582
Is psychotherapy effective?, pp. 612–615

What's New in the Thirteenth Edition?

In addition to our thorough, line-by-line updating of every chapter, and our ongoing efforts to make no assumptions about student readers' gender identity, sexual orientation, culture, relationship or family status, age, economic background, or physical ability, we offer much that is new in this thirteenth edition:

1. **Over 2100 research citations dated 2015–2020**. Our ongoing scrutiny of dozens of scientific periodicals and science news sources, enhanced by commissioned reviews and countless emails from instructors and students, enables integrating our field's most important, thought-provoking, and student-relevant new discoveries. Part of the pleasure that sustains this work is

learning something new every day! ***See MacmillanLearning.com for a chapter-by-chapter list of significant Content Changes.***

2. **More support for teaching that *psychology is a science,* and that *critical thinking* and research matter!** (See "Expanded Focus on Critical Thinking and Research," p. xiii.)
3. **NEW Student Preface—*Student Success: How to Apply Psychology to Live Your Best Life.*** When we ask our teaching colleagues to share the most important lessons they wish to impart to students, they often tell us they want to teach students to ***think critically,*** and to ***apply psychology to their own lives*** so that they can live better and be more successful. This brief new Student Success preface, which previews relevant resources in the text and in LaunchPad, helps get students on the right path with sections on
   - Thinking Critically and Scientifically,
   - Self-Control and Self-Improvement,
   - Time Management and Study Tips,
   - Social Life, and
   - Finding Meaning and Pursuing Goals.
4. **Improved, updated coverage of gender identity and sexual orientation.** A lot has changed in the field of psychology since the last edition was written, especially in the fast-moving subfields of human sexuality and gender psychology. We sought extra reviews from experts and instructors and made extensive updates to this coverage. In Chapter 4, Chapter 11, and elsewhere, we've worked to be appropriately inclusive and fully up-to-date in our presentation—representing the abundance of current research in this area, but also encompassing the lived experiences of many people, which may not yet be well represented in the literature.

5. **Ask Yourself Questions.** New "Ask Yourself" questions appear periodically throughout each chapter to help students apply what they are learning to their own lives. This helps make the material more meaningful, and more memorable. These questions are repeated in the Lecture Guides, for use as classroom discussion starters. We continue to offer "Assess Your Strengths" personal self-assessments in LaunchPad, allowing students to actively apply key principles to their own experiences and develop their strengths.
6. **"Thinking Critically About …" Infographic Activities.** All of these infographics in the text have been revised and updated for the new edition, with two entirely new pieces on "Sexual Aggression" (Chapter 4) and "How to Be Persuasive" (Chapter 13; see **FIGURE 1**). They are also now accompanied by ***new corresponding activities in LaunchPad.***
7. **Active Learning.** Our Instructor's Resources have long been considered the "gold standard" in the field, and they nicely support students' active learning in class. There are additional NEW Classroom Exercises, Student Projects, Demonstrations, and Lecture/Discussion Topics that work well for think-pair-share, small-group, and large-group activities. These new activities for each chapter cover diversity in psychology and were created by Salena Brody (University of Texas, Dallas).
8. **New research and research design-oriented iClicker questions.** We have new iClicker questions for each chapter, written by Jennifer Zwolinski (University of San Diego), that help engage students on research topics, such as designing an effective study, understanding the component parts of key research that's

presented in the text, and weighing the implications of research results.

Sample "Ask Yourself" questions Here are two samples, taken from Chapter 5, Developing Through the Life Span, and Chapter 12, Emotions, Stress, and Health.

ASK YOURSELF

Are you the same person you were as a preschooler? As an 8-year-old? As a 12-year-old? How are you different? How are you the same?

ASK YOURSELF

Imagine a situation in which you would like to change the way you feel. How could you do so by altering your facial expressions or the way you carry yourself? In what other settings could you apply your knowledge of these feedback effects?

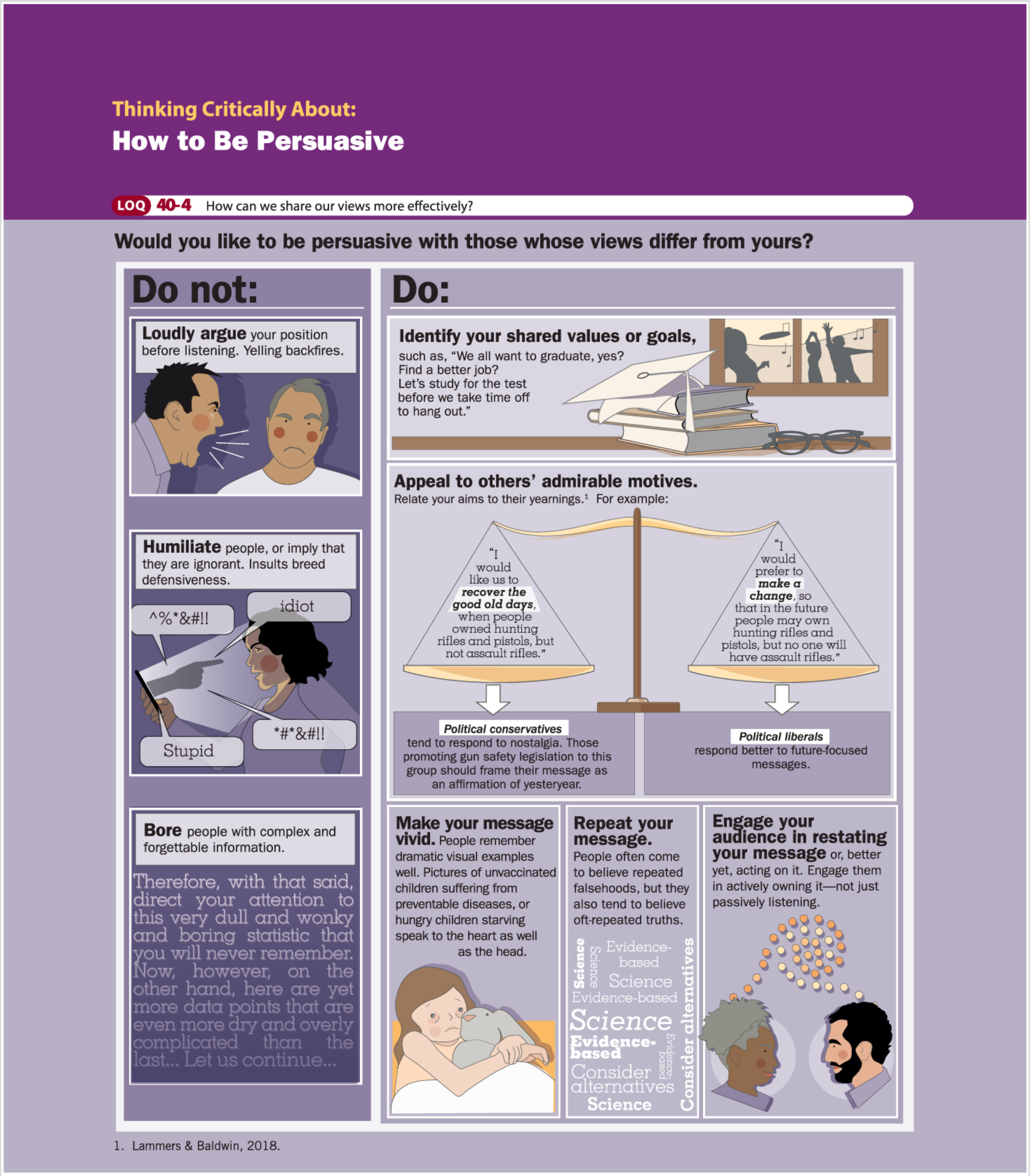

FIGURE 1 Sample "Thinking Critically About" infographic

Why Should I Use *Psychology*, Thirteenth Edition, and Its Resources?

There are several reasons we think you should consider using this text and its resources for your classes:

1. **These resources are *top quality*.** Our resources offer *up-to-date, carefully checked content and assessment you can rely on,* with a study system that follows best practices from learning and memory research. This new thirteenth edition includes *2100 citations* dated 2015–2020, representing the field's most important, thought-provoking, and student-relevant new discoveries. We have worked with dozens of helpful reviewers, and with our editors we have run the text manuscript through *eight* drafts. Our dedicated Media and Test Bank authors and editors have focused similar intensity on their work. (For example, our 10,000 Test Bank questions go through four stages of checking to ensure there is appropriate, useful coverage for each new edition, and that different levels and kinds of questions have been included.)
2. **This text and its resources *make life easier for instructors*.** We've imagined the worst-case scenario of being asked to teach a course on a Friday and being ready to teach on a Monday. Step 1: Assign a book students tell us they love! Step 2: You have what you need with *LaunchPad's full course solution* (e-book, LearningCurve adaptive quizzing and other assessments, iClicker questions, classroom activities and other Instructor Resources, abundant videos, and numerous engaging student tutorials and activities for each chapter—all reporting to an easy-to-use gradebook). Or you may opt for the simplified (and extra-affordable) *Achieve Read & Practice* (e-book and LearningCurve adaptive quizzing, reporting to a gradebook with analytics on student performance). These engaging, integrated, top-notch options are both ready to use as is, with a default courses set up, or you can readily tweak them to suit your needs. Our popular LearningCurve adaptive quizzing system has been shown to bring students to class better

prepared, and help them do better in class. We've included callouts from the text pages to especially pertinent, helpful online resources. (See **FIGURE 2** for a sample.)

For an animated tutorial on correlations, engage online with ***Concept Practice: Positive and Negative Correlations.*** See also the ***Video: Correlational Studies*** for another helpful tutorial animation.

FIGURE 2 Sample LaunchPad callout from Chapter 1

3. **Macmillan Learning offers students *affordable options.*** The digital-only, rental, or looseleaf options compete with Open Educational Resources (OER) printouts on price, and far surpass OER on success in the course for students, and ease of use and success for instructors.
4. **We wrote this text to be *inclusive of diverse student readers.*** From the first edition, we have endeavored to make no assumptions in terms of students' gender identity, sexual orientation, culture, relationship or family status, age, economic background, or physical ability. The text includes abundant, integrated coverage of psychology's diversity, and plenty of everyday life applications to draw all students into the content. Since this text's first edition, one of its Eight Guiding Principles has been "To convey respect for human unity and diversity." This edition offers an even more thoroughly **cross-cultural perspective** on psychology, with a world-based presentation for our worldwide student readers. We have included important new research and fresh examples from around the world in our efforts to help students understand

human behavior in a broad sense, and to expose students to the world beyond their own culture. Salena Brody (University of Texas, Dallas) created new classroom activities for each chapter covering diversity in psychology topics, and she revised our newly illustrated Timeline (Appendix A) to reflect the many contributions from women and people of color to the history of psychology. (See **TABLE 5**, The Psychology of Gender, Gender Identity, and Sexuality, and **TABLE 6**, The Psychology of Cultural Diversity and Inclusion.)

TABLE 5 The Psychology of Gender, Gender Identity, and Sexuality

Coverage of the *psychology of gender, gender identity, and sexuality* can be found on the following pages:

TABLE 6 The Psychology of Cultural Diversity and Inclusion

Coverage of the *psychology of cultural diversity and inclusion* can be found on the following pages:

adolescence, pp. 189–190, 196–197 attachment, pp. 180–181, 183, 184–185 child raising, pp. 149–150 cognitive development, p. 179 moral development, pp. 192–193 parenting styles, pp. 143–144, 186–188 social development, pp. 194–196	second languages and, pp. 343–344, 346, 349–350 sign language, pp. 342, 344 universal grammar, p. 341 verbal interaction encouraged in, p. 150	Psychological disorders definitions of "normality," pp. 552–553 dissociative identity disorder, p. 586 eating disorders, pp. 590–591 rates of, pp. 560–561 schizophrenia, pp. 554, 581–582 somatic symptoms, p. 566 stress and, p. 554 suicide and, p. 557 *susto,* p. 554 *taijin kyofusho,* p. 554 treatment of, p. 618	Well-being, pp. 438–439 *See also* Chapter 4: Nature, Nurture, and Human Diversity, and Chapter 13: Social Psychology.

5. **These resources teach *critical thinking*.** See p. xiii and Table 4 for details and a deeper list of coverage.
6. **This text offers excellent *neuroscience* coverage, maps almost exactly to the MCAT Behavioral Sciences Section, and is perfect for nursing and premed students.** We have continued to improve our strong neuroscience, behavior genetics, and evolutionary psychology coverage in this new edition, reflecting the dynamic nature of these subfields. See **TABLE 7** and **TABLE 8** for a list of topics covered. *Psychology,* Thirteenth Edition, al*so* maps well onto the MCAT's behavioral sciences section. Since 2015, the

MCAT has devoted 25 percent of its questions to the "Psychological, Social, and Biological Foundations of Behavior." The new section's topics match up almost exactly with the topics in this text. See **TABLE 9** for a sample. For a complete pairing of the MCAT behavioral science topics with this book's contents, see the MCAT Correlation Guide provided in LaunchPad's Instructor Resources. In addition, the Test Bank questions for *Psychology,* Thirteenth Edition, are keyed to the MCAT behavioral science section's topics.

TABLE 7 Neuroscience

In addition to the coverage found in Chapter 2, *neuroscience* can be found on the following pages:

- Aggression, pp. 496–497
- Aging: physical exercise and the brain, p. 202
- Animal cognition, pp. 337–338
- Animal language, pp. 346–347
- Antisocial personality disorder, pp. 588–589
- Arousal, pp. 397–398
- Attention-deficit hyperactivity disorder (ADHD) and the brain, p. 595
- Autism spectrum disorder (ASD), pp. 592–594
- Biofeedback, p. 461
- Biological psychology, p. 52
- Dual processing, pp. 92–93, 193, 228, 247
- Electroconvulsive therapy, pp. 625–626
- Emotion and cognition, pp. 418–422
- Fear-learning, pp. 264, 568–569
- Fetal alcohol syndrome and brain abnormalities, pp. 170–171
- Frequent head trauma, risks of, pp. 73–74
- Functional connectivity, p. 81
- Hallucinations, p. 97
    - hallucinogens and, pp. 79, 117–119
- Meditation, pp. 88–89, 246, 439, 461–464
    - mindfulness and mindfulness meditation, pp. 463–464
- Memory
    - emotional memories, pp. 304–305
    - explicit and implicit memories, pp. 296–298
    - physical storage of, pp. 302–306
    - sleep and, p. 100
    - synaptic changes and, pp. 305–306
- Mirror neurons, pp. 284–286
- Pain, pp. 243–245
    - controlling pain, pp. 246–247
    - experienced and imagined pain, pp. 245, 285–286
    - phantom limb pain, p. 245
- Parallel processing, pp. 93, 228, 294
- Perception
    - brain damage and, p. 228
    - color vision, pp. 225–226
    - feature detection, p. 227
    - transduction, pp. 212–213
    - visual information

in infancy and childhood, pp. 173–174 pruning and, pp. 100, 142, 173, 190, 253 sexual differentiation in utero, p. 155 Brain imaging techniques, pp. 66–69, 73 Cognitive neuroscience, pp. 9, 68, 89–90 Drug use, pp. 120–121 adolescent brain development and, p. 113	sleep and, pp. 99, 101, 102 stress and, pp. 170, 181, 185, 304, 315, 422–423, 446–447, 449, 451, 453–454, 566 weight control and, pp. 392 Hunger, pp. 387–389 Insight, pp. 85, 327, 333–334, 462 Intelligence, pp. 354–357 creativity, pp. 334–336 twins, pp. 370–371 Language, pp. 345–346, 375 deafness and, p. 345 thinking in images and, pp. 350–351	in memory, pp. 305–306 in obsessive-compulsive disorder, pp. 608–609 in schizophrenia, pp. 583, 623 sleep and, p. 104 temperament and, pp. 131–132, 182–184 Observational learning and brain imaging, pp. 283, 284 Optimum arousal: brain mechanisms for rewards, pp. 383–384, 385 Orgasm, p. 395	smell, pp. 248–250 synesthesia, p. 253 taste, pp. 247–248 touch, p. 243 vision, pp. 221–236 Sexual orientation, pp. 402–404 Sleep cognitive development and, p. 108 memory and, pp. 100, 104, 107 recuperation during, p. 100 Smell and emotion, p. 250 Social support, p. 458 Unconscious mind, pp. 525–526

TABLE 8 Behavior Genetics and Evolutionary Psychology

In addition to the coverage found in Chapter 4, *behavior genetics* is covered on the following pages:			
Abuse, intergenerational transmission of, pp. 185, 287 Adaptability, p. 75 Aggression, pp. 495–500 intergenerational transmission of,	Drug use, pp. 120–123 Eating disorders, pp. 589–591 Epigenetics, pp. 11, 133–134, 170, 185, 373, 403, 522, 554–555, 568, 576, 583 Happiness, pp. 438–440 Hunger and taste preference, p. 390	Pain, pp. 243–247 Parenting styles, pp. 186–187 Perception, pp. 235–236 Personality traits, pp. 532–537 Psychological disorders and ADHD, pp. 594–595	Reward deficiency syndrome, p. 73 Romantic love, pp. 206–207 Sexual dysfunctions, p. 396

Biological predispositions in learning, pp. 278–280 in operant conditioning, pp. 280–281 Brainstem, pp. 69–70 Classical conditioning, pp. 264, 279–280 Cognitive development, p. 179 Darwin, Charles, pp. 6, 10 Emotion, effects of facial expressions and, pp. 430–431	Fear, pp. 331, 569 Feature detection, p. 227 Fight or flight, p. 445 Gender development, p. 151 Gene–environment interaction, pp. 133–134 Hearing, pp. 238–239 Hunger and taste preference, p. 390 Instincts, pp. 382–383	companionate, p. 506 Math and spatial ability, p. 375 Mating preferences, pp. 138–140 Memory, adaptive, p. 305 Nature–nurture, p. 161 Need to belong, pp. 407–408 Obesity, p. 392 Overconfidence, p. 332 Perceptual adaptation, p. 236 Prejudice, p. 492	171 Sensory adaptation, p. 216 Sexual orientation, pp. 399–405 Sexuality, pp. 138–140, 394–395, 399–405 Sleep, pp. 95, 99–101, 104 Smell, pp. 248–249 Taste, pp. 247–248 Therapeutic lifestyle change, p. 621 *See also* Chapter 2: The Biology of Behavior.

TABLE 9 Sample MCAT Correlation With *Psychology*, Thirteenth Edition

MCAT 2015 Content Category 6C: Responding to the world	***Psychology*, Thirteenth Edition, Correlations**	**Page Numbers**
Emotion	Emotion: Introduction to emotion; Expressing emotion; Experiencing emotion	417–440
Three components of emotion (i.e., cognitive, physiological, behavioral)	Emotion: Arousal, behavior, and cognition	417–422
Universal emotions (e.g., fear, anger, happiness, surprise, joy, disgust, and sadness)	Culture and emotional expression—including the universal emotions	428–430
	Experiencing emotion—including the	432–440

	basic emotions	
Adaptive role of emotion	Emotion as the body's adaptive response	418, 422–423, 433–434, 445–446
	Emotions and the autonomic nervous system	422–423
Theories of emotion *James-Lange theory* *Cannon-Bard theory* *Schachter-Singer theory* *Zajonc; LeDoux; Lazarus*	James-Lange theory: Arousal comes before emotion Cannon-Bard theory: Arousal and emotion occur simultaneously Schachter and Singer two-factor theory: Arousal + label = emotion Zajonc, LeDoux, and Lazarus: Does cognition always precede emotion?	418–419 419 419–420 420–422
The role of biological processes in perceiving emotion	Emotions and the autonomic nervous system	422–423
Brain regions involved in the generation and experience of emotions	The physiology of emotions—including the brain's pathways for emotions	420–422, 423
	Zajonc, LeDoux, and Lazarus: Does cognition always precede emotion?	420–422
The role of the limbic system in emotion	Emotions and the autonomic nervous system The limbic system	422–423 71–72
	Physiological differences among specific emotions	423–424
Emotion and the autonomic nervous system	Emotions and the autonomic nervous system	422–423
Physiological markers of emotion (signatures of emotion)	The physiology of emotions	420–422
Stress	Stress and illness	441–452
The nature of stress *Appraisal*	Stress: Some basic concepts The stress response system	441–446 441

Different types of stressors (i.e., cataclysmic events, personal) *Effects of stress on psychological functions*	Stress appraisal Stressors—things that push our buttons	442–445 445–446
Stress outcomes/response to stressors	The stress response system	445–446
Physiological	The stress response system	445–446
	Stress and vulnerability to disease	446–452
	Thinking critically about: Stress and health	451
Emotional	Stress and heart disease: The effects of personality, pessimism, and depression	449–451
	Coping with stress	453–459
	Posttraumatic stress disorder	565–566
Behavioral	The stress response system	445–446
	Coping with stress	453–459
Managing stress (e.g., exercise, relaxation techniques, spirituality)	Reducing Stress: aerobic exercise; relaxation and meditation; faith communities	459–466

7. **The study system follows best practices from learning and memory research.** This text's learning system harnesses the *testing effect,* which documents the benefits of actively retrieving information through regular testing (**FIGURE 3**). Thus, our popular LearningCurve adaptive quizzing provides a personalized study plan. In the text, each chapter offers **Retrieval Practice** questions interspersed throughout (**FIGURE 4**). Creating these *desirable difficulties* for students along the way optimizes the testing effect, as does *immediate feedback* via answers that are available for checking. In addition, each main section of text

begins with a numbered question that establishes a **learning objective** and directs student reading. The **Review** sections repeat these questions as a further self-testing opportunity (with answers available to check). The Review sections also offer a self-test on the **Terms and Concepts to Remember,** and **Master the Material** questions to promote optimal retention.

8. **You won't find better service and support anywhere.** The Macmillan representatives who market and sell these resources, help set up instructors' courses, and in many other ways service instructor and student course needs are the best in the business. Many of these folks have become personal friends. We've been grateful to be working with a family-owned publisher that has been so supportive of our teaching mission and has encouraged us to create the best teaching and learning materials.

FIGURE 3 How to learn and remember
For my [DM's] 5-minute animated guide to more effective studying, visit tinyurl.com/HowToRemember.

RETRIEVAL PRACTICE

RP-2 What does a good theory do?

RP-3 Why is replication important?

ANSWERS IN APPENDIX E

FIGURE 4 Sample Retrieval Practice feature

key terms Look for complete definitions of each important term near the term's introduction in the narrative.

LaunchPad and Achieve Read & Practice Resources

LaunchPad

It has been a joy for me [ND] to teach the course with **LaunchPad** (LaunchPadWorks.com), which my students love. LaunchPad makes it easy to engage students effectively starting on Day 1 of the class when I make a LaunchPad assignment. With immediate engagement, and active learning throughout the course, most students have fun with the material and stay in my class.

Scattered throughout this book, students will find interesting and informative review notes and quotes from researchers and others that will encourage them to be active learners and to apply their new knowledge to everyday life.

LaunchPad facilitates active learning as it solves key challenges in the course (**FIGURE 5**). In combination with the meticulously created text, these online resources give students everything they need to succeed, while giving you, the instructor, everything *you* need to quickly set up a course, shape the content to your syllabus, craft presentations, assign and assess homework, and guide the progress of individual students and the class as a whole:

- Our **e-book** can go with any student, anywhere. It is fully mobile-compatible and meets accessibility standards.
- **LearningCurve game-like quizzing** motivates students and adapts to their needs based on their performance. Additional reporting tools and metrics will help you assess the progress of individual students and the class as a whole.
- **iClicker offers active learning simplified, and now includes the REEF mobile app (iClicker.com).** iClicker's simple, flexible tools in LaunchPad help you give students a voice, facilitate active learning and engage remote learners. Students can use iClicker remotes, or the REEF mobile app on their phone, tablet, or laptop to participate more meaningfully. LaunchPad includes a robust collection of iClicker questions for each chapter, including new questions for each chapter designed to help students understand the value and importance of research.
- The **Concept Practice collection** offers 120 dynamic, interactive 5-minute tutorials that teach and reinforce the course's foundational ideas.
- The **Topic Tutorials: PsychSim6,** Thomas Ludwig's (Hope College) award-winning interactive psychology simulations, place students in the role of scientist or participant in activities that highlight important concepts, processes, and experimental approaches.
- In the **Assess Your Strengths** activities, students apply what they are learning from the text to their own lives and experiences by considering key "strengths." Each activity starts with a

personalized video introduction from us [DM and ND], and students assessing themselves on the strength (critical thinking, quality of sleep, self-control, relationship strength, belonging, hope, and more) using scales developed by researchers. Next, students get tips for nurturing that strength in their own lives, and take a quiz to help solidify their learning.

- **NEW "Thinking Critically About…" infographic activities** for each chapter teach and reinforce critical-thinking skills.
- **LMS integration** into your school's system is readily available. Check with your local sales representative for details.
- **The Video Assignment Tool** makes it easy to assign and assess video-based activities and projects, and provides a convenient way for students to submit video coursework.
- **The Gradebook** gives a clear window on performance for the whole class, for individual students, and for individual assignments.
- A **streamlined interface** helps students manage their schedule of assignments, while ***social commenting tools*** let them connect with classmates and learn from one another. 24/7 help is a click away, accessible from a link in the upper right corner.
- LaunchPad offers curated **optional pre-built chapter units,** which can be used as is or customized. Or choose not to use them and build your course from scratch.
- Our **Instructor Resources** include suggestions for lectures, classroom exercises and demonstrations, and student projects (which work well for think-pair-share, small-group, and large-group activities); ***Lecture Guides*** (summarizing key text discussions and connecting instructor resources with text learning objectives); the best ***Test Banks*** in the industry (over

10,000 carefully authored, professionally edited questions that are tightly coordinated with the text by the same editor since the first edition); and nice starter image slides with textbook graphics.

- In addition, we offer access to the **Macmillan Community** (Community.Macmillan.com). Created *by* instructors *for* instructors, this is an ideal forum for interacting with fellow educators—including Macmillan authors—in your discipline. Join ongoing conversations about everything from course prep and presentations to assignments and assessments to teaching with media, keeping pace with—and influencing—new directions in your field. It includes exclusive access to classroom resources, blogs (including my [DM's] TalkPsych.com), webinars, professional development opportunities, and more.

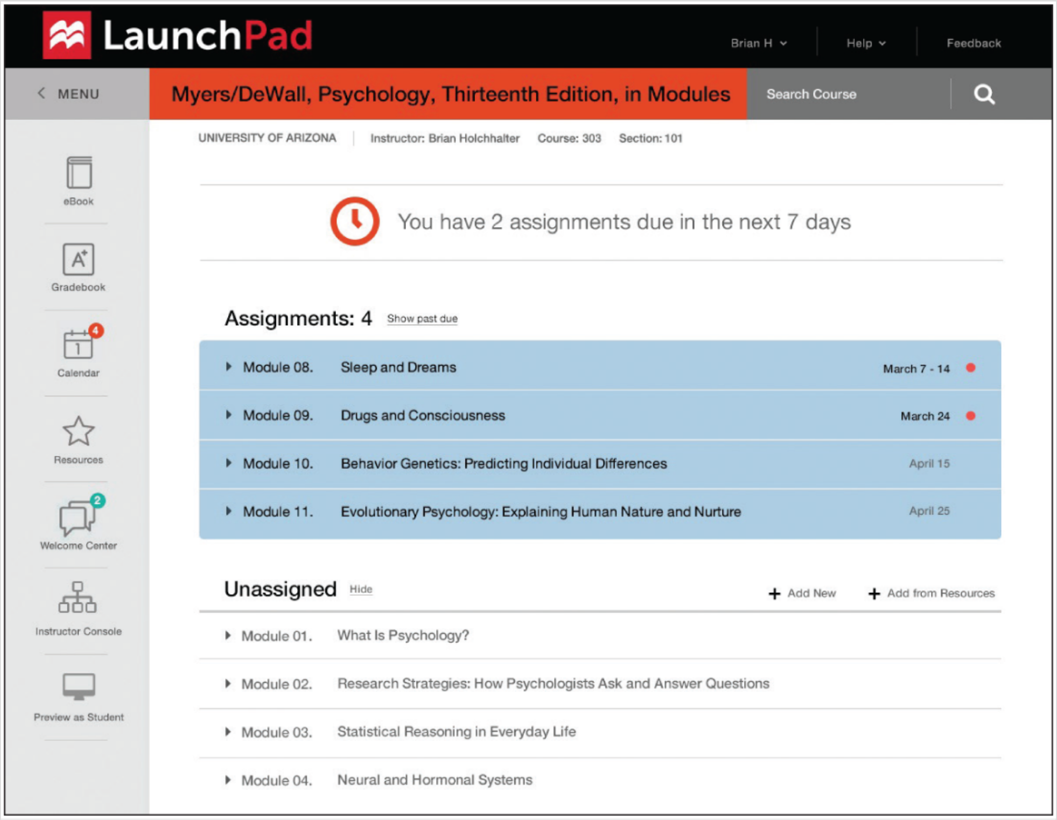

FIGURE 5 Sample from LaunchPad

Achieve Read & Practice

Achieve Read & Practice is the marriage of our LearningCurve adaptive quizzing and our mobile, accessible e-book in one, easy-to-use and affordable product (FIGURE 6). New, built-in analytics help instructors track student progress and intervene to help students succeed. Instructors who have used Achieve Read & Practice have been surprised by its truly easy interface, and pleased with their course results. In a study of 227 students at six institutions, instructors found a significant improvement in the proportion of students who stayed on track with the assigned reading, and they found that students who retook quizzes (a helpful feature of Achieve

Read & Practice) earned higher grades in the course. (Access the full report at MacmillanLearning.com/Catalog/Page/LearningScience.)

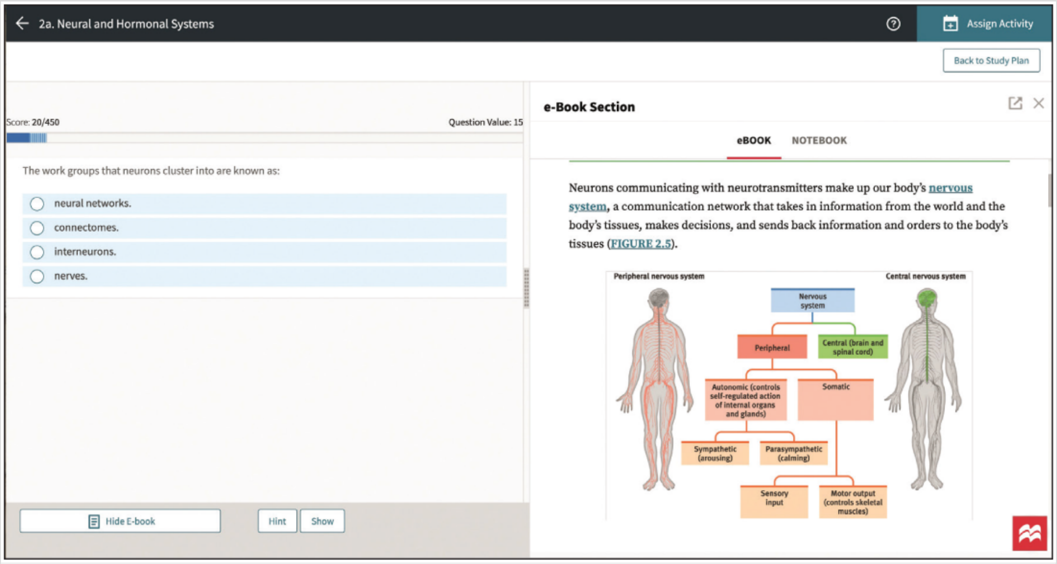

FIGURE 6 Sample from Achieve Read & Practice

Myers' and DeWall's Eight Guiding Principles

We have retained the goals—the guiding principles—that have animated this text since its first edition.

Facilitating the Learning Experience

1. **To teach critical thinking** By presenting research as intellectual detective work, we model a scientific mindset. Students will discover how critical thinking can help them evaluate competing ideas and popular claims—from ESP and memory construction to group differences in intelligence and alternative therapies. Our

"Thinking Critically About" infographic features help engage students in this learning. (See p. xii, and Table 4, for more about critical thinking in this text.)

2. **To provide applications of principles** Throughout the narrative, illustrations, and online resources we relate psychology's findings to real-world applications. We make psychology meaningful to students by showing how it relates to their lives—their life-span development, their search for relationships and happiness, their understanding of negative forces, such as prejudice, and so much more. The "Ask Yourself" questions throughout each chapter, and our "Assess Your Strengths" activities in LaunchPad invite students to apply important concepts to their own lives, and to learn ways to develop key personal strengths. (See **TABLE 10**, Positive Psychology, for more about how we encourage understanding of happiness and human strengths, and see the new Student Preface—Student Success: How To Apply Psychology to Live Your Best Life on p. xxxi.)

TABLE 10 Positive Psychology

Coverage of *positive psychology* topics can be found in the following chapters:	
Topic	**Chapter**
Altruism/compassion	1, 4, 7, 12, 13, 14, 16
Coping	5, 6, 11, 12, 15, 16
Courage	12, 13, 14, 15, Appendix C
Creativity	1, 3, 9, 10, 11, 12, 14, Appendix C
Emotional intelligence	10
Empathy	4, 5, 6, 7, 12, 13, 14, 16
Flow	12, Appendix C
Gratitude	12, 16
Happiness/life satisfaction	Prologue, 1, 3, 5, 11, 12, 13, 14, Appendix C
Humility	Prologue, 4, 14, Appendix C

Humor	12, 15
Integrity	5, 12
Justice	5, 16
Leadership	4, 11, 12, 13, 14, Appendix C
Love	1, 4, 5, 6, 11, 12, 13, 14
Morality	2, 4, 5, 7, 9, 13
Optimism	5, 12, 14, 15
Personal control	1, 4, 7, 10, 11, 12, 15, 16
Resilience	4, 5, 10, 12, 15, 16
Self-awareness	6, 10, 14, 16
Self-control	5, 7, 11, 12, 13, 14, 15
Self-discipline	5, 10, 11, 12
Self-efficacy	14, 16
Self-esteem	3, 5, 11, 12, 14, 15, 16, Appendix C
Spirituality	3, 4, 5, 12, 14, 16
Toughness (grit)	10, 11
Wisdom	Prologue, 5, 9, 10, 12, 14, Appendix C

3. **To reinforce learning at every step** Everyday examples and thought-provoking questions encourage students to process the material actively. Self-testing opportunities throughout the text and online resources help students learn and retain important concepts and terminology.

Demonstrating the Science of Psychology

4. **To show the process of inquiry** We try to show students not just the outcome of research, but how the research process works, often by putting them in the role of experimenter or participant in classic studies. We introduce research stories as mysteries that unravel as one clue after another falls into place. Our “How Would You Know?” activities in LaunchPad allow students to play the role of researcher in thinking about research questions and how they may be studied effectively.

5. **To be as up-to-date as possible** While retaining psychology's classic studies and concepts, we also present the most important recent developments. In this edition, 2100 references are dated 2015–2020. Likewise, new photos and new everyday examples are drawn from today's world.
6. **To put facts in the service of concepts** Our intention is not to overwhelm students with facts, but to reveal psychology's major concepts—to teach students how to think, and to offer psychological ideas worth thinking about. Learning Objective Questions and Retrieval Practice questions throughout each chapter help students focus on the most important concepts. Concept Practice and Topic Tutorial activities in LaunchPad help ensure student understanding of key points.

Promoting Big Ideas and Broadened Horizons

7. **To enhance comprehension by providing continuity** Many chapters have a significant issue or theme that links subtopics and ties the chapter together. The Learning chapter conveys the idea that bold thinkers can serve as intellectual pioneers. The Thinking and Language chapter raises the issue of human rationality and irrationality. The Psychological Disorders chapter conveys empathy for, and understanding of, troubled lives. Other threads, such as cognitive neuroscience, dual processing, and individual and group diversity, weave throughout the whole book, and students hear a consistent voice.
8. **To convey respect for human unity and diversity** Throughout the book, readers will see evidence of human kinship in our shared biology—our common mechanisms of seeing and learning,

hungering and feeling, loving and hating. They will also better understand our diversity—our individual diversity in development and aptitudes, temperament and personality, and disorder and health; and our cultural diversity in attitudes and expressive styles, child-raising and care for the elderly, and life priorities and experiences.

In Appreciation

Aided by input from thousands of instructors and students over the years, this has become a better, more effective, more accurate book than two authors alone (these authors at least) could write. Our indebtedness continues to the innumerable researchers who have been so willing to share their time and talent to help us accurately report their research, and to the hundreds of instructors who have taken the time to offer feedback.

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At Macmillan Learning, a host of people played key roles in creating this thirteenth edition.

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To achieve our goal of supporting the teaching of psychology, these resources not only must be authored, reviewed, edited, and produced, but also made available to teachers of psychology, with effective guidance and professional and friendly servicing close at hand. For their exceptional success in doing all this, our author team is grateful to Macmillan Learning's professional sales and marketing team. We are especially grateful to Executive Marketing Manager Kate Nurre, and Learning Solutions Specialists Robyn Burnett and Elizabeth Chaffin Woosley for tirelessly working to inform our teaching colleagues of our efforts to assist their teaching, and for the joy of working with them.

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Again, I [DM] gratefully acknowledge the editing assistance and mentoring of my writing coach, poet Jack Ridl, whose influence resides in the voice you will be hearing in the pages that follow. He, more than anyone, cultivated my delight in dancing with the language, and taught me to approach writing as a craft that shades into art. Likewise, I [ND] am grateful to my intellectual hero and mentor, Roy Baumeister, who taught me how to hone my writing and embrace the writing life. I'm also indebted to John Tierney, who has offered unending support and served as a role model of how to communicate to a general audience.

And we have enjoyed our ongoing work with each other on this our eighth co-authored book. Nathan's fresh insights and contributions continue to enrich this book as we work together on each chapter.

With support from our wonderful editors, this is a team project. In addition to our work together on the textbook, Nathan and I contribute to the monthly "Teaching Current Directions in Psychological Science" column in the *APS Observer* (tinyurl.com/MyersDeWall). I [DM] also blog at TalkPsych.com, where I share exciting new findings, everyday applications, and observations on all things psychology (with special thanks to my talented, longtime editor, Nancy Fleming).

Finally, our gratitude extends to the many students and instructors who have written to offer suggestions, or just an encouraging word. It is for them, and those about to begin their study of psychology, that we have done our best to introduce the field we love.

• • •

The day this book went to press was the day we started gathering information and ideas for the next edition. Your input will influence how this book continues to evolve. So, please, do share your thoughts.

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Student Success: How to Apply Psychology to Live Your Best Life

As you will see in the chapters to come, some things—including our temperament, body type, sexual orientation, and personality traits—can be restrained with willpower, yet are mostly beyond our power to change. In such ways it's better to accept than to fight who we are.

In other ways, we *can* change and become the person we aspire to be. Consider five ways we can use psychology to live our best life (more on each in the chapters to come):

- thinking critically when forming judgments and making decisions,
- attending to self-control and self-improvement,
- managing our time and study,
- enjoying a satisfying social life, and

- finding meaning while pursuing goals.

Thinking Critically and Scientifically

To live your best life, you will need to learn to think critically—guidance for which you will find in every chapter of this book. You will need to base your hopes, your fears, and your decisions on a foundation of truth, and to understand the importance of scientific thinking and the careful research that underlies all of what we will be presenting.

Alas, misinformation spreads readily. Many people fear terrorism, mass shootings, and air travel more than the vastly greater threats they face from in-home guns and car travel. In the United States, 2 in 3 people have, year after year, perceived crime as rising—even while it has been dramatically falling (McCarthy, 2019). And "how many of the world's 1-year old children have been vaccinated against some disease"—20, 50, or 80 percent? In most countries, more than 4 in 5 people guess 20 or 50 percent, when the truth is 88 percent (Rosling, 2018).

Not only does it help us individually to know the truth about what threatens and benefits us, it also helps us collectively. Democracy presumes our wisdom. When we voters grasp truth—when facts prevail over false news—we can support sensible policies and elect benevolent leaders.

Misinformation comes from various sources:

- Some people or organizations aim to deceive us, in order to sell a product or to undermine a political opponent.
- Sensationalized news can be misleading—vivid images of horrific shootings or plane crashes may lead us to disproportionately fear some dangers too much, and others too little.
- If we interact only with people, websites, and news sources that reflect our way of thinking, we will confirm rather than challenge our presumptions.
- We have a natural “truth bias,” an inclination to believe what others say, especially when repeated.

Fortunately, ignorance of our ignorance can be remedied by education. And that brings you to this book and its resources, which offer psychology’s contribution to critical thinking. To learn how we can protect ourselves against errors and biases that may hack our brain, and to better understand the importance of current, scientific research and the careful procedures it follows, read on. You will also want to explore the “How Would You Know?” research activities in LaunchPad, which give you a hands-on opportunity to experience the value of research from the inside out. And check out my [DM’s] new tutorial animation, “Thinking Critically in Our Post-Truth World” in LaunchPad, and also at tinyurl.com/PostTruthMyers.

With a mix of open-minded curiosity and evidence-seeking questioning we can better sift falsehood from fact. And we can live smarter and more flourishing lives.

Self-Control and Self-Improvement

We can apply our smart thinking to all aspects of living our best life, including appropriate self-care. Family, work, and school commitments can make it difficult to find time to achieve our goals, sustain our health, and have fun. But to care for others, we first need to care for ourselves.

Self-Control

Success starts with **self-control**—the ability to restrain impulses and delay short-term gratification for greater long-term rewards. What's your level of self-control? On a scale from ***1 (not at all like me) to 5 (very much like me),*** indicate how much each of the following statements reflects how you typically are (Tangney et al., 2004):

1. ________________ I am good at resisting temptation.
2. ________________ I have a hard time breaking bad habits.
3. ________________ I am lazy.
4. ________________ I say inappropriate things.
5. ________________ I do certain things that are bad for me, if they are fun.

6. ______________ I refuse things that are bad for me.
7. ______________ I wish I had more self-discipline.
8. ______________ People would say that I have iron self-discipline.
9. ______________ Pleasure and fun sometimes keep me from getting work done.
10. ______________ I have trouble concentrating.
11. ______________ I am able to work effectively toward long-term goals.
12. ______________ Sometimes I can't stop myself from doing something, even if I know it is wrong.
13. ______________ I often act without thinking through all the alternatives.

To tally your total score:

- ***Reverse*** your rating for items 2, 3, 4, 5, 7, 9, 10, 12, and 13 (1=5, 2=4, 3=3, 4=2, 5=1).
- Now ***add*** your ratings to establish your ***total score.***
- Total scores range from 13 to 65, with higher scores indicating more self-control. The average score was 39 in two studies of college students (Tangney et al., 2004).

To improve your self-control, watch my [ND's] video, "Self-Control—Our Greatest Inner Strength," available in LaunchPad or at tinyurl.com/DeWallSelf-Control.

LaunchPad Alternatively, you can have your score automatically calculated in the LaunchPad activity *Assess Your Strengths: How Much Self-Control Do You Have, and Why Is*

Self-Improvement

Here are some tips for improving your self-care:

- **Set and announce your goals.** Specific and realistic goals—such as “draft that paper by next Friday”—direct attention, promote effort, and motivate persistence. To make yourself accountable, announce your goal to friends or family.
- **Develop an action plan.** Specify *how* you will progress toward your goal. People who flesh out goals with detailed plans become more focused, and are more likely to finish on time. Fantasizing your ultimate success (a great paper turned in on time, a good course grade, a sports victory) helps. But imagining the step-by-step details helps more.
- **Form beneficial habits.** Is there some behavior, such as exercising, that you would like to make automatic? Make yourself do it every day for two months and you will have transformed a hard-to-do behavior into a must-do habit.
- **Plan for a full night’s sleep.** Work commitments, family stresses, and other challenges can interfere with sleep. Screen time and social time can also intrude. The first step in changing your sleep routine starts with a question, “Do I want to increase my happiness, energy, focus, and health?” If so, try to find a way to give your body more of the sleep it craves. (See Chapter 3 for tips on getting better sleep.)

- **Create a supportive environment.** It's easier to eat healthy when you don't have junk food around. At meals, control portion size by using smaller plates and bowls. To focus on a project, remove distractions. At night, stash your phone so you can sleep undisturbed. Engage with friends who bring out the best rather than the worst in you.
- **Control substance use.** Many psychoactive drugs, such as nicotine, are highly addictive and can readily hijack our daily lives, long-term goals, and good health. Although some drugs, such as caffeine, may be safely consumed in moderation, many others will seriously disrupt our best life unless avoided entirely. (More on this in Chapter 3.)
- **Make time for exercise.** Frequent aerobic exercise is a great time investment. Even in small amounts, aerobic exercise boosts health, increases energy, lifts mood, improves memory, and calms anxiety.
- **Incorporate mindfulness meditation.** Practicing mindfulness can help you manage your stress and regulate your emotions more healthfully.
- **Build coping skills and a healthy lifestyle.** Strengthening our *resilience* and managing our emotions helps us cope with stress. We can also boost our mental health with lifestyle changes—daily practices that mark flourishing lives. For more information, see Chapter 12, and also "Thinking Critically About: Therapeutic Lifestyle Change" in Chapter 16.

LaunchPad Consider ways to build your resilience by engaging with the LaunchPad activity *Assess Your Strengths: How Resilient Are You, and Why Should You Build More*

Time Management and Study Tips

Some students fail. Some survive. And some thrive. So, what choices can you make to thrive?

You can start by making a plan for how you will manage your time and maximize your learning. As legendary basketball coach John Wooden (1977) said, “When you fail to prepare, you’re preparing to fail.”

It may seem as if there are not enough hours in the week to get everything done. It may be that you are not using your time as efficiently as you could. To assess your current time management and study skills, complete the survey below by answering YES or NO:[1]

1. ____________ Have you estimated how many hours you will need to study each week?
2. ____________ Do you tend to complete your assignments on time?
3. ____________ Have you estimated how long it takes to complete each of your assignments?
4. ____________ Do you begin to work on long-term assignments at the beginning of the term?

5. ______________ Do you make lists of things to do in your head rather than on paper or in a digital scheduling program?
6. ______________ Do you participate in social activities even when you know you should be studying?
7. ______________ Do you schedule time to study for exams?
8. ______________ Do you have a job that requires more than 20 hours a week?
9. ______________ Do you know exactly what tasks you are going to do when you sit down to study?
10. ______________ Do you attempt the assignments from your most difficult class first?

Give yourself one point for each *NO* answer to questions 5, 6, and 8, and one point for each *YES* answer to all the other questions. How many total points did you earn? People who score higher than 7 tend already to have good time management and study skills; people who score below 5 benefit most from learning how to improve. We can all use a reminder of best practices. Here are a few tips.

Manage Your Time

Your time is your most precious resource. Managing your time requires intentionally planning *when* you will progress toward your goals. Start by carefully tracking your time use for a week—including all personal, school, and work time—and watching for patterns and opportunities. (We [DM and ND] have each done this and were surprised by how much time we were wasting!) Next, create a “time budget” that allows you to enjoy life, be energized, and complete your study, work, and family tasks. Plan time for recreation and friends; social media; sleep, eating, and personal care; class time and study; and any employment or home obligations. Determine precisely when you will do each, by *creating weekly and daily schedules that make guilt-free space for each activity*. To become the person you wish to be, live intentionally, day by day.

stock_colors/Getty Images

Time for success Making a realistic, day-to-day schedule will allow you time for what you *need* to do as well as time for what you *want* to do.

Manage Your Mental Energy

Some tasks are mentally demanding. Plan your day to make space for such tasks when you have the most energy. Allow time to rest and recover before engaging the next demanding task. By tracking your mental energy, you will know when to spend it and when to save it.

Play Offense

Car troubles, family problems, and work challenges happen. Sometimes we have to play "defense" against life's demands and problems, leaving us stressed and short of our goals. The solution: When possible, play "offense" against your environment. Rather than just letting the day happen to you, start each day with a plan. Control how you spend your time. Establishing routines and making decisions in advance conserves energy by reducing daily decision making. If you know you are going to study two hours in the morning before class, you won't waste time weighing what to do.

Study Smart

To remember what you read, use the SQ3R (Survey, Question, Read, Retrieve, Review) system: *S*urvey the chapter organization. Identify *Q*uestions your reading should answer. *R*ead actively, seeking answers. *R*etrieve and rehearse key ideas. Finally, *R*eview the chapter's organization and concepts.

Those last two "R's" are especially important: You will retain information best through repeated self-testing and rehearsal of previously studied material. Getting *immediate feedback* makes this *testing effect* even stronger. That's the idea behind our effective online adaptive quizzing system, LearningCurve, and the frequent self-testing opportunities throughout this text.

Distributing your study time, rather than cramming, will also help. Establishing a schedule, and sticking to it, will spread the load out across the term. For more information, see "Use Psychology to Become a Stronger Person—and a Better Student" at the end of the Prologue and "Improving Memory" in Chapter 8, and view my [DM's] 5-minute animation at tinyurl.com/HowToRemember.

Social Life

Living your best life requires social support. Here are some tips for forming and maintaining healthy, supportive relationships:

- **Prioritize people.** We humans are social animals. We need to belong. We are happier and healthier when supported by, and giving support to, our friends. So, make the effort to make friends, such as by joining a club, sports team, or fellowship group. Get to know your instructors. And do not take your friends and loved ones for granted. Attend to them. Affirm them. Share your daily experiences and feelings with them.

- **Enjoy social media and your phone without letting them control you.** Use social media and your phone to stay connected with friends and family, but without hijacking your time and other priorities. And when posting on social media, remember that someday a potential employer may be Googling your name.
- **Embrace a speak-up culture rather than a call-out culture.** To disagree is to be human. You will disagree with others, and others will disagree with you. Indeed, we often learn by exploring these other perspectives. (This is why it is so important for psychological scientists to practice humility.) When you disagree, avoid *calling out* others (publicly shaming them). Instead, *speak up:* Approach the person and explain your disagreement without blaming them. We have a natural tendency to explain others' behaviors based on their personality traits ("He's a selfish jerk") rather than their situation ("He's sleep-deprived and stressed"). To resist this tendency, take the other person's perspective.
- **It's time to be the adult in the room.** As we grow up, we pass through different stages of development. Most adolescents seek social acceptance while still depending on family. The transition from adolescence to adulthood requires becoming more independent. As adults, we need to own our goals, attitudes, values, and beliefs, and to make our own decisions and solve our own problems.

Mariusz Szczawinski/Alamy

Social success Nurturing relationships is an important part of a successful life. Make time and energy for important others, and you will have better physical and psychological health.

LaunchPad To assess and nurture your feelings of belonging and your relationship strength, engage online with these two LaunchPad activities (1) *Assess Your Strengths: How Strong Is Your Need to Belong, and How Can you Strengthen Your Feelings of Belonging?* and (2) *Assess Your Strengths: How Strong Is Your Relationship, and How Might You Increase Its Strength*?

Finding Meaning and Pursuing Goals

To have meaning is to have a life filled with purpose, coherence, and significance. Most people want a meaningful life, but they report feeling unfulfilled in some area of their life. They may not be fully engaged in their work. Or they may feel stuck in a daily routine that brings money without meaning. To live your best life, take the following steps to promote meaning and pursue goals:

- **Imagine your possible self.** Who is the person you wish to be? Who is the "possible self" you dream of becoming? *Define who you hope to be and what you aim to achieve.* With that vision in mind, you can then lay out specific goals and strategies that will take you where you want to go.
- **Live your dream daily.** Here's a good rule for success: Whatever you hope to achieve, *do something toward that every day.* Do you want to be kinder, more educated, more assertive? Then, every day, do a kind act, learn something new, or practice asserting yourself. Although many days you may accomplish less than you'd hoped, even small daily steps toward a goal can, over time, take you to your destination—transforming your possible self into your actual self.
- **Adopt a "growth mindset."** It's surprisingly powerful to believe that our abilities are changeable through energy and effort. Some things we should accept, but many things we have the power to change. If you see your math or writing or speaking ability as like a muscle—something that gets stronger with training and practice—you will, in fact, develop more skill. Your mindset matters. (More on this in Chapter 10.)
- **Find your calling.** No need to rush it. Most students change their vocational plans along the way, and you likely will, too. But notice what sorts of activities absorb you and make time fly. Is it being with people? Working with your hands? Solving problems with your mind? Watch for work and activities that

will enable you to do what you love and to love what you do, and pursue those paths.

LaunchPad To further develop your goal-setting ability, engage with the LaunchPad activity *Assess Your Strengths: How Might Your Willingness to Think of the Future Affect Your Ability to Achieve Long-Term Goals?*

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* * *

Throughout this book you will encounter additional pointers to a flourishing life—counting your blessings, expressing gratitude, finding *flow,* acting happy, training your willpower, becoming mindful, opting for optimism, and more. In such ways, you can not only survive, you can thrive. Don't be too hard on yourself if you experience setbacks. If you try to do a little better each day, you can, over time, accomplish goals that might seem impossible at the outset. As Reinhold Niebuhr suggested, seek the serenity to accept things you cannot change, but also feel empowered to change the things you can.

Prologue The Story of Psychology

FatCamera/Getty Images

Astronomer Owen Gingerich has described the human brain as “by far the most complex physical object known to us in the entire cosmos” (2006, p. 29). On the scale of outer space, we are less than a single grain of sand on all the oceans’ beaches, and our lifetime lasts but a relative nanosecond. Yet there is nothing more awe inspiring than our own inner space. Our consciousness—our mind somehow arising from matter—remains a profound mystery. Our thinking, emotions, and actions (and their interplay with others’ thinking, emotions, and actions) fascinate us. Outer space staggers us with its enormity. But inner space enthralls us. Enter psychological science.

From news and media portrayals, you might think that psychologists offer counseling, analyze personality, dispense child-raising advice, examine crime scenes, and testify in court. Do they? *Yes*— and much more. Consider some of psychology’s questions that you may wonder about:

- Have you ever found yourself reacting to something as one of your biological parents would—perhaps in a way you vowed you *never* would—and then wondered how much of your personality you inherited? *To what extent do genes predispose our individual differences in personality? How do home and community environments shape us?*
- Have you ever worried about how to act among people of a different culture, gender identity, or sexual orientation? *How are we alike as members of the human family? How do we differ?*
- Have you ever awakened from a nightmare and wondered why you had such a crazy dream? *Why do we dream?*

- Have you ever played peekaboo with a 6-month-old and wondered why the baby finds your disappearing/reappearing act so delightful? *What do babies actually perceive and think?*
- Have you ever wondered what fosters school and work success? *Does inborn intelligence explain why some people get richer, think more creatively, or relate more sensitively? Or does gritty effort, and a belief in the power of persistence, matter more?*
- Have you ever become depressed or anxious and wondered whether you'll ever feel "normal"? *What triggers our bad moods—and our good ones? What's the line between a routine mood swing and a psychological disorder?*

Psychology is a science that seeks to answer such questions about us all—how and why we think, feel, and act as we do.

What Is Psychology?

Once upon a time, on a planet in our neighborhood of the universe, there came to be people. Soon thereafter, these creatures became intensely interested in themselves and in one another: "Who are we? What produces our thoughts? Our feelings? Our actions? And how are we to understand and manage those around us?"

Psychology Is a Science

LEARNING OBJECTIVE QUESTION LOQ P-1

How is psychology a science?

Underlying all science is, first, a passion to explore and understand without misleading or being misled. Some questions *(Is there life after death?)* are beyond science. Answering them requires a leap of faith. With many other ideas *(Can some people demonstrate extrasensory perception?),* the proof is in the pudding. We can let the facts speak for themselves.

To assist your learning, numbered Learning Objective Questions appear at the beginning of major sections. You can test your understanding by trying to answer the question before, and then again after, you read the section.

Magician James Randi has used this **empirical approach** when testing those claiming to see glowing auras around people's bodies:

> *Randi:* Do you see an aura around my head?
> *Aura seer:* Yes, indeed.
> *Randi:* Can you still see the aura if I put this magazine in front of my face?
> *Aura seer:* Of course.
> *Randi:* Then if I were to step behind a wall barely taller than I am, you could determine my location from the aura visible above my head, right?

empirical approach
an evidence-based method that draws on observation and experimentation.

Randi once told me [DM] that no aura seer had agreed to take this simple test.

> **Throughout the text, the most important concepts are boldfaced. As you study, you can find these terms defined nearby and in the Glossary at the end of the book. (In the e-book, definitions are always a click away.)**

No matter how sensible-seeming or how wild an idea, the smart thinker asks: *Does it work?* When put to the test, do the data support its predictions? Subjected to such scrutiny, crazy-sounding ideas sometimes find support. During the 1700s, scientists scoffed at the notion that meteorites had extraterrestrial origins. When two Yale scientists challenged the conventional opinion, Thomas Jefferson reportedly scoffed, "Gentlemen, I would rather believe that those two Yankee professors would lie than to believe that stones fell from Heaven." Sometimes scientific inquiry turns jeers into cheers.

More often, science becomes society's garbage collector, sending crazy-sounding ideas to the waste heap atop previous claims of perpetual motion machines, miracle cancer cures, and out-of-body travels into centuries past. To sift reality from fantasy and fact from fiction therefore requires a *scientific attitude:* being skeptical but not cynical, open-minded but not gullible. When ideas compete, careful testing can reveal which ones best fit the facts. Do some people have a psychic power to predict an unexpected catastrophe? Is *electroconvulsive therapy* (delivering an electric shock to the brain) an effective treatment for severe depression? As we will see, putting such claims to the test has led psychological scientists to answer *No* to the first question and *Yes* to the second.

Putting a scientific attitude into practice requires not only curiosity and skepticism but also *humility*—an awareness of our own vulnerability to error and an openness to new perspectives (Leary et al., 2017). What matters is not my opinion or yours, but the truths revealed by our questioning and testing. If people or other animals don't behave as our ideas predict, then so much the worse for our ideas. This humble attitude was expressed in one of psychology's early mottos: "The rat is always right." (See Thinking Critically About: The Scientific Attitude.)

Throughout the book, information sources are cited in parentheses, with researchers' names and the date the research was published. Every citation can be found in the end-of-book References section, with complete documentation that follows American Psychological Association (APA) style.

Thinking Critically About:
The Scientific Attitude

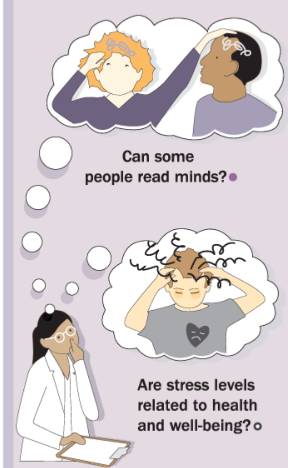
LOQ P-2 What are the three key elements of the scientific attitude, and how do they support scientific inquiry?

Three basic attitudes helped make modern science possible.

1 CURIOSITY:

Does it work?

When put to the test, can its predictions be confirmed?



No one has yet been able to demonstrate extrasensory mind-reading.

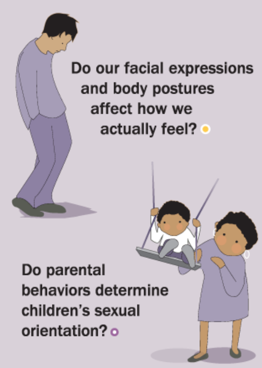
Many studies have found that higher stress relates to poorer health.

2 SKEPTICISM:

What do you mean?

How do you know?

Sifting reality from fantasy requires a healthy skepticism—an attitude that is not cynical (doubting everything), but also not gullible (believing everything).



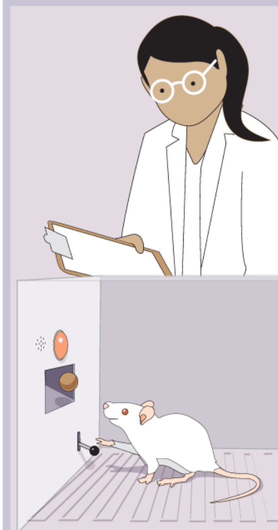
Our facial expressions and body postures can affect how we feel.

Chapter 11 explains that there is not a relationship between parental behaviors and children's sexual orientation.

3 HUMILITY:

That was unexpected! Let's explore further.

Researchers must be willing to be surprised and follow new ideas. People and other animals don't always behave as our ideas and beliefs would predict.



The rat is always right.

Humility predicts helpfulness and realistic academic confidence (Erlandsson et al., 2018). One nine-country study asked 40,000 teens which of 16 math concepts they were familiar with, including three fake terms: “proper number,” “subjective scaling,” and “declarative fraction.” Those who arrogantly claimed to know the nonexistent concepts were often men from advantaged backgrounds (Jerrim et al., 2019). *The point to remember:* Knowing what we *don’t* know enables generosity and intellectual humility.

ASK YOURSELF

Were you surprised to learn that psychology is a science? How would you explain that now if someone asked you about it?

Critical Thinking

LOQ P-3

How does critical thinking feed a scientific attitude, and smarter thinking for everyday life?

The scientific attitude—curiosity + skepticism + humility—prepares us to think smarter. This smart thinking, called **critical thinking**, examines assumptions, appraises the source, discerns hidden biases, evaluates evidence, and assesses conclusions. When reading a research report, an online opinion, or a news story, critical thinkers ask questions: *How do they know that? What is this person’s* *agenda? Is the conclusion based on anecdote, or on evidence? Does the evidence justify a cause-effect conclusion? What alternative explanations are possible?*

critical thinking
thinking that does not automatically accept arguments and conclusions. Rather, it examines assumptions, appraises the source, discerns hidden biases, evaluates evidence, and assesses conclusions.

> **From a tongue-in-cheek Twitter feed: "The problem with quotes on the internet is that you never know if they're true."** — Abraham Lincoln

Critical thinkers wince when people make factual claims based on their gut: "I *feel like* climate change is [or isn't] happening." "I *feel like* self-driving cars are more [or less] dangerous." "I *feel like* my candidate is more honest." Such beliefs (commonly mislabeled as feelings) may or may not be true. Critical thinkers are open to the possibility that they might be wrong. Sometimes the best evidence confirms what we believe. Other times it challenges and beckons us to a different way of thinking. Cynics often seem smart, but most demonstrate less cognitive ability and academic competence than average (Stavrova & Ehlebracht, 2018). To believe everything—or to reject everything—is to be a fool. Critical thinking, informed by science, helps clear the colored lenses of our biases. Consider: Does climate change threaten our future, and, if so, is it human-caused? In 2016, some climate-action advocates interpreted record Louisiana flooding as proof of climate change. In 2015, climate-change skeptics perceived North American bitter winter cold as discounting global warming. Rather than having their understanding of climate change swayed by such local examples of today's weather, critical thinkers say, "Show me the evidence." Over time, is the Earth actually warming? Are the polar ice caps melting? Are vegetation patterns changing? Are extreme weather events becoming more frequent? And is human activity emitting atmospheric CO_2 that would lead us to expect such changes?

When contemplating such issues, critical thinkers will also consider the credibility of sources. They will look at the evidence *(Do the facts support them, or are they just makin' stuff up?)*. They will recognize multiple perspectives. And they will expose themselves to news sources that challenge their preconceived ideas.

Some religious people may view critical thinking and scientific inquiry, including psychology's, as a threat. Yet many leaders of the scientific revolution, including Copernicus and Newton, were deeply religious people acting on the idea that "in order to love and honor God, it is necessary to fully appreciate the wonders of his handiwork" (Stark, 2003a,b).

> **"My deeply held belief is that if a god anything like the traditional sort exists, our curiosity and intelligence are provided by such a god. We would be unappreciative of those gifts ... if we suppressed our passion to explore the universe and ourselves."** — Carl Sagan, *Broca's Brain*, 1979

Critical inquiry can lead us to surprising findings. Some examples from psychological science: Massive losses of brain tissue early in life may have minimal long-term effects (see Chapter 2). Within days, newborns can recognize their mother by her odor (see Chapter 5). After brain damage, a person may be able to learn new skills yet be unaware of such learning (see Chapter 8). Diverse groups—all genders, old and young, wealthy and not wealthy, with varying physical abilities—report roughly comparable levels of personal happiness (see Chapter 12).

Later chapters also illustrate how critical inquiry sometimes debunks popular presumptions. Sleepwalkers are *not* acting out their dreams (see Chapter 3). Our past experiences are *not* all recorded verbatim in our brains; with brain stimulation or hypnosis, one *cannot* simply replay and relive long-buried or repressed memories (see Chapter 8). Most people do *not* suffer from unrealistically low self-esteem, and high self-esteem is *not* all good (see Chapter 14). Opposites tend *not* to attract (see Chapter 13). In these instances and many more, what psychological scientists have learned is not what is widely believed.

Psychology's critical inquiry can also identify effective policies. To deter crime, should we invest money in lengthening prison sentences, or should we increase the likelihood of arrest? To help people recover from a trauma, should counselors help them relive it, or not? To increase voting, should we tell people about the low turnout problem, or emphasize that their peers are voting? What matters is not what we “feel” is true, but what *is* true. When put to critical thinking’s test—and contrary to common practice—the second option in each of this paragraph’s examples wins (Shafir, 2013). Thinking critically can—and sometimes does—change the world.

Critical thinking can also change us, by helping us assess popular applications of psychology. Looking at a self-help book, we can consider the author’s expertise and goals. We can ask: Are the suggestions based on evidence or anecdote? And how might the author’s personal values and agenda affect the advice? If you defer to guidance about how to live—how to raise children, how to achieve self-fulfillment, how to respond to sexual feelings, how to get ahead at work—you are accepting value-laden advice. A science of behavior and mental processes can help us reach our goals. But it cannot decide which goals are worth pursuing. Psychological scientists teach, but they do not preach.

Study Tip: Memory research reveals a *testing effect:* We retain information much better if we actively retrieve it by self-testing and rehearsing. (More on this at the end of this Prologue.) To bolster your learning and memory, take advantage of the Retrieval Practice opportunities you’ll find throughout this text—with answers for checking in Appendix E, or a click away in the e-book.

RETRIEVAL PRACTICE

RP-1 Describe what’s involved in critical thinking.

ANSWERS IN APPENDIX E

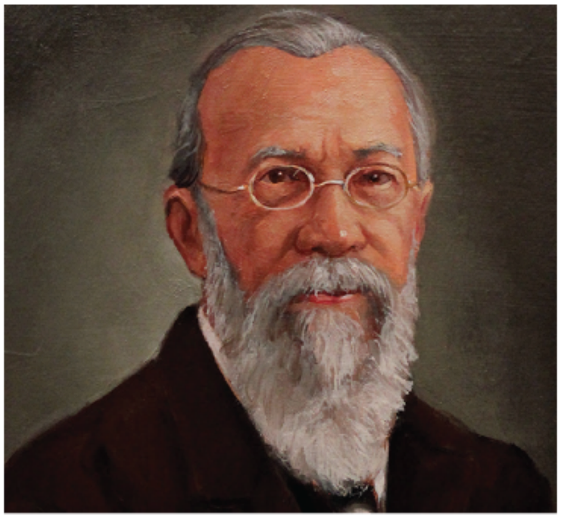
Psychological Science Is Born

LOQ P-4

What were some important milestones in psychology’s early history?

To be human is to be curious about ourselves and the world around us. Before 300 B.C.E., the Greek naturalist and philosopher Aristotle theorized about learning and memory, motivation and emotion, perception and personality. Today we chuckle at some of his guesses, like his suggestion that a meal makes us sleepy by causing gas and heat to collect around what he believed was the source of our personality, the heart. But credit Aristotle with asking the right questions.

Psychology’s First Laboratory



Wilhelm Wundt (1832–1920) Wundt established the first psychology laboratory at the University of Leipzig, Germany.

Philosophers' thinking about thinking continued until the birth of psychology as we know it. That happened on a December day in 1879, in a small, third-floor room at Germany's University of Leipzig. There, two young men were helping an austere, middle-aged professor, Wilhelm Wundt, create an experimental apparatus. Their machine measured how long it took for people to press a telegraph key after hearing a ball hit a platform (Hunt, 1993). Curiously, people responded in about one-tenth of a second when asked to press the key as soon as the sound occurred—and in about two-tenths of a second when asked to press the key as soon as they were consciously aware of perceiving the sound. (To be aware of one's awareness takes a little longer.) Wundt was seeking to measure "atoms of the mind"—the fastest and simplest mental processes. So began the first psychological laboratory, staffed by Wundt and psychology's first graduate students.

Psychology's First Schools of Thought

Before long, this new science of psychology became organized into different branches, or schools of thought, each promoted by pioneering thinkers. Two early schools were **structuralism** and **functionalism**.

structuralism
an early school of thought promoted by Wundt and Titchener; used introspection to reveal the structure of the human mind.

functionalism
an early school of thought promoted by James and influenced by Darwin; explored how mental and behavioral processes function—how they enable the organism to adapt, survive, and flourish.

STRUCTURALISM

Macmillan Learning

Edward Bradford Titchener (1867–1927) Titchener used introspection to search for the mind's structural elements.

Much as chemists developed the periodic table to classify chemical elements, so psychologist Edward Bradford Titchener aimed to classify and understand elements of the mind's structure. He engaged people in self-reflective *introspection* (looking inward), training them to report elements of their experience as they looked at a rose, listened to a metronome, smelled a scent, or tasted a substance. What were their immediate sensations, their images, their feelings? And how did these relate to one another? Alas, structuralism's technique of introspection proved somewhat unreliable. It required smart, verbal people, and its results varied from person to person and experience to experience. As introspection waned, so did structuralism. Hoping to assemble the mind's structure from simple elements was rather like trying to understand a car by examining its disconnected parts.

FUNCTIONALISM

Philosopher-psychologist William James sought to go beyond labeling our inward thoughts and feelings by considering their evolved *functions.* Smelling is what the nose does; thinking is what the brain does. But *why* do the nose and brain do these things? Under the influence of evolutionary theorist Charles Darwin, James assumed that thinking, like smelling, developed because it was *adaptive*—it helped our ancestors survive and reproduce. Consciousness serves a function. It enables us to consider our past, adjust to our present, and plan our future. To explore the mind's adaptive functions, James studied down-to-earth emotions, memories, willpower, habits, and moment-to-moment streams of consciousness.

James' writings moved the publisher Henry Holt to offer James a contract for a textbook on the new science of psychology. James agreed and began work in 1878, with an apology for requesting two years to finish his writing. The text proved an unexpected chore and actually took him 12 years. (Why are we not surprised?) More than a century later, people still read the resulting *Principles of Psychology* (1890) and marvel at the brilliance and elegance with which James introduced psychology to the educated public.

Psychology's First Women

James' legacy stems from his Harvard mentoring as well as from his writing. In 1890—thirty years before American women had the right to vote—he admitted Mary Whiton Calkins into his graduate seminar over the objections of Harvard's president (Scarborough & Furumoto, 1987). When Calkins joined, the other students (all men) dropped out. So James tutored her alone. Later, she finished all of Harvard's Ph.D. requirements, outscoring all the male students on the qualifying exams. Alas, Harvard denied her the degree she had earned, offering her instead a doctorate from Radcliffe College, its undergraduate “sister” school for women. Calkins resisted the unequal treatment and refused the degree. She nevertheless went on to become a distinguished memory researcher and, in 1905, the first female president of the American Psychological Association (APA).

Macmillan Learning

William James (1842–1910) and Mary Whiton Calkins (1863–1930) James was a legendary teacher-writer who authored an important 1890 psychology text. He mentored Calkins, who became a pioneering memory researcher and the first female president of the American Psychological Association.

Macmillan Learning

Margaret Floy Washburn (1871–1939)
The first woman to receive a psychology Ph.D., Washburn synthesized animal behavior research in *The Animal Mind* (1908).

The honor of being the first official female psychology Ph.D. later fell to Margaret Floy Washburn, who also wrote an influential book, *The Animal Mind,* and became the second female APA president in 1921. But Washburn's gender barred doors for her, too. Although her thesis was the first foreign study Wundt published in his psychology journal, she could not join the all-male organization of experimental psychologists founded by Titchener, her own graduate adviser (Johnson, 1997). What a different world from the recent past: Between 1997 and 2019, more than half of the elected presidents of the science-focused Association for Psychological Science (APS) were women. In the United States, Canada, and Europe, women now earn most psychology doctorates.

(a)

(b)

Top: 1964 meeting of the Society of Experimental Psychologists in Berkeley, California. Reprinted by permission of the Society of Experimental Psychologists. http://www.sepsych.org/1964.php; bottom: Gordon B. Moskowitz, professor in Lehigh's Department of Psychology

Psychology increasing diversity At this 1964 meeting of the Society of Experimental Psychologists (a), Eleanor Gibson was easy to spot among the many male members, all in a sea of White faces. By contrast, women now are 62 percent of Association for Psychological Science members and 75 percent of its psychology student affiliates, as is clear in this current photo of APS graduate students (b). People of color have made enormous contributions to the field (see, for example, coverage of Kenneth Clark and Mamie Phipps Clark in Chapter 1), and psychology's diversity continues to grow. For more on the history of these changes, see Appendix A, the Story of Psychology: A Timeline.

ASK YOURSELF

How do you think psychology might change in the future as more women, and others from historically excluded groups, contribute their ideas to the field?

RETRIEVAL PRACTICE

RP-2 What event defined the start of scientific psychology?

RP-3 Why did introspection fail as a method for understanding how the mind works?

RP-4 The school of __________ used introspection to define the mind's makeup; __________ focused on how mental processes enable us to adapt, survive, and flourish.

ANSWERS IN *APPENDIX E*

Psychological Science Matures

LOQ P-5

How did behaviorism, Freudian psychology, and humanistic psychology further the development of psychological science?

In psychology's early days, many psychologists shared with the English essayist C. S. Lewis the view that "there is one thing, and only one in the whole universe which we know more about than we could learn from external observation." That one thing, Lewis said, is ourselves. "We have, so to speak, inside information" (1960, pp. 18–19). Wundt and Titchener focused on inner sensations, images, and feelings. James also engaged in introspective examination of the stream of consciousness and of emotion, hoping to understand how they help humans survive and thrive. For these and other early pioneers, *psychology* was defined as "the science of mental life."

Behaviorism

That definition endured until the 1920s, when the first of two provocative American psychologists challenged it. John B. Watson and, later, B. F. Skinner dismissed introspection and redefined *psychology* as "the scientific study of observable behavior." After all, they said, science is rooted in observation: What you cannot observe and measure, you cannot scientifically study. You cannot observe a sensation, a feeling, or a thought, but you *can* observe and record people's *behavior* as they are *conditioned*—as they respond to and learn in different situations. Many agreed, and **behaviorism** was one of two major forces in psychology well into the 1960s.

behaviorism
the view that psychology (1) should be an objective science that (2) studies behavior without reference to mental processes. Most psychologists today agree with (1) but not with (2).

Macmillan Learning

John B. Watson (1878–1958) and Rosalie Rayner (1898–1935) Working with Rayner, Watson championed psychology as the scientific study of behavior. In a controversial study on a baby who became famous as “Little Albert,” he and Rayner showed that fear could be learned.

Macmillan Learning

B. F. Skinner (1904–1990) This leading behaviorist rejected introspection and studied how consequences shape behavior.

Freudian (Psychoanalytic) Psychology

The other major force was Sigmund Freud's *psychoanalytic psychology,* which emphasized the ways our unconscious mind and childhood experiences affect our behavior. (In chapters to come, we'll look more closely at Freud's teachings, including his theory of personality, and his views on unconscious sexual conflicts and the mind's defenses against its own wishes and impulses.)

Macmillan Learning

Sigmund Freud (1856–1939) The controversial ideas of this famed personality theorist and therapist have influenced humanity's self-understanding.

Humanistic Psychology

As the behaviorists had rejected the early twentieth-century definition of *psychology,* other groups rejected the behaviorist definition. In the 1960s, **humanistic psychologists**, led by Carl Rogers and Abraham Maslow, found both behaviorism and Freudian psychology too limiting. Rather than focusing on conditioned responses or childhood memories, the humanistic psychologists focused on our growth potential, our needs for love and acceptance, and the environments that nurture or limit personal growth.

humanistic psychology
a historically significant perspective that emphasized human growth potential.

RETRIEVAL PRACTICE

RP-5 From the 1920s through the 1960s, the two major forces in psychology were ____________ and ____________ psychology.

ANSWERS IN APPENDIX E

Contemporary Psychology

LOQ P-6

How has contemporary psychology focused on cognition, on biology and experience, on culture and gender, and on human flourishing?

Simultaneous with humanistic psychology's emergence, psychologists in the 1960s pioneered a *cognitive revolution.* This led the field back to its early interest in how our mind processes and retains information. **Cognitive psychology** today continues its scientific exploration of how we perceive, process, and remember information, and of how thinking and emotion interact in anxiety, depression, and other disorders. The marriage of cognitive psychology (the science of mind) and neuroscience (the science of brain) gave birth to **cognitive neuroscience**. This specialty, with researchers in many disciplines, studies the brain activity underlying mental activity.

cognitive psychology
the study of mental processes, such as occur when we perceive, learn, remember, think, communicate, and solve problems.
cognitive neuroscience
the interdisciplinary study of the brain activity linked with cognition (including perception, thinking, memory, and language).

Today's psychology builds on the work of many earlier scientists and schools of thought. To encompass psychology's concern with observable behavior *and* with inner thoughts and feelings, we now define **psychology** as the *science of behavior and mental processes.* Let's unpack this definition. *Behavior* is anything an organism *does*—any action we can observe and record. Yelling, smiling, blinking, sweating, talking, tweeting, and questionnaire marking are all observable behaviors. *Mental processes* are our internal, subjective experiences—our sensations, perceptions, dreams, thoughts, beliefs, and feelings.

psychology
the science of behavior and mental processes.

The key word in today's definition of psychology is *science*. Psychology is less a set of findings than a way of asking and answering questions. Our aim, then, is not merely to report results but also to show you how psychologists play their game. You will see how researchers evaluate conflicting opinions and ideas. And you will learn how all of us, whether scientists or simply curious people, can think harder and smarter when experiencing and explaining the events of our lives.

Psychology—the science of behavior and mental processes—has roots in many disciplines and countries. The young science of psychology developed from the more established fields of philosophy and biology. Wundt was both a philosopher and a physiologist. James was an American philosopher. Freud was an Austrian physician. Ivan Pavlov, who pioneered the study of learning, was a Russian physiologist. Jean Piaget, the last century's most influential observer of children, was a Swiss biologist. These "Magellans of the mind," as psychology historian Morton Hunt (1993) called them, illustrate the diversity of psychology's origins.

Like those pioneers, today's estimated 1+ million psychologists are citizens of many lands (Zoma & Gielen, 2015). The International Union of Psychological Science has 82 member nations, from Albania to Zimbabwe. In China, the first university psychology department was established in 1978; by 2016 there were 270 (Zhang, 2016). Psychology is both *growing* and *globalizing*. The story of psychology is being written in many places, with interests ranging from the study of nerve cell activity to the study of international conflicts. Contemporary psychology, shaped by many forces, is particularly influenced by our understanding of biology and experience, culture and gender, and human flourishing.

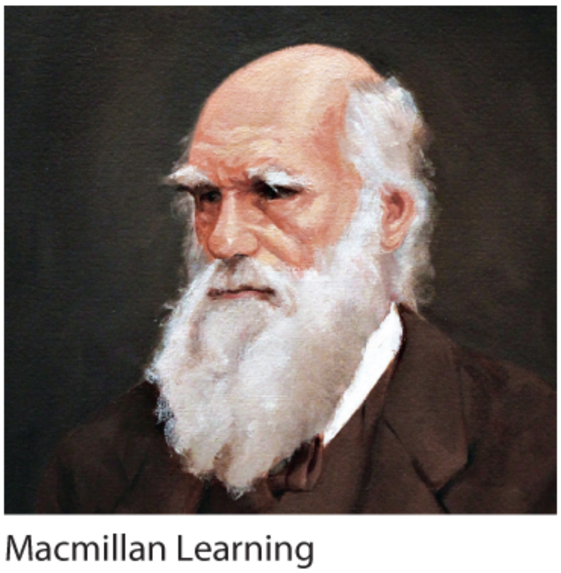
ASK YOURSELF

How would you have defined psychology before taking this class?

Evolutionary Psychology and Behavior Genetics

Are our human traits inherited, or do they develop through experience? This has been psychology's biggest and most persistent issue. But the debate over the **nature–nurture issue** is ancient. The Greek philosopher Plato (428–348 B.C.E.) assumed that we inherit character and intelligence and that certain ideas are inborn. Aristotle (384–322 B.C.E.) countered that there is nothing in the mind that does not first come in from the external world through the senses.

nature–nurture issue
the longstanding controversy over the relative contributions that genes and experience make to the development of psychological traits and behaviors. Today's science sees traits and behaviors arising from the interaction of nature and nurture.



Charles Darwin (1809–1882) Darwin argued that natural selection shapes behaviors as well as bodies.

In the 1600s, European philosophers rekindled the debate. John Locke argued that the mind is a blank slate on which experience writes. René Descartes disagreed, believing that some ideas are innate. Descartes' views gained support from a curious naturalist two centuries later. In 1831, an indifferent student but ardent collector of beetles, mollusks, and shells set sail on a historic round-the-world journey. The 22-year-old voyager, Charles Darwin, pondered the incredible species variation he encountered, including tortoises on one island that differed from those on nearby islands. Darwin's *On the Origin of Species* (1859) explained this diversity by proposing the evolutionary process of **natural selection:** From among chance variations, nature selects traits that best enable an organism to survive and reproduce in a particular environment. Darwin's principle of natural selection—what philosopher Daniel Dennett (1996) has called "the single best idea anyone has ever had"—is still with us 160+ years later as biology's organizing principle. Evolution also has become an important principle for twenty-first-century psychology. This would surely have pleased Darwin, who believed his theory explained not only animal structures (such as a polar bear's white coat) but also animal behaviors (such as the emotional expressions associated with human lust and rage).

natural selection
the principle that the inherited traits enabling an organism to survive and reproduce in a particular environment will (in competition with other trait variations) most likely be passed on to succeeding generations.

The nature–nurture issue recurs throughout this text as today's psychologists explore the relative contributions of biology and experience. They ask, for example: How are we humans *alike* because of our common biology and evolutionary history? That's the focus of **evolutionary psychology**. And how do we individually *differ* because of our differing genes and environments? That's the focus of **behavior genetics**.

evolutionary psychology
the study of the evolution of behavior and the mind, using principles of natural selection.
behavior genetics

the study of the relative power and limits of genetic and environmental influences on behavior.

A nature-made nature–nurture experiment Identical twins have the same genes. This makes them ideal participants in studies designed to shed light on hereditary and environmental influences on personality, intelligence, and other traits. Fraternal twins have different genes but often share a similar environment. Twin studies provide a wealth of findings—described in later chapters—showing the importance of both nature and nurture.

We can, for example, ask: Are gender differences biologically predisposed or socially constructed? Is children's grammar mostly innate or formed by experience? How are intelligence and personality differences influenced by heredity and by environment? Are sexual behaviors more "pushed" by inner biology or "pulled" by external incentives? Should we treat psychological disorders—depression, for example—as disorders of the brain, disorders of thought, or both?

Such debates continue. Yet over and over again we will see that in contemporary science the nature–nurture tension dissolves: *Nurture works on what nature provides.* In Chapter 4, you'll also learn about *epigenetics*—how experience can influence genetic expression. And in [Chapter 2] you will see that our species has been graced with the great biological gift of brain *plasticity:* an enormous capacity to learn and adapt. Moreover, every psychological event (every thought, every emotion) is simultaneously a biological event. Thus, depression can be both a brain disorder *and* a thought disorder.

ASK YOURSELF

Think of one of your own traits. (For example, are you a planner or a procrastinator—do you usually complete assignments on time, or late? Are you more an extravert or introvert—do you become energized by social interactions, or recharge by spending time alone?) How do you think that trait was influenced by nature and nurture?

RETRIEVAL PRACTICE

RP-6 How did the cognitive revolution affect the field of psychology?
RP-7 What is natural selection?
RP-8 What is contemporary psychology's position on the nature–nurture issue?

ANSWERS IN APPENDIX E

Cross-Cultural and Gender Psychology

What can we learn about people in general from psychological studies done in one time and place—often with participants from what psychologists have called the WEIRD cultures (*W*estern, *E*ducated, *I*ndustrialized, *R*ich, and *D*emocratic [Henrich et al., 2010; Hruschka et al., 2018])? As we will see time and again, **culture**—shared ideas and behaviors that one generation passes on to the next—matters. Our culture shapes our standards of promptness and frankness, our attitudes toward premarital sex and varying body shapes, our tendency to be casual or formal, our willingness to make eye contact, our conversational distance, and much, much more. Being aware of such differences, we can restrain our assumptions that others will think and act as we do.

culture
the enduring behaviors, ideas, attitudes, values, and traditions shared by a group of people and transmitted from one generation to the next.

Left: Jane Barlow/Getty Images; right: Hemis/Alamy

Culture and kissing Kissing crosses cultures. Yet how we do it varies. Imagine yourself kissing someone on the lips. Do you tilt your head right or left? In Western cultures, in which people read from left to right, about two-thirds of couples kiss right, as in Prince Harry and Duchess Meghan's wedding kiss and Auguste Rodin's sculpture, *The Kiss.* In one study, 77 percent of Hebrew- and Arabic-language right-to-left readers kissed tilting left (Shaki, 2013).

> **"All people are the same; only their habits differ."** — Confucius, 551–479 B.C.E.

It is also true, however, that our shared biological heritage unites us as a universal human family. Some aspects of our humanity—how we see and hear, how our bodies respond to stress, how our smiles communicate feeling—we share with all humans (Stroebe et al., 2018). The same underlying processes guide people everywhere. Some examples:

- People diagnosed with *specific learning disorder* (formerly called dyslexia) exhibit the same brain malfunction whether they are Italian, French, or British (Paulesu et al., 2001).
- Variation in languages may impede communication across cultures. Yet all languages share deep principles of grammar.
- People in different cultures vary in feelings of loneliness (Lykes & Kemmelmeier, 2014). But across cultures, loneliness is magnified by shyness, low self-esteem, and being unmarried (Jones et al., 1985; Rokach et al., 2002).

Left: Roy Toft/National Geographic Creative; right: Antonia Brune

A smile is a smile the world around This book tells the story of psychology as a global science, one that studies and celebrates cultural and gender similarities and differences. For example, cultural norms vary in when and how often people should smile, but a naturally happy smile *means* the same thing anywhere in the world.

We are each in certain respects like all others, like some others, and like no other. Studying people from all cultures helps us discern our similarities and our differences, our human kinship and our diversity.

You will see throughout this book that our *gender identity*—our sense of being male, female, neither, or some combination of male and female—also matters, as does our biologically influenced *sex*. Today's researchers report gender differences in what we dream, in how we express and detect emotions, and in our risk for alcohol use disorder, depression, and eating disorders. Gender differences fascinate us, and studying them is potentially beneficial. For example, many researchers have observed that women carry on conversations more readily to build relationships, while men talk more to give information and advice (Tannen, 2001). Understanding these differences can help us prevent conflicts and misunderstandings in everyday interactions.

But again, psychologically as well as biologically, humans are overwhelmingly similar. Regardless of gender, we learn to walk at about the same age. We experience the same sensations of light and sound. We remember vivid emotional events and forget mundane details. We feel the same pangs of hunger, desire, and fear. We exhibit similar overall intelligence and well-being.

The point to remember: Even when specific attitudes and behaviors vary by gender or across cultures, as they often do, the underlying processes are much the same.

ASK YOURSELF

How have your cultural experiences influenced your development?

Our online learning tools will help you excel in this course. Take advantage of the adaptive quizzing that adjusts to your individual needs, ***Assess Your Strengths*** personal self-assessments, interactive simulations, and ***How Would You Know?*** research activities.

For an excellent tour of psychology's roots, view the 9.5-minute ***Video: The History of Psychology.***

Positive Psychology

Psychology's first hundred years often focused on understanding and treating troubles, such as abuse and anxiety, depression and disease, prejudice and poverty. Much of today's psychology continues the exploration of such challenges. Without slighting the need to repair damage and cure disease, Martin Seligman and others (2002, 2011, 2016) have called for more research on *human flourishing*—on understanding and developing the emotions and traits that help us to thrive. These psychologists call their approach **positive psychology**. They believe that happiness is a by-product of a pleasant, engaged, and meaningful life. Thus, positive psychology uses scientific methods to explore the building of a "good life" that engages our skills, and a "meaningful life" that points beyond ourselves.

positive psychology
the scientific study of human flourishing, with the goals of discovering and promoting strengths and virtues that help individuals and communities to thrive.

Psychology's Three Main Levels of Analysis

LOQ P-7

How do psychologists use the biopsychosocial approach, and how can it help us understand our diverse world?

We all share a biologically rooted human nature. Yet many psychological and social-cultural influences fine-tune our assumptions, values, and behaviors. We differ individually by gender identity, physical ability, and sexual orientation. And each of us is a complex system that is part of a larger social system—a family, ethnic group, culture, and *socioeconomic* status (combines education, income, and occupation). The **biopsychosocial approach** integrates these three **levels of analysis**—the biological, psychological, and social-cultural.

biopsychosocial approach
an integrated approach that incorporates biological, psychological, and social-cultural levels of analysis.
levels of analysis
the differing complementary views, from biological to psychological to social-cultural, for analyzing any given phenomenon.

Consider horrific school shootings. Do they occur because the shooters have brain disorders or genetic tendencies that cause them to be violent? Because they observe brutality in the media or play violent video games? Because they live in a gun-toting society? The biopsychosocial approach enables psychologists to move beyond labels ("school shooter") and to consider the interconnected factors that may lead to violent acts (Pryor, 2019) (**FIGURE 1**). Clinical psychologists use this approach to help people with mental disorders (Teachman et al., 2019).

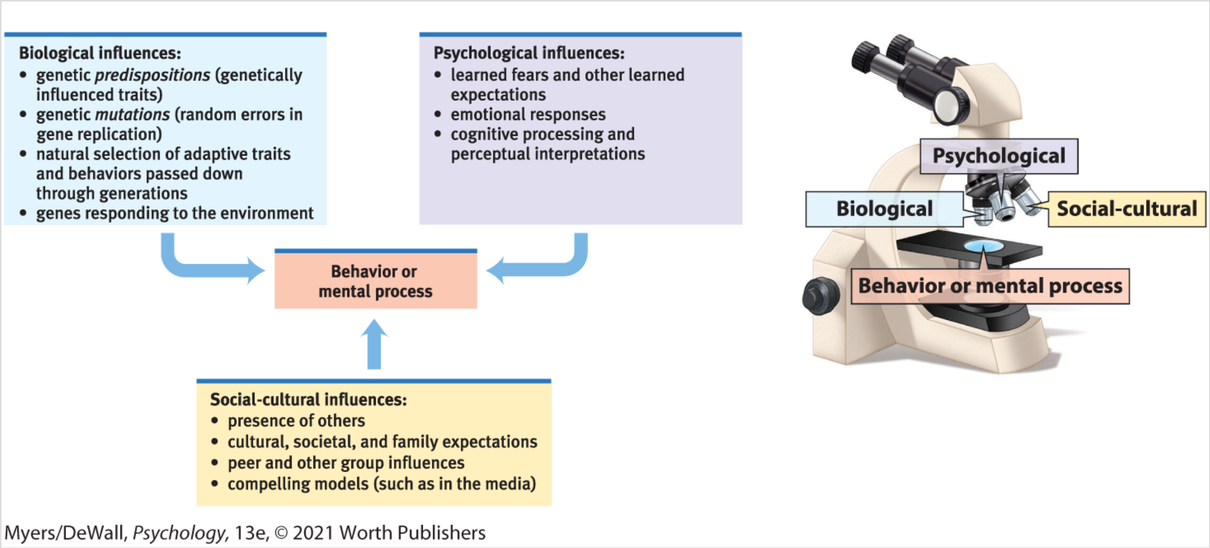


FIGURE 1 Biopsychosocial approach This integrated viewpoint incorporates various levels of analysis and offers a more complete picture of any given behavior or mental process.

Each level of analysis offers a perspective for looking at a behavior or mental process, yet each by itself is incomplete. Each perspective described in TABLE 1 asks different questions and has its limits, but together they complement one another. Consider, for example, how they shed light on anger:

- Someone working from a ***neuroscience perspective*** might study brain circuits that cause us to be red in the face and "hot under the collar."
- Someone working from an ***evolutionary perspective*** might analyze how anger facilitated the survival of our ancestors' genes.
- Someone working from a ***behavior genetics perspective*** might study how heredity and experience influence our individual differences in temperament.

- Someone working from a ***psychodynamic perspective*** might view an outburst as an outlet for unconscious hostility.
- Someone working from a ***behavioral perspective*** might attempt to determine what triggers aggressive acts.
- Someone working from a ***cognitive perspective*** might study how our interpretation of a situation affects our anger and how our anger affects our thinking.
- Someone working from a ***social-cultural perspective*** might explore how expressions of anger vary across cultural contexts.

TABLE 1 Psychology's Theoretical Perspectives

Perspective	Focus	Sample Questions	Examples of Subfields Using This Perspective
Neuroscience	How the body and brain enable emotions, memories, and sensory experiences	How do pain messages travel from the hand to the brain? How is blood chemistry linked with moods and motives?	Biological; cognitive; clinical
Evolutionary	How the natural selection of traits has promoted the survival of genes	How does evolution influence behavior tendencies?	Biological; developmental; social
Behavior genetics	How our genes and our environment influence our	To what extent are psychological traits such as intelligence, personality, sexual orientation, and	Personality; developmental; legal/forensic

	individual differences	vulnerability to depression products of our genes? Of our environment?	
Psychodynamic	How behavior springs from unconscious drives and conflicts	How can someone's personality traits and disorders be explained by unfulfilled wishes and childhood traumas?	Clinical; counseling; personality
Behavioral	How we learn observable responses	How do we learn to fear particular objects or situations? What is the most effective way to alter our behavior, say, to lose weight or stop smoking?	Clinical; counseling; industrial-organizational
Cognitive	How we encode, process, store, and retrieve information	How do we use information in remembering? Reasoning? Solving problems?	Cognitive neuroscience; clinical; counseling; industrial-organizational
Social-cultural	How behavior and thinking vary across situations and cultures	How are we affected by the people around us, and by our surrounding culture?	Developmental; social; clinical; counseling

The point to remember: Like two-dimensional views of a three-dimensional object, each of psychology's perspectives is helpful. But each by itself fails to reveal the whole picture.

ASK YOURSELF

Which of psychology's theoretical perspectives do you find most interesting? Why?

RETRIEVAL PRACTICE

RP-9 What advantage do we gain by using the biopsychosocial approach in studying psychological events?

RP-10 The ________-________ perspective in psychology focuses on how behavior and thought differ from situation to situation and from culture to culture, while the ________ perspective emphasizes observation of how we respond to and learn in different situations.

ANSWERS IN APPENDIX E

Psychology's Subfields

LOQ P-8

What are psychology's main subfields?

Picturing a chemist at work, you may envision a laboratory scientist surrounded by test tubes and high-tech equipment. Picture a psychologist at work, and you would be right to envision

- a white-coated scientist probing a rat's brain.
- an intelligence researcher measuring how quickly an infant shows boredom by looking away from a familiar picture.
- an executive evaluating a new "healthy lifestyles" training program for employees.
- a researcher at a computer analyzing "big data" from social media status updates or Google searches.
- a therapist actively listening to a depressed client's thoughts.

- a traveling academic visiting another culture and collecting data on variations in human values and behaviors.
- a teacher or writer sharing the joy of psychology with others.

The cluster of subfields we call psychology is a meeting ground for different disciplines. Thus, it's a perfect home for those with wide-ranging interests. In its diverse activities, from biological experimentation to cultural comparisons, the tribe of psychology is united by a common quest: *describing and explaining behavior and the mind underlying it*.

"I'm a social scientist, Michael. That means I can't explain electricity or anything like that, but if you ever want to know about people I'm your man."
J.B. Handelsman/Cartoon Stock

Some psychologists conduct **basic research** that builds psychology's knowledge base. We will meet a wide variety of such researchers, including *biological psychologists* exploring the links between body and mind; *developmental psychologists* studying our changing abilities from womb to tomb; *cognitive psychologists* experimenting with how we perceive, think, and solve problems; *personality psychologists* investigating our persistent traits; and *social psychologists* exploring how we view and affect one another.

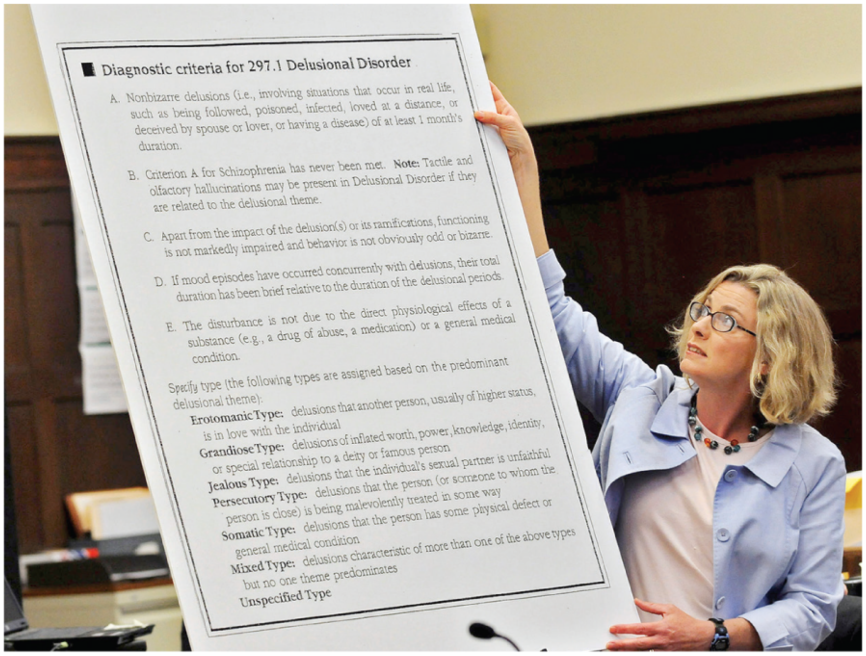
basic research
pure science that aims to increase the scientific knowledge base.

These and other psychologists also may conduct **applied research**, tackling practical problems. *Industrial-organizational psychologists,* for example, use psychology's concepts and methods in the workplace to help organizations and companies select and train employees, boost morale and productivity, design products, and implement systems.

applied research
scientific study that aims to solve practical problems.

Psychology is a science, but it is also a profession that helps people have healthier relationships, overcome feelings of anxiety or depression, and raise thriving children. *Counseling psychology* and *clinical psychology* grew out of different historical traditions. Early counseling psychologists offered job skills guidance, whereas clinical psychologists worked alongside psychiatrists to assess and provide psychotherapy to people in the first psychology clinics. Today's counseling psychologists and clinical psychologists have a lot in common. **Counseling psychologists** help people to cope with challenges and crises (including academic, vocational, and relationship issues) and assist those with psychological disorders to improve their personal and social functioning. **Clinical psychologists** focus on assessing and treating people with mental, emotional, and behavior disorders. Both counseling and clinical psychologists administer and interpret tests, provide counseling and therapy to people with all levels of psychological difficulties, and undergo the same licensing exams. They sometimes also conduct basic and applied research. By contrast, **psychiatrists,** who also may provide psychotherapy, are medical doctors licensed to prescribe drugs and otherwise treat physical causes of psychological disorders.

counseling psychology
a branch of psychology that assists people with problems in living (often related to school, work, or relationships) and in achieving greater well-being.
clinical psychology
a branch of psychology that studies, assesses, and treats people with psychological disorders.
psychiatry
a branch of medicine dealing with psychological disorders; practiced by physicians who sometimes provide medical (for example, drug) treatments as well as psychological therapy.



Ted Fitzgerald/AP Images

Psychology in court *Forensic psychologists* apply psychology's principles and methods in the criminal justice system. They may assess witness credibility or testify in court about a defendant's state of mind and future risk.

Rather than seeking to change people to fit their environment, **community psychologists** work to create social and physical environments that are healthy for all (Bradshaw et al., 2009; Trickett, 2009). To prevent bullying, they might consider ways to improve the culture of the school and neighborhood, and how to increase bystander intervention (Polanin et al., 2012).

community psychology
a branch of psychology that studies how people interact with their social environments and how social institutions (such as schools and neighborhoods) affect individuals and groups.

With perspectives ranging from the biological to the social, and with settings ranging from the laboratory to the clinic to the office, psychology relates to many fields. Psychologists teach in medical schools, business schools, law schools, and theological seminaries, and they work in hospitals, factories, and corporate offices. They engage in interdisciplinary studies, such as psychobiography (the study of the lives and personalities of public figures), psycholinguistics (the study of language and thinking), and psychoceramics (the study of crackpots).[1]

Left: LAURENT/GLICK/AGE Fotostock; center: Hope College Public Relations; right: Scott J. Ferrell/Getty Images

Psychology: A science and a profession Psychologists experiment with, observe, test, and help modify behavior. Here we see psychologists testing a child, measuring emotion-related physiology, and doing face-to-face therapy.

ASK YOURSELF

When you signed up for this course, what did you know about different psychology specialties?

Want to learn more? See Appendix B, Career Fields in Psychology, at the end of this book, and go to our online ***Pursuing a Psychology Career*** resource to learn about the many interesting options available to those with bachelor's, master's, and doctoral degrees in psychology. To review and test your understanding of psychology's perspectives and subfields, engage online with ***Concept Practice: Psychology's Current Perspectives*** and ***Concept Practice: Psychology's Subfields.***

Psychology also influences culture. Knowledge transforms us. Learning about the solar system and the germ theory of disease alters the way people think and act. Learning about psychology's findings also changes people: They less often judge psychological disorders as moral failings, treatable by punishment and ostracism. They less often regard and treat women as men's mental inferiors. They less often view and raise children as ignorant, willful beasts in need of taming. "In each case," noted Morton Hunt (1990, p. 206), "knowledge has modified attitudes, and, through them, behavior." Once aware of psychology's well-researched ideas—about how body and mind connect, how a child's mind grows, how we construct our perceptions, how we learn and remember, how people across the world are alike (and different)—your mind may never again be the same.

> **"The mind, once stretched by a new idea, never returns to its original dimensions."** —Ralph Waldo Emerson, 1803–1882

But bear in mind psychology's limits. Don't expect it to answer the ultimate questions, such as those posed by Russian novelist Leo Tolstoy (1904): "Why should I live? Why should I do anything? Is there in life any purpose which the inevitable death that awaits me does not undo and destroy?"

Although many of life's significant questions are beyond psychology, some very important ones are illuminated by even a first psychology course. Through painstaking research, psychologists have gained insights into brain and mind, dreams and memories, depression and joy. Even the unanswered questions can renew our sense of mystery about things we do not yet understand. Moreover, your study of psychology can help teach you how to ask and answer important questions—how to think critically as you evaluate competing ideas and claims.

> **"I have uttered what I did not understand, things too wonderful for me."** — Job 42:3

Psychology deepens our appreciation for how we humans perceive, think, feel, and act. By so doing, it can enrich our lives and enlarge our vision. Through this book we hope to help guide you toward that end. As educator Charles Eliot said a century ago: "Books are the quietest and most constant of friends, and the most patient of teachers."

RETRIEVAL PRACTICE

RP-11 Match the specialty (i through iii) with the description (a through c).

i. Clinical	a. works to create social and physical environments that are healthy for

psychology	all
ii. Psychiatry	b. studies, assesses, and treats people with psychological disorders but usually does not provide medical therapy
iii. Community psychology	c. is a branch of medicine dealing with psychological disorders

ANSWERS IN APPENDIX E

Use Psychology to Become a Stronger Person—and a Better Student

LOQ P-9

How can psychological principles help you learn, remember, and thrive?

Psychology is not just about understanding others; it is also about understanding ourselves. It is only through such learning that we can be—and show to the world—our best selves. Throughout this text, we will offer evidence-based suggestions that you can use to live a happy, effective, flourishing life, including the following:

- ***Manage your time to get a full night's sleep.*** Unlike sleep-deprived people, who live with fatigue and gloomy moods, well-rested people live with greater energy, happiness, and productivity.

- ***Make space for exercise.*** Aerobic activity not only increases health and energy; it also is an effective remedy for mild to moderate depression and anxiety.
- ***Set long-term goals, with daily aims.*** Successful people take time each day to work toward their goals, such as exercising or sleeping more, or eating more healthfully. Over time, they often find that their daily practice becomes a habit.
- ***Have a growth mindset.*** Rather than seeing their abilities as fixed, successful people view their abilities as like a muscle—something that grows stronger with effortful use.
- ***Prioritize relationships.*** We humans are social animals. We flourish when connected in close relationships. We are both happier and healthier when supported by (and when supporting) caring friends.

Psychology's research also shows how we can learn and retain information. Many students assume that the way to cement new learning is to reread. What helps more—and what this book therefore encourages—is *repeated self-testing and rehearsal* of previously studied material. Memory researchers Henry Roediger and Jeffrey Karpicke (2006) call this phenomenon the **testing effect**. (It is also sometimes called the *retrieval practice effect* or *test-enhanced learning*.) They note that "testing is a powerful means of improving learning, not just assessing it." In one study, English-speaking students who had been tested repeatedly recalled the meaning of 20 previously learned Lithuanian words better than those who had spent the same time restudying the words (Ariel & Karpicke, 2018).

Repetitive testing's rewards also make it reinforcing: Students who used repetitive testing once found it helped, and more often used it later when learning new material.

testing effect
enhanced memory after retrieving, rather than simply rereading, information. Also referred to as a *retrieval practice effect* or *test-enhanced learning.*

Many other studies, including in college classrooms, confirm that *frequent quizzing and self-testing boosts students' retention* (Cho et al., 2017; Foss & Pirozzolo, 2017; Trumbo et al., 2016).

> **"If you read a piece of text through twenty times, you will not learn it by heart so easily as if you read it ten times while attempting to recite it from time to time and consulting the text when your memory fails."** — Francis Bacon, *Novum Organum*, 1620

As you will see in Chapter 8, to master information you must *actively process it.* In one digest of 225 studies, students engaged in active learning showed the highest examination performance in science, technology, engineering, and mathematics (the STEM fields) (Freeman et al., 2014). Likewise, when learning a new language, those who practice speaking it learn better than those who passively listen to it (Hopman & MacDonald, 2018). Better to talk than listen. So don't treat your mind like your stomach, something to be filled passively. Treat it more like a muscle that grows stronger with exercise. Countless experiments reveal that people learn and remember best when they put material in their own words, rehearse it, and then retrieve and review it again.

The *SQ3R* study method incorporates these principles (McDaniel et al., 2009; Robinson, 1970). **SQ3R** is an acronym for its five steps: *S*urvey, *Q*uestion, *R*ead, *R*etrieve,[2] *R*eview.

SQ3R
a study method incorporating five steps: *S*urvey, *Q*uestion, *R*ead, *R*etrieve, *R*eview.

To study a chapter, first *survey,* taking a bird's-eye view. Scan the table of contents on the chapter's first page, and notice the organization.

Before you read each main section, try to answer its numbered Learning Objective *Question* (for this section: "How can psychological principles help you learn, remember, and thrive?"). Researchers Roediger and Bridgid Finn (2010) have found that "trying and failing to retrieve the answer is actually helpful to learning." Those who test their understanding *before* reading, and discover what they don't yet know, will learn and remember better.

Then *read,* actively searching for the answer to the Learning Objective Question (LOQ).

At each sitting, read only as much of the chapter (usually a single main section) as you can absorb without tiring. Read actively and critically. Ask questions. Take notes. Make the ideas your own: How does what you've read relate to your own life? Does it support or challenge your assumptions? How convincing is the evidence? (Our new *Ask Yourself* questions and *Apply Psychological Science* features throughout each chapter will help you engage personally with the material.) Write out what you know. "Writing is often a tool for learning," say researchers (Arnold et al., 2017).

Having read a section, *retrieve* its main ideas: "Active retrieval promotes meaningful learning," says Karpicke (2012). So *test yourself.* This will not only help you figure out what you know; the testing itself will help you learn and retain the information more effectively. Even better, test yourself repeatedly. To facilitate this, we offer periodic *Retrieval Practice* questions throughout each chapter (for example, the questions at the end of this section). After answering these questions for yourself, you can check the answers in Appendix E and reread the material as needed.

> **"It pays better to wait and recollect by an effort from within, than to look at the book again."** — William James, *Principles of Psychology*, 1890

Finally, *review:* Read over any notes you have taken, again with an eye on the chapter's organization, and quickly review the whole chapter. Write or say what a concept is before rereading to check your understanding.

Survey, question, read, retrieve, review. We have organized this book's chapters to facilitate your use of the SQ3R study system. Each chapter begins with an outline that aids your *survey*. Headings and Learning Objective *Questions* suggest issues and concepts you should consider as you *read*. The material is organized into sections of readable length. The Retrieval Practice questions will challenge you to *retrieve* what you have learned, and thus *retain* it better. The end-of-section *Review* is set up as a self-test, with the collected Learning Objective Questions and key terms listed, along with Master the Material questions in a variety of formats. In the e-book, answer-checking is a click away. In the printed text, answers may be found in Appendix C and Appendix D. Survey, question, read …

Four additional study tips may further boost your learning:

Distribute your study time. One of psychology's oldest findings is that *spaced practice* promotes better retention than *massed practice*. You'll remember material better if you space your time over several study periods—perhaps one hour a day, six days a week—rather than cram it into one week-long or all-night study blitz. For example, rather than trying to read an entire chapter in a single sitting, read just one main section and then turn to something else. *Interleaving* your study of psychology with your study of other subjects boosts long-term retention and protects against overconfidence (Kornell & Bjork, 2008; Taylor & Rohrer, 2010).

Spacing your study sessions requires a disciplined approach to managing your time. For more tips on time management, see the new Student Preface—Student Success: How to Apply Psychology to Live Your Best Life at the beginning of this text.

Learn to think critically. Both inside and outside of this course, critical thinking—smart thinking—is a key to wisdom. Whether you are reading or conversing, note people's assumptions and values. What perspective or bias underlies an argument? Evaluate evidence. Is it anecdotal? Or is it based on informative experiments? Assess conclusions. Are there alternative explanations?

Process class information actively. Listen for the main ideas and sub-ideas of a lecture. *Write them down.* Ask questions during and after class. In class, as in your private study, process the information actively and you will understand and retain it better. As psychologist William James urged a century ago, *"No reception without reaction, no impression without … expression."* Make the information your own. Engage with the Ask Yourself questions and the Apply Psychological Science features found periodically throughout each chapter to relate what you read to your own life. Tell someone else about it. (As any teacher will confirm, to teach is to remember.)

Also, take notes *by hand.* Handwritten notes, in your own words, typically engage more active processing, with better retention, than does verbatim note taking on laptops (Mueller & Oppenheimer, 2014).

Worth Publishers

More learning tips To learn more about the testing effect and the SQ3R method, view the 5-minute animation, "Make Things Memorable," at tinyurl.com/HowToRemember.

Overlearn. Psychology tells us that overlearning improves retention. We are prone to overestimating how much we know. You may understand a chapter as you read it, but that feeling of familiarity can be deceptively comforting. By using the Retrieval Practice and Master the Material questions as well as our online learning opportunities, you can test your knowledge and *overlearn* in the process.

Memory experts Elizabeth Bjork and Robert Bjork (2011, p. 63) offer simple, scientifically supported advice for how to improve your retention and your grades:

Spend less time on the input side and more time on the output side, such as summarizing what you have read from memory or getting together with friends and asking each other questions. Any activities that involve testing yourself—that is, activities that require you to retrieve or generate information, rather than just representing information to yourself—will make your learning both more durable and flexible.

ASK YOURSELF

Of all of these helpful principles, which ones seem most relevant and important for improving your own life and studies? How will you add them to your usual routines?

RETRIEVAL PRACTICE

RP-12 The ____________ ____________ describes the enhanced memory that results from repeated retrieval (as in self-testing) rather than from simple rereading of new information.
RP-13 What does SQ3R stand for?

ANSWERS IN APPENDIX E

REVIEW The Story of Psychology

LEARNING OBJECTIVES

Test yourself Answer these repeated Learning Objective Questions on your own (before checking the answers in Appendix D) to improve your retention of the concepts (McDaniel et al., 2009, 2015).

LOQ P-1: How is psychology a science?
LOQ P-2: What are the three key elements of the scientific attitude, and how do they support scientific inquiry?
LOQ P-3: How does critical thinking feed a scientific attitude, and smarter thinking for everyday life?
LOQ P-4: What were some important milestones in psychology's early history?
LOQ P-5: How did behaviorism, Freudian psychology, and humanistic psychology further the development of psychological science?
LOQ P-6: How has contemporary psychology focused on cognition, on biology and experience, on culture and gender, and on human flourishing?
LOQ P-7: How do psychologists use the biopsychosocial approach, and how can it help us understand our diverse world?
LOQ P-8: What are psychology's main subfields?
LOQ P-9: How can psychological principles help you learn, remember, and thrive?

TERMS AND CONCEPTS TO REMEMBER

Test yourself Write down the definition in your own words, then check your answer.

empirical approach
critical thinking
structuralism
functionalism
behaviorism
humanistic psychology
cognitive psychology
cognitive neuroscience
psychology
nature–nurture issue
natural selection
evolutionary psychology
behavior genetics
culture
positive psychology
biopsychosocial approach
levels of analysis
basic research
applied research
counseling psychology
clinical psychology
psychiatry
community psychology
testing effect
SQ3R

MASTER THE MATERIAL

Test yourself Answer the following questions on your own first, then check your answers in Appendix E.

1. How can critical thinking help you evaluate claims in the media, even if you're not a scientific expert on the issue?
2. In 1879, in psychology's first experiment, ______________ ______________ and his students measured the time lag between hearing a ball hit a platform and pressing a key.
3. William James would be considered a(n) ______________. Wilhelm Wundt and Edward Titchener would be considered ______________.
   a. functionalist; structuralists
   b. structuralist; functionalists
   c. evolutionary theorist; structuralists
   d. functionalist; evolutionary theorists
4. In the early twentieth century, ______________ redefined psychology as "the science of observable behavior."
   a. John B. Watson
   b. Abraham Maslow
   c. William James
   d. Sigmund Freud
5. Nature is to nurture as

a. personality is to intelligence.
b. biology is to experience.
c. intelligence is to biology.
d. psychological traits are to behaviors.

6. "Nurture works on what nature provides." Describe what this means, using your own words.

7. Which of the following is true regarding gender differences and similarities?
   a. Differences among the genders outweigh any similarities.
   b. Despite some gender differences, the underlying processes of human behavior are the same.
   c. Both similarities and differences among the genders depend more on biology than on environment.
   d. Gender differences are so numerous that it is difficult to make meaningful comparisons.

8. Martin Seligman and other researchers who explore various aspects of human flourishing refer to their field of study as ________ ________.

9. A psychologist treating emotionally troubled adolescents at a local mental health agency is most likely to be a(n)
   a. research psychologist.
   b. psychiatrist.
   c. industrial-organizational psychologist.
   d. clinical psychologist.

10. A mental health professional with a medical degree who can prescribe medication is a ______________.

11. A psychologist conducting basic research to expand psychology's knowledge base may
    a. design a computer screen with limited glare and assess the effect on computer operators' eyes after a day's work.
    b. treat older people who are overcome by depression.
    c. observe 3- and 6-year-olds solving puzzles and analyze differences in their abilities.
    d. interview children with behavioral problems and suggest treatments.

Continue testing yourself with **LearningCurve** or **Achieve Read & Practice** to learn and remember most effectively.

CHAPTER 1
Thinking Critically With Psychological Science

Eva-Katalin/Getty Images

Hoping to satisfy their curiosity about people and to relieve their own woes, millions turn to “psychology.” They read advice columns aimed at helping people cope with their problems, overcome their addictions, and save their marriages. They watch “celebrity psychics” demonstrate their supposed powers. They attend stop-smoking hypnosis seminars. They play online games, hoping to strengthen their brain. They immerse themselves in self-help books, websites, and lectures that promise to teach the path to love, the road to personal happiness, and the “hacks,” or shortcuts, to success.

Others, intrigued by claims of psychological truth, wonder: How—and how much—does parenting shape children’s personalities and abilities? Are first-born children more driven to achieve? Do dreams have deep meaning? Do we sometimes remember events that never happened? Does psychotherapy heal?

In working with such questions, the science of psychology does more than speculate. To separate uninformed opinions from examined conclusions, psychologists use the *scientific method* to conduct research. Let’s consider how psychology’s researchers do their science.

Research Strategies: How Psychologists Ask and Answer Questions

The Need for Psychological Science

LEARNING OBJECTIVE QUESTION LOQ 1-1

How does our everyday thinking sometimes lead us to a wrong conclusion?

Some people think that psychology merely proves what we already know and then dresses it in jargon: “You get paid for using fancy methods to tell me what my grandmother knew?”

Indeed, Grandma’s common sense is often right. As the baseball great Yogi Berra (1925–2015) once said, “You can observe a lot by watching.” (We also have Berra to thank for other gems, such as “Nobody goes there anymore—it’s too crowded,” and “If the people don’t want to come out to the ballpark, nobody’s gonna stop ’em.”) Because we’re all behavior watchers, it would be surprising if many of psychology’s findings had *not* been foreseen. Many people believe that love breeds happiness, for example, and they are right (we have what Chapter 11 calls a deep “need to belong”).

But sometimes Grandma's common sense, informed by countless casual observations, is wrong. In later chapters, we will see how research has overturned popular ideas—that familiarity breeds contempt, that dreams predict the future, and that most of us use only 10 percent of our brain. We will also see how research has surprised us with discoveries about how the brain's chemical messengers control our moods and memories, about other animals' abilities, and about the effects of stress on our capacity to fight disease.

Other things seem like commonsense truth only because we so often hear them repeated. Mere repetition of statements—whether true or false—makes them easier to process and remember, and thus more true-seeming (Dechêne et al., 2010; Fazio et al., 2015). Easy-to-remember misconceptions ("Vitamin C prevents the common cold") can therefore overwhelm hard truths. This power of familiar, hard-to-erase falsehoods is a lesson well known to political manipulators, and kept in mind by critical thinkers.

> **"All effective propaganda must be limited to a very few points and must harp on these in slogans."** — Adolf Hitler, *Mein Kampf*, 1926

Three common flaws in commonsense thinking—*hindsight bias, overconfidence,* and *perceiving order in random events*—illustrate how, as novelist Madeleine L'Engle (1973) observed, "The naked intellect is an extraordinarily inaccurate instrument."

> **“Those who trust in their own wits are fools.”** — Proverbs 28:26

Did We Know It All Along? Hindsight Bias

Consider how easy it is to draw the bull’s-eye *after* the arrow strikes. After the stock market drops, people say it was “due for a correction.” After the athletic match, we credit the coach if a “gutsy play” wins and criticize the same “stupid play” if it doesn’t. After a war or an election, its outcome usually seems obvious. Although history may therefore seem like a series of inevitable events, the actual future is seldom foreseen. No one’s diary recorded, “Today the Hundred Years War began.”

> **“Life is lived forwards, but understood backwards.”** — Philosopher Søren Kierkegaard, 1813–1855

This **hindsight bias** is easy to demonstrate by giving half the members of a group some purported psychological finding and giving the other half an opposite result. Tell the first group, for example: “Psychologists have found that separation weakens romantic attraction. As the saying goes, ‘Out of sight, out of mind.’” Ask them to imagine why this might be true. Most people can, and after hearing an explanation, nearly all will then view this true finding as unsurprising.

hindsight bias
the tendency to believe, after learning an outcome, that one would have foreseen it. (Also known as the *I-knew-it-all-along phenomenon.*)

Tell the second group the opposite: “Psychologists have found that separation strengthens romantic attraction. As the saying goes, ‘Absence makes the heart grow fonder.’” People given this untrue result can also easily imagine it, and most will also see it as unsurprising. When opposite findings both seem like common sense, there is a problem.

> **“Anything seems commonplace, once explained.”** — Dr. Watson to Sherlock Holmes

Such errors in people’s recollections and explanations show why we need psychological research. It’s not that common sense is usually wrong. Rather, common sense describes, after the fact, what *has* happened better than it predicts what *will* happen.

More than 800 scholarly papers have shown hindsight bias in people young and old from around the world (Roese & Vohs, 2012). As physicist Niels Bohr reportedly jested, “Prediction is very difficult, especially about the future.”

Everett Collection/Newscom

Hindsight bias When drilling its Deep-water Horizon oil well in 2010, BP employees took shortcuts and ignored warning signs, without intending to harm people, the environment, or their company's reputation. *After* an explosion killed 11 employees and caused the largest ever marine oil spill, the foolishness of those judgments became (in hindsight) obvious.

Overconfidence

We humans tend to think we know more than we do. Asked how sure we are of our answers to factual questions *(Is Boston north or south of Paris?)*, we tend to be more confident than correct.[1]

Consider these three anagrams, shown beside their solutions (from Goranson, 1978):

WREAT → WATER
ETRYN → ENTRY
GRABE → BARGE

About how many seconds do you think it would have taken you to unscramble each of these? Did hindsight influence you? Knowing the answers tends to make us overconfident. (Surely the solution would take only 10 seconds or so?) In reality, the average problem solver spends 3 minutes, as you also might, given a similar anagram without the solution: OCHSA.[2]

Fun anagram solutions from Wordsmith (wordsmith.org):
Snooze alarms = Alas! No more z's
Dormitory = dirty room
Slot machines = cash lost in 'em

Are we any better at predicting social behavior? Psychologist Philip Tetlock (1998, 2005) collected more than 27,000 expert predictions of world events, such as the future of South Africa or whether Quebec would separate from Canada. His repeated finding: These predictions, which experts made with 80 percent confidence on average, were right less than 40 percent of the time. It turns out that only about 2 percent of people do an excellent job predicting social behavior. Tetlock (with Gardner, 2016) calls them "superforecasters." Superforecasters avoid overconfidence. Faced with a difficult prediction, a superforecaster "gathers facts, balances clashing arguments, and settles on an answer."

Overconfidence in history: "We don't like their sound. Groups of guitars are on their way out." — Decca Records, in turning down a recording contract with the Beatles in 1962

"Computers in the future may weigh no more than 1.5 tons." — *Popular Mechanics*, 1949

"They couldn't hit an elephant at this distance." — General John Sedgwick just before being killed during a U.S. Civil War battle, 1864

"No woman in my time will be prime minister." — Margaret Thatcher, 1969 (British Prime Minister, 1979–1990)

ASK YOURSELF

Do you have a hard time believing you may be overconfident? Could overconfidence be at work in that self-assessment? How might reading this section about overconfidence help reduce your tendency to be overconfident?

RETRIEVAL PRACTICE

RP-1 Why, after friends start dating, do we often feel that we *knew* they were meant to be together?

ANSWERS IN APPENDIX E

Perceiving Order in Random Events

We're born with an eagerness to make sense of our world. People see a face on the Moon, hear Satanic messages in music played backward, or perceive the Virgin Mary's image on a grilled cheese sandwich. Even in random data, we often find patterns, because—here's a curious fact of life—*random sequences often don't look random* (Falk et al., 2009; Nickerson, 2002, 2005). Flip a coin 50 times and you may be surprised at the streaks of heads or tails—much like supposed "hot" and "cold" streaks in basketball shooting and baseball hitting. In actual random sequences, patterns and streaks (such as repeating digits) occur more often than people expect (Oskarsson et al., 2009). That also makes it hard for people to generate random-like sequences. When embezzlers try to simulate random digits when specifying how much to steal, their nonrandom patterns can alert fraud experts (Poundstone, 2014).

Why are people prone to pattern-seeking? For most people, a random, unpredictable world is unsettling (Tullett et al., 2015). Making sense of our world relieves stress and helps us get on with daily living (Ma et al., 2017).

Some happenings, such as winning a lottery twice, seem so extraordinary that we find it difficult to conceive an ordinary, chance-related explanation. "But with a large enough sample," said statisticians Persi Diaconis and Frederick Mosteller (1989), "any outrageous thing is likely to happen." An event that happens to but

1 in 1 billion people every day occurs about 7 times a day, more than 2500 times a year.

“The really unusual day would be one where nothing unusual happens.” — Statistician Persi Diaconis (2002)

The point to remember: Our commonsense thinking is flawed due to three powerful tendencies—hindsight bias, overconfidence, and our tendency to perceive patterns in random events. But scientific inquiry can help us sift reality from illusion.

Play the role of a researcher using scientific inquiry to think smarter about random hot streaks in sports. Engage online with the activity ***How Would You Know If There Is a “Hot Hand” in Basketball?***

Psychological Science in a Post-Truth World

LOQ 1-2

Why are we so vulnerable to believing untruths?

In 2017, the Oxford English Dictionary’s word of the year was *post-truth*—describing a modern culture where people’s emotions and personal beliefs often override their acceptance of objective facts.

Consider two U.S. examples of such “truth decay”—of widely shared misinformation:

Belief: *The crime rate is rising.* Every recent year, 7 in 10 adults told Gallup that there is more crime “than there was a year ago” (Swift, 2016).

Fact: For several decades, both violent and property crime rates have been *falling*. In 2015, the violent crime rate was less than half the 1990 rate (BJS, 2017; Statista, 2017).

Belief: *Many immigrants are criminals* (McCarthy, 2017). Memorable incidents feed this narrative. Stories of an immigrant murdering, burglarizing, or lying spread through social networks and news outlets. Such fears are commonplace not only in North America but also in Europe and Australia (Nunziata, 2015).

Fact: Most immigrants are *not* criminals. Compared with native-born Americans, immigrants are 44 percent *less* likely to be imprisoned (CATO, 2017; Flagg, 2018, 2019). The same has been true in Italy, the United Kingdom, and elsewhere (Di Carlo et al., 2018).

Political party bias has distorted Americans’ thinking. Psychologist Peter Ditto and his colleagues (2019a,b) reported that researchers have found “partisan bias in both liberals and conservatives, and at virtually identical levels.” In the United States, a majority of Republicans believed unemployment had increased under Democratic President Barack Obama (it decreased), while a majority of strong Democrats believed inflation had worsened under Republican President Ronald Reagan (it improved) (Gelman, 2009; PPP, 2016). One study found that both U.S. Democrats and Republicans discriminate against the other-party candidates for college scholarships (Iyengar & Westwood, 2015). So, let none of us smugly think "Yes, but bias doesn't apply to *me*." Bias goes both ways.

U.S. Democrats and Republicans share concern about failures to separate fact from fiction. In his farewell address, President Barack Obama (2017) warned that without a "common baseline of facts," democracy is threatened: "We become so secure in our bubbles that we start accepting only information, whether it's true or not, that fits our opinions, instead of basing our opinions on the evidence that is out there." The late Republican Senator John McCain (2017) similarly expressed alarm about "the growing inability, and even unwillingness, to separate truth from lies."

Marty Bucella/Cartoon Stock

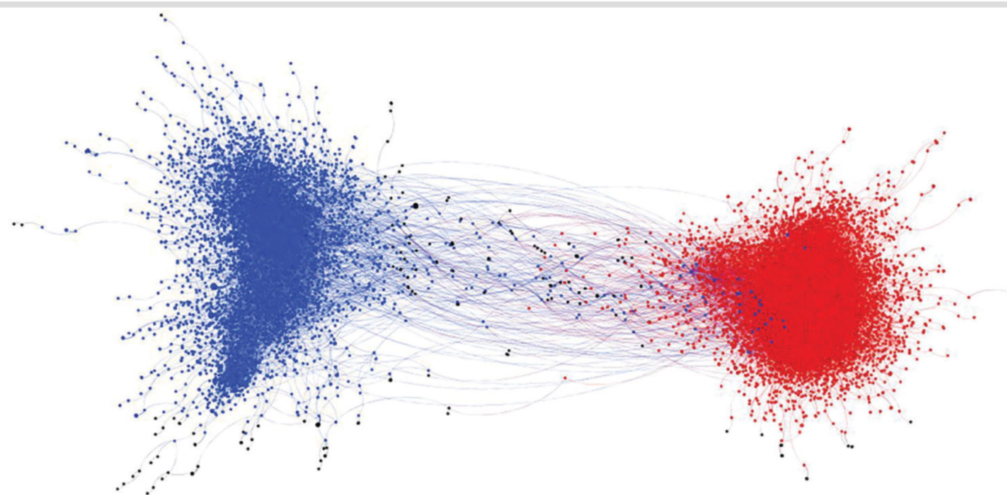
So why do post-truth era people so often, in the words of psychologist Tom Gilovich (1991), "know what isn't so?"

False news Some misinformation gets fed to us intentionally. It's "lies in the guise of news" (Kristof, 2017). In the 2016 U.S. election cycle, 6 percent of all Twitter-enabled news consumption was fake news (Grinberg et al., 2019). And made-up news persists. In one analysis of 126,000 stories tweeted by 3 million people, falsehoods—especially false political news—"diffused significantly farther, faster, deeper, and more broadly than the truth" (Vosoughi et al., 2018). The good news is that most people can often tell the difference between high- and low-quality information sources (Pennycook & Rand, 2019).

Repetition In experiments, statements become more believable when they are repeated (De keersmaecker et al., 2019). What we hear over and over—perhaps a made-up smear of a political opponent—gets remembered and comes to seem true (Fazio et al., 2015).

Availability of powerful examples In the media, "if it bleeds it leads." Gruesome violence—a horrific murder, a mass killing, a plane crash—gets reported, with vivid images that color our judgments. No wonder Americans grossly overestimate their risk of being victimized by crime, terror, and plane crashes.

Group identity and the echo chamber of the like-minded Our social identities matter. Feeling good about our groups helps us feel good about ourselves. On social media we tend to friend people who think as we do (see **FIGURE 1.1**). We often read news sources that affirm our views and demonize news sources that do not.



Moral contagion in social networks William J. Brady, Julian A. Wills, John T. Jost, Joshua A. Tucker, Jay J.Van Bavel Proceedings of the National Academy of Sciences Jul 2017, 114 (28) 7313-7318; DOI:10.1073/pnas.1618923114

FIGURE 1.1 The meeting of like minds On social media, most people discuss contentious issues, such as gun control, same-sex marriage, and climate change, only with likeminded others. In this graph of politically charged Twitter activity, each node represents a user who sent a message; each line represents a user who retweeted another user. As we can see, users overwhelmingly sent messages to, and retweeted messages from, those who shared their liberal (blue) or conservative (red) ideology (Brady et al., 2017).

The good news is that we can build a real-truth world by embracing a scientific mindset. With a mix of curiosity, skepticism, and humility, we can adopt the spirit of critical thinking: To accept everything is to be gullible; to deny everything is to be a cynic.

> **"We have … become sloppier than ever: Tweet first, research later. Post first, rescind later. Guess first, confirm later."** — Luvvie Ajayi, *I'm Judging You: The Do-Better Manual,* 2016

"I'm sorry, Jeannie, your answer was correct, but Kevin shouted his incorrect answer over yours, so he gets the points."

Joe Dator The New Yorker Collection/The Cartoon Bank

To experience my [DM's] recap of some important, scientific thinking strategies, view the 3.5-minute animated video: ***Thinking Critically in Our "Post-Truth" World*** (also at tinyurl.com/PostTruthMyers).

The Scientific Method

The foundation of all science is a scientific attitude that combines *curiosity, skepticism,* and *humility.* Psychologists arm their scientific attitude with the *scientific method*—a self-correcting process for evaluating ideas with observation and analysis. Psychological science welcomes hunches and plausible-sounding theories. And it puts them to the test. If a theory works—if the data support its predictions—so much the better for that theory. If the predictions fail, the theory gets revised or rejected. When researchers submit their work to a scientific journal, *peer reviewers*—other scientists who are experts in that field—provide anonymous evaluations of a study's theory, originality, and accuracy. With this feedback in hand, the journal editor decides whether the research deserves publication.

Constructing Theories

LOQ 1-3

How do theories advance psychological science?

In everyday conversation, we often use *theory* to mean "mere hunch." Someone might, for example, discount evolution as "only a theory"—as if it were mere speculation. In science, a **theory** explains behaviors or events by offering ideas that organize observations. By using deeper principles to organize isolated facts, a theory summarizes and simplifies. As we connect the observed dots, a coherent picture emerges.

theory
an explanation using an integrated set of principles that organizes observations and predicts behaviors or events.

A theory of how sleep affects memory, for example, helps us organize countless sleep-related observations into a short list of principles. Imagine that we observe over and over that people with good sleep habits tend to answer questions correctly in class and do well at test time. We might therefore theorize that sleep improves memory. So far so good: Our principle neatly summarizes a list of observations about the effects of a good night's sleep.

Yet no matter how reasonable a theory may sound—and it does seem reasonable to suggest that sleep boosts memory—we must put it to the test. A good theory produces testable *predictions,* called **hypotheses**. Such predictions specify what results would support the theory and what results would disconfirm it. To test our theory about sleep effects on memory, we might hypothesize that when sleep deprived, people will remember less from the day before. To test that hypothesis, we might assess how well people remember course materials they studied either before a good night's sleep or before a shortened night's sleep (**FIGURE 1.2**). The results will either support our theory or lead us to revise or reject it.

hypothesis
a testable prediction, often implied by a theory.

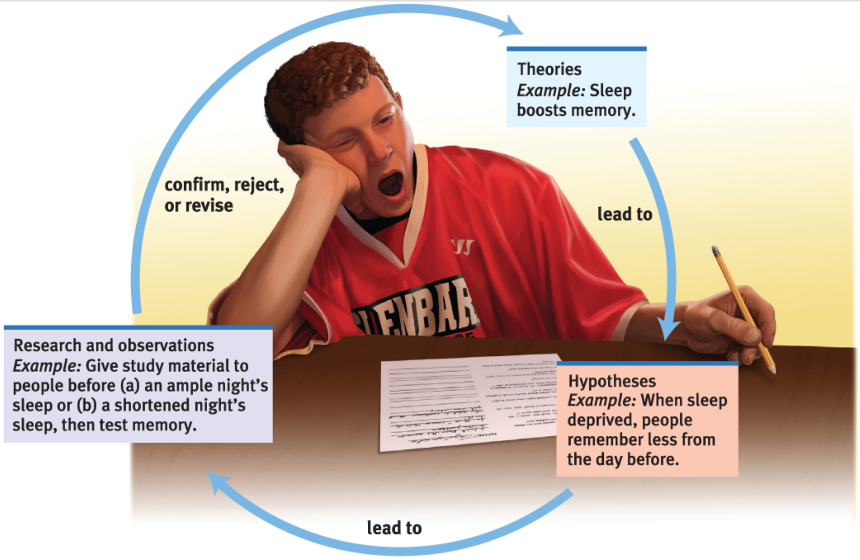


FIGURE 1.2 The scientific method A self-correcting process for asking questions and observing nature's answers.

Our theories can bias our observations. Having theorized that better memory springs from more sleep, we may see what we expect: We may perceive sleepy people's comments as less accurate. The urge to see what we expect is strong, both inside and outside the laboratory, as when people's views of climate change influence their interpretation of local weather events.

As a check on their own biases, psychologists report their research with precise, measurable **operational definitions** of research procedures and concepts. *Sleep deprived,* for example, may be defined as "at least 2 hours less" than the person's natural sleep. (Likewise, a study of "aggression" may observe how many pins you stab into a doll that represents a lab partner, or a study of "helping" may record dollars donated.) Using these carefully worded statements, others can **replicate** (repeat) the original observations with different participants, materials, and circumstances. If they get similar results, confidence in the finding's reliability grows. The first study of hindsight bias, for example, aroused psychologists' curiosity. Now, after many successful replications with differing people and questions, we feel sure of the phenomenon's power. Replication is confirmation.

operational definition
a carefully worded statement of the exact procedures (operations) used in a research study. For example, *human intelligence* may be operationally defined as what an intelligence test measures. (Also known as *operationalization.*)
replication
repeating the essence of a research study, usually with different participants in different situations, to see whether the basic finding can be reproduced.

Replication is an essential part of good science. Psychology experienced a "replication crisis" when recent multi-lab efforts to replicate as many as 100 studies produced mixed results—ranging from 36 percent to 85 percent of studies replicating (Camerer et al., 2018a; Klein et al., 2014, 2018; Open Science Collaboration, 2015). (None of these nonreproducible findings appear in this text.) Replication failures often result when samples are small, so psychologists increasingly study large samples of people (Camerer et al., 2018b; Sassenberg & Ditrich, 2019; Stanley et al., 2018). Bigger sample = a bigger chance of replication.

Today's psychological research is benefitting from more replications, more rigorous research methods, and more sharing of research data (Dougherty et al., 2018; Smaldino & McElreath, 2016; Zwaan et al., 2018). More and more psychologists use **preregistration** to publicly communicate their planned study design, hypotheses, data collection, and analyses (Nosek et al., 2018). (This openness and transparency also prevents later modifications, such as changing the hypotheses to fit the data.) There is still a place for *exploratory research:* Investigators gather data and seek patterns that inspire theories, which can then be tested with *confirmatory research (*with preregistered hypotheses and preplanned analyses).

preregistration
publicly communicating planned study design, hypotheses, data collection, and analyses.

Explorations, replications, preregistrations, and the open sharing of raw data are enabling "Psychology's Renaissance" of improved scientific practices (Motyl et al., 2017; Nelson et al., 2018).

> **"Failure to replicate is not a bug; it is a feature. It is what leads us along the path—the wonderfully twisty path—of scientific discovery."** — Lisa Feldman Barrett, "Psychology Is Not in Crisis," 2015

Psychological and medical science also harness the power of **meta-analysis**. Meta-analysis is a procedure for statistically synthesizing a body of scientific evidence. By combining the results of many studies, researchers avoid the problem of small samples and arrive at a bottom-line result.

meta-analysis
a statistical procedure for analyzing the results of multiple studies to reach an overall conclusion.

In the end, our theory will be useful if it (1) *organizes* observations and (2) implies *predictions* that anyone can use to check the theory or to derive practical applications. (Does people's sleep predict their retention?) Eventually, our research may (3) stimulate further research that leads to a revised theory that better organizes and predicts.

As we will see next, we can test our hypotheses and refine our theories using *descriptive* methods (which describe behaviors, often through case studies, surveys, or naturalistic observations), *correlational* methods (which associate different factors), and *experimental* methods (which manipulate factors to discover their effects). To think critically about popular psychology claims, we need to understand these methods and know what conclusions they allow.

RETRIEVAL PRACTICE

RP-2 What does a good theory do?
RP-3 Why is replication important?

ANSWERS IN APPENDIX E

Description

LOQ 1-4

How do psychologists use case studies, naturalistic observations, and surveys to observe and describe behavior, and why is random sampling important?

The starting point of any science is description. In everyday life, we all observe and describe people, often drawing conclusions about why they think, feel, and act as they do. Psychologists do much the same, though more objectively and systematically, through

- ***case studies*** (in-depth analyses of individuals or groups).
- ***naturalistic observations*** (recording the natural behavior of many individuals).
- ***surveys* and interviews** (asking people questions).

THE CASE STUDY

Among the oldest research methods, the **case study** examines one individual or group in depth in the hope of revealing things true of us all. Some examples:

- ***Brain damage.*** Much of our early knowledge about the brain came from case studies of individuals who suffered particular impairments after damage to a certain brain region.
- ***Children's minds.*** Jean Piaget taught us about children's thinking after carefully observing and questioning only a few

children.

- ***Animal intelligence.*** Studies of various animals, including a few chimpanzees, have revealed their capacity for understanding and language.

case study
a descriptive technique in which one individual or group is studied in depth in the hope of revealing universal principles.

Intensive case studies are sometimes very revealing, and they often suggest directions for further study.

But atypical individual cases may mislead us. Both in our everyday lives and in science, unrepresentative information can lead to mistaken judgments and false conclusions. Indeed, anytime a researcher mentions a finding *(Smokers die younger: 95 percent of men over 85 are nonsmokers)* someone is sure to offer a contradictory anecdote *(Well, I have an uncle who smoked two packs a day and lived to be 89!)*.

Dramatic stories and personal experiences (even psychological case examples) command our attention and are easily remembered. Journalists understand that and often begin their articles with compelling stories. Stories move us. But stories can mislead. Which of the following do you find more memorable? (1) “In one study of 1300 dream reports concerning a kidnapped child, only 5 percent correctly envisioned the child as dead” (Murray & Wheeler, 1937). (2) “I know a man who dreamed his sister was in a car accident, and two days later she died in a head-on collision!" Numbers can be numbing, but *the plural of anecdote is not evidence*. A single story of someone who supposedly changed from gay to straight is not evidence that sexual orientation is a choice. As psychologist Gordon Allport (1954, p. 9) said, "Given a thimbleful of [dramatic] facts we rush to make generalizations as large as a tub."

Skye Hohmann/Alamy

Freud and Little Hans Sigmund Freud's case study of 5-year-old Hans' extreme fear of horses led Freud to his theory of childhood sexuality. He conjectured that Hans felt unconscious desire for his mother, feared castration by his rival father, and then transferred this fear into his phobia about being bitten by a horse. As Chapter 14 will explain, today's psychological science discounts Freud's theory of childhood sexuality but does agree that much of the human mind operates outside our conscious awareness.

The point to remember: Individual cases can suggest fruitful ideas. What's true of all of us can be glimpsed in any one of us. But to find those general truths, we must employ other research methods.

RETRIEVAL PRACTICE

RP-4 We cannot assume that case studies always reveal general principles that apply to all of us. Why not?

ANSWERS IN APPENDIX E

See the ***Video: Case Studies*** for an animated tutorial.

NATURALISTIC OBSERVATION

A second descriptive method records responses in natural environments. These **naturalistic observations** range from watching chimpanzee societies in the jungle, to videotaping and analyzing parent-child interactions in different cultures, to recording racial differences in students' self-seating patterns in a school lunchroom. In the digital age, naturalistic observations have increased—thanks to "big data" harvested from phone apps, social media, Google searches, and more.

naturalistic observation
a descriptive technique of observing and recording behavior in naturally occurring situations without trying to manipulate and control the situation.

Until recently, naturalistic observation was mostly "small science"—possible to do with pen and paper rather than fancy equipment and a big budget (Provine, 2012). But today's digital technologies have transformed naturalistic observations into big science. Want to keep track of how often people go to the gym, a café, or the library? All you need is access to their phone's global positioning system (GPS) (Harari et al., 2016). And new technologies—wearable cameras and fitness sensors, and internet-connected smart-home sensors—offer increasing possibilities for people to allow accurate recording of their activity, relationships, sleep, and stress (Nelson & Allen, 2018; Yokum et al., 2019).

The billions of people entering personal information online have also enabled big-data observations (without disclosing anyone's identity). One research team studied the ups and downs of human moods by counting positive and negative words in 504 million Twitter messages from 84 countries (Golder & Macy, 2011). As **FIGURE 1.3** shows, people seemed happier on weekends, shortly after waking, and in the evenings. (Are late Saturday evenings often a happy time for you, too?) Another study found that negative emotion (especially anger-related) words in 148 million tweets from 1347 U.S. counties predicted the counties' heart disease rates *better* than smoking and obesity rates (Eichstaedt et al., 2015). Google enables us to learn about the world, and people's Google use enables us to learn about them. For example, the words people search and the questions they ask can pinpoint a geographical area's level of racism and depression. But Google searches also reveal our universal human likeness—as illustrated by the word “pregnant” being searched in conjunction with the same food cravings across varied countries (Stephens-Davidowitz, 2017). Across the globe, we are kin beneath the skin.

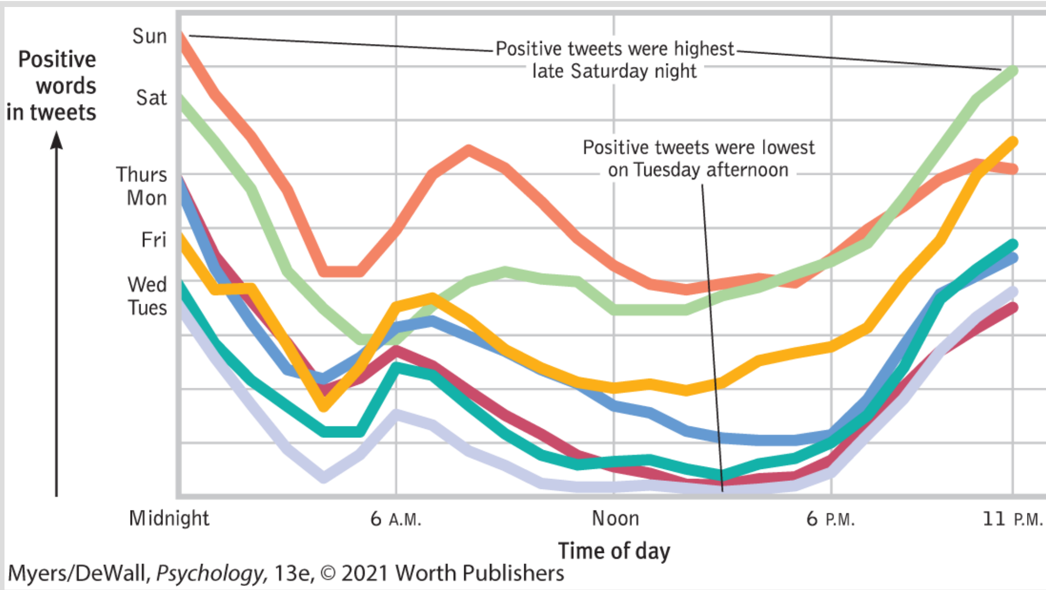


FIGURE 1.3 Twitter message moods, by time and by day This graph illustrates how, without knowing anyone’s identity, researchers can use big data to study human behavior on a massive scale. It now is also possible to associate people’s moods with, for example, their locations or with the weather, and to study the spread of ideas through social networks. (Data from Golder & Macy, 2011.)

Like the case study, naturalistic observation does not *explain* behavior. It *describes* it. Nevertheless, descriptions can be revealing. We once thought, for example, that only humans use tools. Then naturalistic observation revealed that chimpanzees sometimes insert a stick in a termite mound and withdraw it, eating the stick’s load of termites. Such unobtrusive naturalistic observations paved the way for later studies of animal thinking, language, and emotion, which further expanded our understanding of our fellow animals. Thanks to researchers' observations, we know that chimpanzees and baboons use deception: Psychologists repeatedly saw one young baboon pretending to have been attacked by another as a tactic to get its mother to drive the other baboon away from its food (Whiten & Byrne, 1988).

MICHAEL NICHOLS/National Geographic Creative

A natural observer "Observations, made in the natural habitat," noted chimpanzee observer Jane Goodall (1998), "helped to show that the societies and behavior of animals are far more complex than previously supposed."

Naturalistic observations also illuminate human behavior. Here are two findings you might enjoy:

- ***A funny finding.*** We humans laugh 30 times more often in social situations than in solitary situations (Provine, 2001).

(Have you noticed how seldom you laugh when alone?)

- ***Culture and the pace of life.*** Naturalistic observation also enabled Robert Levine and Ara Norenzayan (1999) to compare the pace of life—walking speed, accuracy of public clocks, and so forth—in 31 countries. Their conclusion: Life is fastest paced in Japan and Western Europe, and slower paced in economically less-developed countries.

Naturalistic observation offers interesting snapshots of everyday life, but it does so without controlling for all the factors that may influence behavior. It's one thing to observe the pace of life in various places, but another to understand what makes some people walk faster than others. Nevertheless, descriptions can be revealing: The starting point of any science is description.

RETRIEVAL PRACTICE

RP-5 What are the advantages and disadvantages of naturalistic observation?

ANSWERS IN APPENDIX E

See the ***Video: Naturalistic Observation*** for a helpful tutorial animation.

THE SURVEY

A **survey** looks at many cases, asking people to report their behavior or opinions. Questions about everything from sexual practices to political opinions are put to the public. Here are some recent survey findings:

- Compared at the same age with those born in the 1960s and 1970s, twice as many Millennials born in the 1990s reported having no sexual partners since age 18 (Twenge et al., 2017). Today's less attached young adults are experiencing what one writer termed a "sex recession" (Julian, 2018).
- 1 in 2 people across 24 countries reported believing in the "existence of intelligent alien civilizations in the universe" (Lampert, 2017).
- 68 percent of all humans—some 5.2 billion people—say that religion is important in their daily lives (from Gallup World Poll data analyzed by Diener et al., 2011).

survey
a descriptive technique for obtaining the self-reported attitudes or behaviors of a particular group, usually by questioning a representative, *random sample* of the group.

But asking questions is tricky. People may shade their answers in a socially desirable direction, such as by underreporting their cigarette consumption or overreporting their voting. And the answers often depend on how questions are worded and how respondents are chosen.

Wording Effects

Even small changes in the order or wording of questions can make a big difference (**TABLE 1.1**). When U.S. White evangelical Christians were asked whether (1) "Humans have evolved over time" or (2) "Humans have existed in their present form since the beginning of time," only 32 percent expressed a belief in evolution (Funk, 2019). But when asked whether (1) "Humans have evolved over time due to processes such as natural selection; God or a higher power had no part in this process"; (2) "Humans have evolved over time due to processes that were guided or allowed by God or a higher power"; or (3) "Humans have existed in their present form since the beginning of time," more than twice as many—68 percent—expressed a belief in evolution. Because wording is such a delicate matter, critical thinkers will reflect on how the phrasing of a question might affect people's expressed opinions.

TABLE 1.1 Survey Wording Effects

Garners More Approval	Garners Less Approval
"aid to the needy"	"welfare"
"affirmative action"	"preferential treatment"
"undocumented workers"	"illegal aliens"
"gun safety laws"	"gun control laws"
"revenue enhancers"	"taxes"
"enhanced interrogation"	"torture"

Random Sampling

In everyday thinking, we tend to generalize from samples we observe, especially vivid cases. An administrator who reads (a) a statistical summary of a professor's student evaluations and (b) the vivid comments of two irate students may be influenced as much by the biased sample of two unhappy students as by the many favorable evaluations in the statistical summary. The temptation to succumb to the *sampling bias*—to generalize from a few vivid but unrepresentative cases—is nearly irresistible.

So how do you obtain a *representative sample?* Say you want to learn how students at your college or university feel about a proposed tuition increase. It's often not possible to survey the whole group. How then could you choose a group that would represent the total student body? Typically, you would seek a **random sample**, in which every person in the entire **population** has an equal chance of being included in the sample group. You might number the names in the general student listing and use a random-number generator to pick your survey participants. (Sending each student a questionnaire wouldn't work because the conscientious people who returned it would not be a random sample.) Large representative samples are better than small ones, but a smaller representative sample of 100 is better than a larger unrepresentative sample of 500. You cannot compensate for an unrepresentative sample by simply adding more people.

random sample
a sample that fairly represents a population because each member has an equal chance of inclusion.

population
all those in a group being studied, from which random samples may be drawn. (*Note:* Except for national studies, this does *not* refer to a country's whole population.)

Political pollsters sample voters in national election surveys just this way. Without random sampling, large samples—such as from website polls—often give misleading results. But by using some 1500 randomly sampled people, drawn from all areas of a country, they can provide a remarkably accurate snapshot of the nation's opinions. Moreover, pollsters can assess the accuracy of their sampling by asking unrelated questions—such as whether the respondents live alone or are married—for which government statistics are available as benchmarks (Bialik, 2018). If the survey sample closely matches the national breakdown of people, so much the better.

Given polling's margin of error and last-minute voter swings, political polls are good but imperfect estimates of likely outcomes. Immediately before the 2016 U.S. presidential election, popular polling analysis website FiveThirtyEight.com gave candidate Hillary Clinton an estimated 71 percent chance of winning. When Donald Trump was then elected, many regarded the prediction as a failure. But consider: When a prediction model estimates a 71 percent chance for one candidate, that candidate should *lose* nearly one third of the time. (Imagine a weather forecast that predicts a 70 percent chance of rain. If it then *always* rained, that would be a flawed forecast.) One analysis of 30,000 general election political predictions in 45 countries between 1942 and 2017 summed it up: Contrary to popular belief, polls are pretty accurate (Jennings & Wlezien, 2018).

With very large samples, estimates become quite reliable. The letter *E* is estimated to represent 12.7 percent of the letters in written English. *E*, in fact, is 12.3 percent of the 925,141 letters in Melville's *Moby-Dick*, 12.4 percent of the 586,747 letters in Dickens' *A Tale of Two Cities*, and 12.1 percent of the 3,901,021 letters in 12 of Mark Twain's works (*Chance News*, 1997).

The point to remember: Before accepting survey findings, think critically. Consider the sample. The best basis for generalizing is from a representative, random sample.

RETRIEVAL PRACTICE

RP-6 What is an unrepresentative sample, and how do researchers avoid it?

ANSWERS IN APPENDIX E

Correlation

LOQ 1-5

What does it mean when we say two things are correlated, and what are positive and negative correlations?

Describing behavior is a first step toward predicting it. Naturalistic observations and surveys often show us that one trait or behavior tends to coincide with another. In such cases, we say the two **correlate**. A statistical measure (the **correlation coefficient**) helps us figure out how closely two things vary together, and thus how well either one *predicts* the other. Knowing how much aptitude test scores *correlate* with school success tells us how well the scores *predict* school success.

correlation
a measure of the extent to which two factors vary together, and thus of how well either factor predicts the other.
correlation coefficient
a statistical index of the relationship between two things (from −1.00 to +1.00).

Throughout this book, we often ask how strongly two **variables** are related: For example, how closely related are the personality test scores of identical twins? How well do intelligence test scores predict career achievement? How much do people's depressive symptoms predict their anxiety? In such cases, **scatterplots** can be very revealing.

variable
anything that can vary and is feasible and ethical to measure.
scatterplot
a graphed cluster of dots, each of which represents the values of two variables. The slope of the points suggests the direction of the relationship between the two variables. The amount of scatter suggests the strength of the correlation (little scatter indicates high correlation).

Each dot in a scatterplot represents the values of two variables. The three scatterplots in **FIGURE 1.4** illustrate the range of possible correlations from a perfect positive to a perfect negative. (Perfect correlations rarely occur in the real world.) A correlation is positive if two sets of scores, such as for height and weight, tend to rise or fall together.

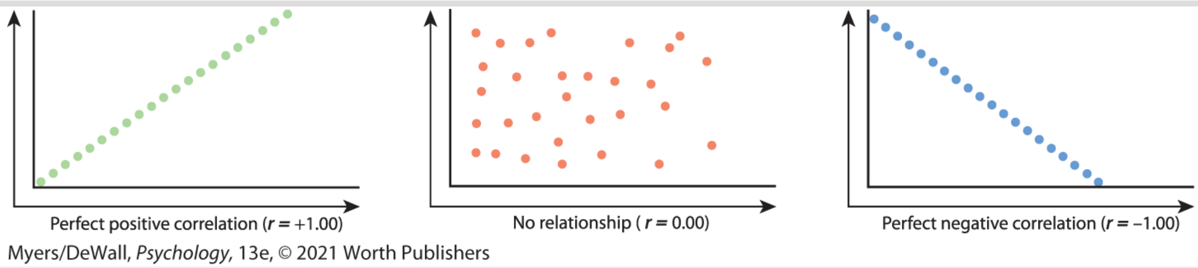


FIGURE 1.4 Scatterplots, showing patterns of correlation Correlations—abbreviated *r*—can range from +1.00 (scores for one variable increase in direct proportion to scores for another), to 0.00 (no relationship), to −1.00 (scores for one variable decrease precisely as scores for the other rise).

Saying that a correlation is "negative" says nothing about its strength. A correlation is negative if two sets of scores relate inversely, one set going up as the other goes down. The correlation between people's height and the distance from their head to the ceiling is strongly (perfectly, in fact) negative.

Statistics can help us understand what we might miss with casual observation. To demonstrate, consider the responses of 2291 Czech and Slovakian volunteers who were asked by Jakub Polák and his colleagues (2019) to rate, on a 1 to 7 scale, their *fear* and *disgust* related to each of 24 animals. With all the relevant data right in front of you (TABLE 1.2), can you tell whether the correlation between participants' fear and their disgust is positive, negative, or close to zero?

TABLE 1.2 People's Fear and Disgust Responses to Various Animals

Animal	Average Fear	Average Disgust
Ant	2.12	2.26
Bat	2.11	2.01
Bull	3.84	1.62
Cat	1.24	1.17
Cockroach	3.10	4.16
Dog	2.25	1.20
Fish	1.15	1.38
Frog	1.84	2.48
Grass snake	3.32	2.47
Horse	1.82	1.11
Lizard	1.46	1.46
Louse	3.58	4.83
Maggot	2.90	4.49
Mouse	1.62	1.78
Panda	1.57	1.17
Pigeon	1.48	2.01
Rat	2.11	2.25
Rooster	1.78	1.34

Roundworm	3.49	4.79
Snail	1.15	1.69
Spider	4.39	4.47
Tapeworm	3.60	4.83
Viper	4.34	2.83
Wasp	3.42	2.84

When comparing the columns in Table 1.2, most people don't detect a relationship between fear and disgust. In fact, the correlation in this imaginary example is positive (r = +.72), as we can see if we display the data as a scatterplot (**FIGURE 1.5**).

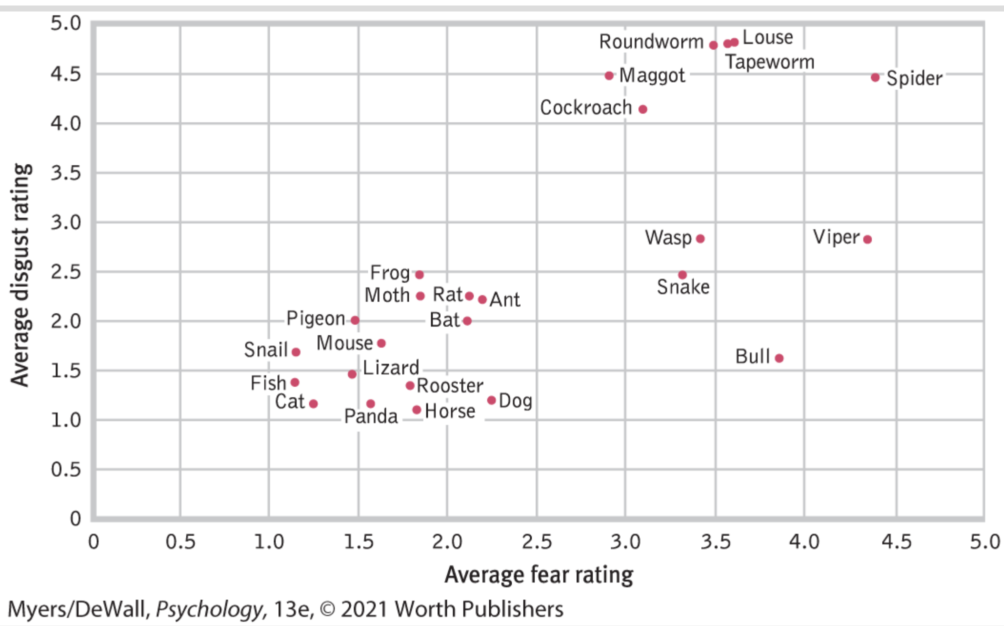


FIGURE 1.5 Scatterplot for fear and disgust felt toward 24 animals This display of average self-reported fear and disgust (each represented by a data point) reveals an upward slope, indicating a positive correlation. The considerable scatter of the data indicates the correlation is much lower than +1.00.

If we don't easily recognize a strong relationship when data are presented systematically, as in Table 1.2, how much less likely are we to notice them in everyday life? To see what is right in front of us, we sometimes need statistical illumination. We can easily see evidence of gender discrimination when given statistically summarized information about job level, seniority, performance, gender, and salary. But we often see no discrimination when the same information dribbles in, case by case (Twiss et al., 1989). Thinking like a psychological scientist helps us value everyone equally—not just those who catch our attention.

The point to remember: A correlation coefficient helps us see the world more clearly by revealing the extent to which two things relate.

RETRIEVAL PRACTICE

RP-7 Indicate whether each association is a positive correlation or a negative correlation.

1. The more husbands viewed internet pornography, the worse their marital relationships (Muusses et al., 2015). ________
2. The more time teen girls spend absorbed with online social media, the more at risk they are for depression and suicidal thoughts (Kelly et al., 2018; Twenge & Campbell, 2019). ________
3. The longer children were breast-fed, the greater their later academic achievement (Horwood & Fergusson, 1998). ________
4. The more leafy vegetables older adults eat, the less their mental decline over the ensuing 5 years (Morris et al., 2018). ________

ANSWERS IN APPENDIX E

For an animated tutorial on correlations, engage online with ***Concept Practice: Positive and Negative Correlations.*** See also the ***Video: Correlational Studies*** for another helpful tutorial animation.

ILLUSORY CORRELATIONS AND REGRESSION TOWARD THE MEAN

LOQ 1-6

What are *illusory correlations,* and what is *regression toward the mean?*

Correlations not only make clear the relationships we might otherwise miss; they also keep us from falsely observing nonexistent relationships. When we believe there is a relationship between two things, we are likely to notice and recall instances that confirm our belief. If we believe that dreams forecast actual events, we may notice and recall confirming instances more than disconfirming instances. The result is an **illusory correlation**.

illusory correlation
perceiving a relationship where none exists, or perceiving a stronger-than-actual relationship.

Illusory correlations can feed an illusion of control—that chance events are subject to our personal control. Gamblers, remembering their lucky rolls, may come to believe they can influence the roll of the dice by again throwing gently for low numbers and hard for high numbers. The illusion that uncontrollable events correlate with our actions is also fed by a statistical phenomenon called

regression toward the mean. Average results are more typical than extreme results. Thus, after an unusual event, things tend to return toward their average level; extraordinary happenings tend to be followed by more ordinary ones. Students who score much lower or higher on an exam than they usually do are likely, when retested, to return to their average. Extrasensory perception (ESP) test subjects who defy chance when first tested nearly always lose their "psychic powers" when retested.

regression toward the mean
the tendency for extreme or unusual scores or events to fall back (regress) toward the average.

Failure to recognize regression is the source of many superstitions and of some ineffective practices—in sports coaching and in the workplace, for example. After berating an employee (or athlete) for poorer-than-usual performance, a manager may—when the employee regresses to normal—feel rewarded by the "improvement." After lavishing praise for an exceptionally fine performance, the manager may be disappointed when the employee's behavior again migrates back toward his or her average. Ironically, then, regression toward the average can mislead us into feeling rewarded after criticizing others ("That criticism really made him work harder!") and feeling punished after praising them ("All those compliments made her slack off!") (Tversky & Kahneman, 1974).

> **“Once you become sensitized to it, you see regression everywhere.”** — Psychologist Daniel Kahneman (1985)

The point to remember: When a fluctuating behavior returns to normal, fancy explanations for why it does so are often wrong. Regression toward the mean is probably at work.

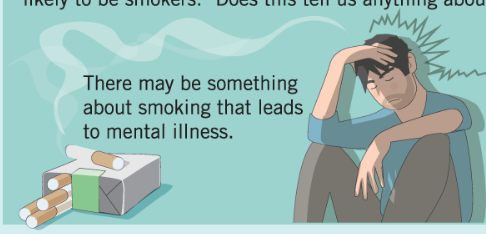
Moreover, although correlational research helpfully reveals relationships, it does not explain them. If teen social media use correlates with (predicts) teen risk of depression, that may—or may not—indicate that social media use affects depression risk. Other explanations are possible (see Thinking Critically About: Correlation and Causation).

Thinking Critically About:

Correlation and Causation

LOQ 1-7 Why do correlations enable prediction but not cause-effect explanation?

Mental illness *correlates* with smoking—meaning that those who experience mental illness are also more likely to be smokers.[1] Does this tell us anything about what *causes* mental illness or smoking? **NO.**



There may be something about smoking that leads to mental illness.

Those with mental illness may be more likely to smoke.

OR ?

There may be some *third variable*, such as a stressful home life, for example, that triggers *both* smoking and mental illness.

So, then, how would you interpret these recent findings?
a) Sexual hook-ups correlate with college women's experiencing depression.
b) *Delaying* sexual intimacy correlates with positive outcomes such as greater relationship satisfaction and stability.[2]

Possible explanations:

1. Sexual restraint → Better mental health and stronger relationships
2. Depression → People being more likely to hook up
3. Some third factor, such as lower impulsivity → Sexual restraint, psychological well-being, and better relationships

Correlations do help us predict.
Consider: Self-esteem correlates negatively with (and therefore predicts) depression. The lower people's self-esteem, the greater their risk for depression.

Possible interpretations:

1. Low self-esteem → Depression
2. Depression → Low self-esteem
3. Some third factor, such as distressing events or biological predisposition → Both low self-esteem and depression

You try it!
A survey of over 12,000 adolescents found that the more teens feel loved by their parents, the less likely they are to behave in unhealthy ways—having early sex, smoking, abusing alcohol and drugs, exhibiting violence.[3] What are three possible ways we could interpret that finding?[4]

***The point to remember:* Correlation does not prove causation.**
Correlation suggests a possible cause-effect relationship but does not prove it. Remember this principle and you will be wiser as you read and hear news of scientific studies.

1. Belluck, 2013. 2. Fielder et al., 2013; Willoughby et al., 2014. 3. Resnick et al., 1997. 4. *ANSWERS:* A. Parental love may produce healthy teens. B. Well-behaved teens may feel more parental love and approval. C. Some third factor, such as income or neighborhood, may influence both parental love AND teen behaviors.

RETRIEVAL PRACTICE

RP-8 You hear the school basketball coach telling her friend that she rescued her team's winning streak by yelling at the players after an unusually bad first half. What is another explanation of why the team's performance improved?

RP-9 Length of marriage positively correlates with hair loss in men. Does this mean that marriage causes men to lose their hair (or that balding men make better husbands)?

Nancy Brown/Getty Images

ANSWERS IN APPENDIX E

Experimentation

LOQ 1-8

What are the characteristics of experimentation that make it possible to isolate cause and effect?

Happy are they, remarked the Roman poet Virgil, "who have been able to perceive the causes of things." How might psychologists sleuth out the causes in correlational studies, such as the small correlation between teen girls' social media use and their risk of depression and self-harm?

EXPERIMENTAL MANIPULATION

Our sleuthing starts with two plain facts:

1. Beginning in 2010, worldwide smart phone and social media use mushroomed.
2. Simultaneously, Canadian, American, and British teen girls' rates of depression, anxiety, self-harm, and suicide also mushroomed (Mercado et al., 2017; Morgan, 2017; Statistics Canada, 2016).

What do such findings mean? Is there a cause-effect connection? If so, should parents limit their middle schoolers' time on Instagram or Snapchat? Even big correlational data from a million teens couldn't tell us. The answers are being debated and the data are mixed. Moving beyond the simple correlation, one research summary noted that, in six of eight *longitudinal* (over time) studies, teens' current social media use predicted future mental health issues (Haidt, 2019). Even so, to identify cause and effect, researchers must **experiment**. Experiments enable researchers to isolate the effects of one or more factors by (1) *manipulating the factors of interest* and (2) *holding constant ("controlling") other factors.* To do so, they often create an **experimental group** in which people receive the treatment (such as reduced screen time), and a contrasting **control group** in which they do not.

experiment
a research method in which an investigator manipulates one or more factors (independent variables) to observe the effect on some behavior or mental process (the dependent variable). By *random assignment* of participants, the experimenter aims to control other relevant factors.
experimental group
in an experiment, the group exposed to the treatment, that is, to one version of the independent variable.
control group
in an experiment, the group *not* exposed to the treatment; contrasts with the experimental group and serves as a comparison for evaluating the effect of the treatment.

To minimize any preexisting differences between the two groups, experimenters **randomly assign** people to each condition. Random assignment—whether with a random numbers table or flip of the coin—effectively equalizes the two groups. If one-third of the volunteers for an experiment can wiggle their ears, then about one-third of the people in each group will be ear wigglers. So, too, with age, attitudes, and other characteristics, which will be similar in the experimental and control groups. Thus, if the groups differ at the experiment's end, we can surmise that the treatment had an effect. (Note the difference between random *sampling*—which creates a representative survey sample—and random *assignment,* which equalizes the experimental and control groups.)

random assignment
assigning participants to experimental and control groups by chance, thus minimizing preexisting differences between the different groups.

So, what do *experiments* reveal about the relationship between girls' social media use and their risk of depression and self-harm? While there have been few actual experiments that vary social media use, one identified nearly 1700 people who agreed to deactivate their Facebook account for four weeks (Allcott et al., 2019). Compared with people in the control group, those randomly assigned to the deactivation group spent more time watching TV and socializing with friends and family—and they reported lower depression, and greater happiness and satisfaction with their lives (and less post-experiment Facebook use). Less Facebook time meant a happier life.

The debate over the effects of prolonged social media use is ongoing. For now, most researchers agree that unlimited teen social media use poses a modest mental health risk. With more large-scale correlational and longitudinal studies, and further experimentation, researchers will refine this tentative conclusion.

The point to remember: Correlational studies, which uncover naturally occurring relationships, are complemented by experiments, which manipulate a factor to determine its effect.

See the ***Video: Random Assignment*** for a tutorial animation.

PROCEDURES AND THE PLACEBO EFFECT

Consider, then, how we might assess therapeutic interventions. Our tendency to seek new remedies when we are ill or emotionally down can produce misleading testimonies. If three days into a cold we start taking zinc tablets and find our cold symptoms lessening, we may credit the pills rather than the cold naturally subsiding. In the 1700s, bloodletting *seemed* effective. People sometimes improved after the treatment; when they didn't, the practitioner inferred the disease was too advanced to be reversed. So, whether or not a remedy is truly effective, enthusiastic users will probably endorse it. To determine its effect, we must control for other factors.

And that is precisely how new drugs and new methods of psychological therapy are evaluated (Chapter 16). Investigators randomly assign participants in these studies to research groups. One group receives a pseudotreatment—an inert *placebo* (perhaps a pill with no drug in it). The other group receives a treatment, such as an antidepressant medication. (You can think of the placebo versus the actual drug as "trick or treatment.") The participants are often *blind* (uninformed) about what treatment, if any, they are receiving. If the study is using a **double-blind procedure,** neither the participants nor those who administer the drug and collect the data will know which group is receiving the treatment.

double-blind procedure
an experimental procedure in which both the research participants and the research staff are ignorant (blind) about whether the research participants have received the treatment or a placebo. Commonly used in drug-evaluation studies.

In double-blind studies, researchers check a treatment's actual effects apart from the participants' and the staff's belief in its healing powers. Just *thinking* you are getting a treatment can boost your spirits, relax your body, and relieve your symptoms. This **placebo effect** is well documented in reducing pain, depression, anxiety, and auditory hallucinations in schizophrenia (Dollfus et al., 2016; Kirsch, 2010). Athletes have run faster when given a supposed performance-enhancing drug (McClung & Collins, 2007). Decaf-coffee drinkers have reported increased vigor and alertness when they thought their brew had caffeine in it (Dawkins et al., 2011). People have felt better after receiving a phony mood-enhancing drug (Michael et al., 2012). And the more expensive the placebo, the more "real" it seems to us—a fake pill that costs $2.50 worked better than one costing 10 cents (Waber et al., 2008). To know how effective a therapy really is, researchers must control for a possible placebo effect.

placebo [pluh-SEE-bo; Latin for "I shall please"] effect
experimental results caused by expectations alone; any effect on behavior caused by the administration of an inert substance or condition, which the recipient assumes is an active agent.

"If I don't think it's going to work, will it still work?"

RETRIEVAL PRACTICE

RP-10 What measures do researchers use to prevent the *placebo effect* from confusing their results?

ANSWERS IN APPENDIX E

INDEPENDENT AND DEPENDENT VARIABLES

Here is an even more potent example: The drug Viagra was approved for use after 21 clinical trials. One trial was an experiment in which researchers randomly assigned 329 men with erectile disorder to either an experimental group (Viagra takers) or a control group (placebo takers given an identical-looking pill). The procedure was double-blind—neither the men taking the pills nor the person giving them knew what participants were receiving. The result: At peak doses, 69 percent of Viagra-assisted attempts at intercourse were successful, compared with 22 percent for men receiving the placebo (Goldstein et al., 1998). Viagra performed.

This simple experiment manipulated just one factor: the drug (Viagra versus no Viagra). We call this experimental factor the **independent variable** because we can vary it *independently* of other factors, such as the men's age, weight, and personality. Other factors that can potentially influence a study's results are called **confounding variables.** Random assignment controls for possible confounding variables.

independent variable
in an experiment, the factor that is manipulated; the variable whose effect is being studied.
confounding variable
in an experiment, a factor other than the factor being studied that might influence a study's results.

Experiments examine the effect of one or more independent variables on some measurable behavior, called the **dependent variable** because it can vary *depending* on what takes place during the experiment. Both variables are given precise *operational definitions,* which specify the procedures that manipulate the independent variable (the exact drug dosage and timing in this study) or measure the dependent variable (the men's responses to questions about their sexual performance). These definitions offer a level of precision that enables others to replicate the study. (See **FIGURE 1.6** for the Facebook experiment design.)

dependent variable
in an experiment, the outcome that is measured; the variable that may change when the independent variable is manipulated.

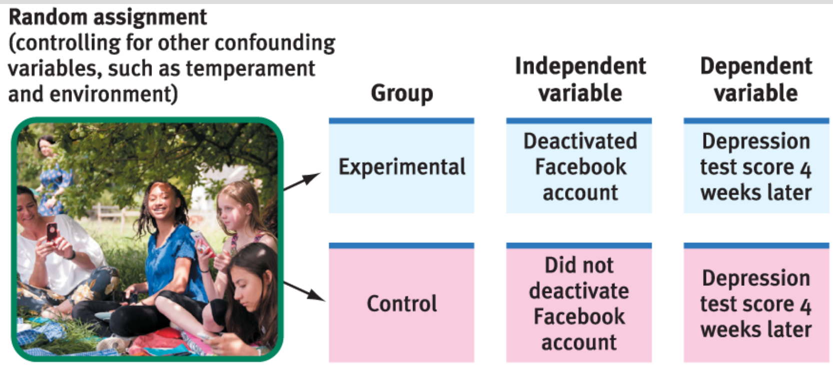


FIGURE 1.6 Experimentation To discern causation, psychologists control for confounding variables by randomly assigning some participants to an experimental group, others to a control group. Measuring the dependent variable (depression test score) will determine the effect of the independent variable (social media exposure).

A similar experiment on a drug approved to increase women's sexual arousal produced a result described as, um, anticlimactic—an additional "half of one satisfying sexual encounter a month" (Ness, 2016; Tavernise, 2016).

Let's pause to check your understanding using a simple psychology experiment: To test the effect of perceived ethnicity on the availability of rental housing, Adrian Carpusor and William Loges (2006) sent identically worded email inquiries to 1115 Los Angeles–area landlords. The researchers varied the ethnic connotation of the sender's name and tracked the percentage of positive replies (invitations to view the apartment in person). "Patrick McDougall," “Said Al-Rahman,” and “Tyrell Jackson” received, respectively, 89 percent, 66 percent, and 56 percent invitations. In this experiment, what was the independent variable? The dependent variable?[3]

> **“[We must guard] against not just racial slurs, but … against the subtle impulse to call Johnny back for a job interview, but not Jamal.”** — U.S. President Barack Obama, eulogy for state senator and church-shooting victim Clementa Pinckney, June 26, 2015

Experiments can also help us evaluate social programs. Do early childhood education programs boost impoverished children’s chances for success? What are the effects of different antismoking campaigns? Do school sex-education programs reduce teen pregnancies? To answer such questions, we can experiment: If an intervention is welcomed but resources are scarce, we could use a lottery to randomly assign some people (or regions) to experience the new program and others to a control condition. If later the two groups differ, the intervention’s effect will be supported (Passell, 1993).

Let’s recap. A *variable* is anything that can vary (infant nutrition, intelligence, social media exposure—anything within the bounds of what is feasible and ethical to measure). Experiments aim to *manipulate* an *independent* variable, *measure* a *dependent* variable, and *control confounding* variables. An experiment has at least two different conditions: an *experimental condition* and a *comparison* or *control condition. Random assignment* works to minimize preexisting differences between the groups before any treatment effects occur. In this way, an experiment tests the effect of at least one independent variable (what we manipulate) on at least one dependent variable (the outcome we measure).

RETRIEVAL PRACTICE

RP-11 By using *random assignment,* researchers are able to control for ______________ ______________, which are other factors besides the independent variable(s) that may influence research results.

RP-12 Match the term on the left (i through iii) with the description on the right (a through c).

i. Double-blind procedure	a. helps researchers generalize from a small set of survey responses to a larger population
ii. Random sampling	b. helps minimize preexisting differences between experimental and control groups
iii. Random assignment	c. controls for the placebo effect; neither researchers nor participants know who receives the real treatment

RP-13 Why, when testing a new drug to control blood pressure, would we learn more about its effectiveness from giving it to half the participants in a group of 1000 than to all 1000 participants?

ANSWERS IN APPENDIX E

See the ***Videos: Experiments*** and ***Confounding Variables*** for helpful tutorial animations.

Research Design

LOQ 1-9

How would you know which research design to use?

Throughout this book, you will read about amazing psychological science discoveries. But how do psychological scientists choose research methods and design their studies in ways that provide meaningful results? Understanding how research is done—how testable questions are developed and studied—is key to appreciating all of psychology. **TABLE 1.3** compares the features of psychology's main research methods. In later chapters, you will read about other research designs, including *twin studies* (Chapter 4) and *cross-sectional* and *longitudinal research* (Chapter 10).

TABLE 1.3 Comparing Research Methods

Research Method	Basic Purpose	How Conducted	What Is Manipulated	Weaknesses
Descriptive	To observe and record behavior	Do case studies, naturalistic observations, or surveys	Nothing	No control of variables; single cases may be misleading
Correlational	To detect naturally occurring relationships; to assess how well one variable predicts another	Collect data on two or more variables; no manipulation	Nothing	Cannot specify cause and effect
Experimental	To explore cause and	Manipulate	The	Sometimes not

	effect	one or more factors; use random assignment	independent variable(s)	feasible; results may not generalize to other contexts; not ethical to manipulate certain variables

In psychological research, no questions are off limits, except untestable (or unethical) ones: Does free will exist? Are people born evil? Is there an afterlife? Psychologists can't test those questions. But they *can* test whether free will beliefs, aggressive personalities, and a belief in life after death influence how people think, feel, and act (Dechesne et al., 2003; Shariff et al., 2014; Webster et al., 2014).

Having chosen their question, psychologists then select the most appropriate research design—*experimental, correlational, case study, naturalistic observation, twin study, longitudinal,* or *cross-sectional*—and determine how to set it up most effectively. They consider how much money and time are available, ethical issues, and other limitations. For example, it wouldn't be ethical for a researcher studying child development to use the experimental method and randomly assign children to loving versus punishing homes.

Next, psychological scientists decide how to measure the behavior or mental process being studied. For example, researchers studying aggressive behavior could measure participants' willingness to blast a stranger with supposed intense noise.

Researchers want to have confidence in their findings, so they carefully consider confounding variables—factors other than those being studied that may affect their interpretation of results.

Psychological research is a creative adventure. Researchers *design* each study, *measure* target behaviors, *interpret* results, and learn more about the fascinating world of behavior and mental processes along the way.

ASK YOURSELF

If you could conduct a study on any psychological question, which question would you choose? How would you design the study?

To help you build your understanding, your critical thinking, and your *scientific literacy skills,* we created online research activities. In these *How Would You Know?* activities, you get to play the role of researcher, making choices about the best ways to test interesting questions. Some examples: How Would You Know If Having Children Relates to Being Happier?, How Would You Know If a Cup of Coffee Can Warm Up Relationships?, and How Would You Know If People Can Learn to Reduce Anxiety?

To review and test your understanding of research methods, engage online with ***Concept Practice: Psychology's Research Methods*** and ***The Language of Experiments,*** and the interactive ***Topic Tutorial: PsychSim6, Understanding Psychological Research.*** For a 9.5-minute video synopsis of psychology's scientific research strategies, see the ***Video: Research Methods.***

Predicting Everyday Behavior

LOQ 1-10

How can simplified laboratory conditions illuminate everyday life?

When you see or hear about psychological research, do you ever wonder whether people's behavior in the lab will predict their behavior in everyday life? Does detecting the blink of a faint red light in a dark room say anything useful about flying an airplane at night? After viewing a violent, sexually explicit film, does a man's increased willingness to push buttons that he thinks will deliver a noise blast to a woman really say anything about whether viewing violent pornography makes a man more likely to abuse a woman?

Before you answer, consider: The experimenter *intends* the laboratory environment to be a simplified reality—one that simulates and controls important features of everyday life. Just as a wind tunnel lets airplane designers re-create airflow forces under controlled conditions, a laboratory experiment lets psychologists re-create psychological forces under controlled conditions.

An experiment's purpose is not to re-create the exact behaviors of everyday life, but to test *theoretical principles* (Mook, 1983). In aggression studies, deciding whether to push a button that delivers a noise blast may not be the same as slapping someone in the face, but the principle is the same. *It is the resulting principles—not the specific findings—that help explain everyday behaviors.*

When psychologists apply laboratory research on aggression to actual violence, they are applying theoretical principles of aggressive behavior, principles they have refined through many experiments. Similarly, it is the principles of the visual system, developed from experiments in artificial settings (such as looking at red lights in the dark), that researchers apply to more complex behaviors such as night flying. And many investigations show that principles derived in the laboratory do typically generalize to the everyday world (Mitchell, 2012).

The point to remember: Psychological science focuses less on specific behaviors than on revealing general principles that help explain many behaviors.

Psychology's Research Ethics

LOQ 1-11

Why do psychologists study animals, and what ethical research guidelines safeguard human and animal welfare? How do psychologists' values influence what they study and how they apply their results?

We have reflected on how a scientific approach can restrain biases. We have seen how case studies, naturalistic observations, and surveys help us describe behavior. We have also noted that correlational studies assess the association between two factors, showing how well one predicts another. We have examined the logic that underlies experiments, which use control conditions and random assignment of participants to isolate the causal effects of an independent variable on a dependent variable.

Yet, even knowing this much, you may still be approaching psychology with a mixture of curiosity and apprehension. So before we plunge in, let's entertain some common questions about psychology's ethics and values.

See the ***Video: Research Ethics*** for a helpful tutorial animation.

Studying and Protecting Animals

Many psychologists study nonhuman animals because they find them fascinating. They want to understand how different species learn, think, and behave. Psychologists also study animals to learn about people. We humans are not *like* animals; we *are* animals, sharing a common biology. Animal experiments have therefore led to treatments for human diseases—insulin for diabetes, vaccines to prevent polio and rabies, transplants to replace defective organs.

Humans are complex. But some of the same processes by which we learn are present in other animals, even sea slugs and honeybees. The simplicity of the sea slug's nervous system is precisely what makes it so revealing of the neural mechanisms of learning. Ditto for the honeybee, which resembles us humans in how it learns to cope with stress (Dinges et al., 2017).

Sharing such similarities, should we not respect our animal relatives? The animal protection movement protests the use of animals in psychological, biological, and medical research. "We cannot defend our scientific work with animals on the basis of the similarities between them and ourselves and then defend it morally on the basis of differences," noted Roger Ulrich (1991). In U.S. national surveys, half of adults oppose and half favor "the use of animals in scientific research"—with support greater among those most informed about science (Strauss, 2018).

> **"Rats are very similar to humans except that they are not stupid enough to purchase lottery tickets."** — Dave Barry, July 2, 2002

Out of this heated debate, two issues emerge. The basic one is whether it is right to place the well-being of humans above that of other animals. In experiments on stress and cancer, is it right that mice get tumors in the hope that people might not? Should some monkeys be exposed to an HIV-like virus in the search for an AIDS vaccine? Humans raise and slaughter 56 billion animals a year

(Thornton, 2019). Is our use and consumption of other animals as natural as the behavior of carnivorous hawks, cats, and whales?

> **"Please do not forget those of us who suffer from incurable diseases or disabilities who hope for a cure through research that requires the use of animals."** — Psychologist Dennis Feeney (1987)

For those who give human life top priority, a second question emerges: What safeguards should protect the well-being of animals in research? One survey of animal researchers gave an answer. Some 98 percent supported government regulations protecting primates, dogs, and cats, and 74 percent also supported regulations providing for the humane care of rats and mice (Plous & Herzog, 2000). Many professional associations and funding agencies already have such guidelines. British Psychological Society (BPS) guidelines call for housing animals under reasonably natural living conditions, with companions for social animals (Lea, 2000). American Psychological Association (APA) guidelines state that researchers must provide "humane care and healthful conditions" and that testing should "minimize discomfort" (APA, 2012). The European Parliament also mandates standards for animal care and housing (Vogel, 2010). Most universities screen research proposals, often through an animal care ethics committee, and laboratories are regulated and inspected.

> **"The greatness of a nation can be judged by the way its animals are treated."** — Mahatma Gandhi, 1869–1948

Animals have themselves benefited from animal research. One Ohio team of research psychologists measured stress hormone levels in samples of millions of dogs brought each year to animal shelters. They devised handling and stroking methods to reduce stress and ease the dogs' transition to adoptive homes (Tuber et al., 1999). Other studies have helped improve care and management in animals' natural habitats. By revealing our behavioral kinship with animals and the remarkable intelligence of chimpanzees, gorillas, and other animals, experiments have also led to increased empathy and protection for them. At its best, a psychology concerned for humans and sensitive to animals serves the welfare of both.

MARY ALTAFFER/AP Images

Animal research benefiting animals Psychologists have helped zoos enrich animal environments—for example, by giving animals more choices to reduce the *learned helplessness* of captivity (Kurtycz, 2015; Weir, 2013). Thanks partly to research on the benefits of novelty, control, and stimulation, these gorillas are enjoying an improved quality of life in New York's Bronx Zoo.

Studying and Protecting Humans

What about human participants? Does the image of white-coated scientists seeming to deliver electric shocks trouble you? Actually, most psychological studies are free of such stress. Blinking lights, flashing words, and pleasant social interactions are more common.

Occasionally, researchers do temporarily stress or deceive people, but only when they believe it is essential to a justifiable end, such as understanding and controlling violent behavior or studying mood swings. Some experiments won't work if participants know everything beforehand. (Wanting to be helpful, the participants might try to confirm the researcher's predictions.)

The ethics codes of the APA and Britain's BPS urge researchers to (1) obtain potential participants' **informed consent** to take part, (2) protect participants from greater-than-usual harm and discomfort, (3) keep information about individual participants confidential, and (4) fully **debrief** people (explain the research afterward, including any temporary deception). To enforce these ethical standards, universities and research organizations have *Institutional Review Boards* that screen research proposals and safeguard "the rights, welfare and well-being of human research participants" (NIEHS, 2019).

informed consent
giving potential participants enough information about a study to enable them to choose whether they wish to participate.
debriefing
the postexperimental explanation of a study, including its purpose and any deceptions, to its participants.

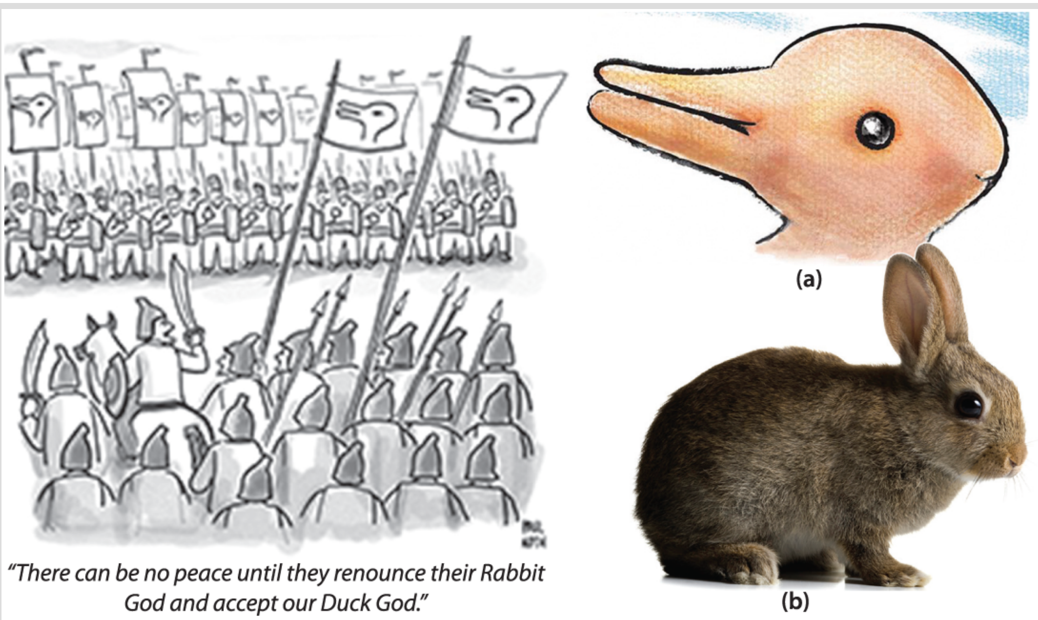
Ensuring Scientific Integrity

In science, as in everyday life, mistakes happen. When data get accidentally miscomputed or misreported, that's forgivable and correctable. What's not acceptable—and will get a scientist banished from the profession—is fraud. Indeed, leading scientists cite honesty as the most important scientific value, followed by curiosity and perseverance (*Nature,* 2016). To seek career advancement by plagiarizing another's words or ideas, or to make up data, is to risk finding one's career ended. Such was the rare case when a Dutch psychologist fabricated data that made it into 58 research articles—fakery that was sniffed out by alert colleagues (Retraction Watch, 2015).

Fake science also has the potential to cause great harm. This happened in 1998 when a now-disbarred British physician, Andrew Wakefield, published an article in the prestigious *Lancet,* reporting a dozen cases in which British children given the measles, mumps, and rubella (MMR) vaccine supposedly developed autism afterward. Other studies failed to reproduce the finding (replication matters!) (Hviid et al., 2019). An investigation revealed a fraud—with falsified data—and the journal retracted the report (Godlee, 2011). Alas, by then the widely publicized finding—"the most damaging medical hoax of the last 100 years" (Flaherty, 2011)—had produced an "anti-vax" movement and declining vaccination rates. Instead of following the typical path toward disease elimination, U.S. measles rates in 2019 rose to their highest levels in 25 years (CDC, 2019; Graham et al., 2019). Unvaccinated children may suffer long-term harm or even death, as well as placing at risk those children too young to be fully vaccinated. Though the science self-corrected, the damage lingers on. Nevertheless, the good news is that scientific scrutiny, complete with replication, can inform and protect us.

Values in Psychology

Values affect what we study, how we study it, and how we interpret results. Researchers' values influence choice of research topics. Should we study worker productivity or worker morale? Sex discrimination or gender differences? Conformity or independence? Values can also color "the facts"—our observations and interpretations. Sometimes we see what we want or expect to see (**FIGURE 1.7**).



Left: The New Yorker Collection, Paul Noth, from cartoonbank.com. All Rights Reserved.; right: Rubberball/Mike Kemp/Getty Images

FIGURE 1.7 What do you see? Our expectations influence what we perceive in (a). Did you see a duck or a rabbit? Show some friends this image with the rabbit photo (b) covered up and see if they are more likely to perceive a duck. (Inspired by Shepard, 1990.)

Even the words we use to describe traits and tendencies can reflect our values. In psychology and in everyday speech, labels describe and labels evaluate: One person's *rigidity* is another's *consistency*. One person's *faith* is another's *fanaticism*. One person's *adultery* is another person's *open marriage*. Our labeling someone as *firm* or *stubborn, careful* or *picky, discreet* or *secretive* reveals our own attitudes.

So, values inform psychological science—and psychological science has the power to persuade. This may lead some to feel distrustful: Is psychology dangerously powerful? Might it be used to manipulate people? Knowledge, like all power, can be used for good or evil. Nuclear power has been used to light up cities—and to demolish them. Persuasive power has been used to educate people—and to deceive them. Although psychology does have the power to deceive, its purpose is to enlighten. Every day, psychologists explore ways to enhance learning, creativity, and compassion. Psychology speaks to many of our world's great problems—war, overpopulation, inequality, climate change, prejudice, family crises, crime—all of which involve attitudes and behaviors. Psychology also speaks to our deepest longings—for nourishment, for love, for happiness. Psychology cannot address all of life's great questions, but it speaks to some mighty important ones.

Left and middle: Macmillan Learning; right: Gordon Parks Foundation

Psychology speaks In making its historic 1954 school desegregation decision, the U.S. Supreme Court cited the expert testimony and research of psychologists Kenneth Clark and Mamie Phipps Clark (1947). The Clarks reported that, when given a choice between Black and White dolls, most African-American children chose the White doll, which indicated that they had likely absorbed and internalized anti-Black prejudice.

ASK YOURSELF

What other questions or concerns do you have about psychology?

RETRIEVAL PRACTICE

RP-14 How are animal and human research participants protected?

ANSWERS IN APPENDIX E

REVIEW Research Strategies: How Psychologists Ask and Answer Questions

LEARNING OBJECTIVES

Test Yourself Answer these repeated Learning Objective Questions on your own (before checking the answers in Appendix D) to improve your retention of the concepts (McDaniel et al., 2009, 2015).

LOQ 1-1: How does our everyday thinking sometimes lead us to a wrong conclusion?
LOQ 1-2: Why are we so vulnerable to believing untruths?
LOQ 1-3: How do theories advance psychological science?
LOQ 1-4: How do psychologists use case studies, naturalistic observations, and surveys to observe and describe behavior, and why is random sampling important?
LOQ 1-5: What does it mean when we say two things are correlated, and what are positive and negative correlations?
LOQ 1-6: What are *illusory correlations,* and what is *regression toward the mean?*
LOQ 1-7: Why do correlations enable prediction but not cause-effect explanation?
LOQ 1-8: What are the characteristics of experimentation that make it possible to isolate cause and effect?
LOQ 1-9: How would you know which research design to use?
LOQ 1-10: How can simplified laboratory conditions illuminate everyday life?
LOQ 1-11: Why do psychologists study animals, and what ethical research guidelines safeguard human and animal welfare? How do

psychologists’ values influence what they study and how they apply their results?

TERMS AND CONCEPTS TO REMEMBER

Test Yourself Write down the definition in your own words, then check your answer.

hindsight bias
theory
hypothesis
operational definition
replication
preregistration
meta-analysis
case study
naturalistic observation
survey
random sample
population
correlation
correlation coefficient
variable
scatterplot
illusory correlation

regression toward the mean
experiment
experimental group
control group
random assignment
double-blind procedure
placebo [pluh-SEE-bo] effect
independent variable
confounding variable
dependent variable
informed consent
debriefing

MASTER THE MATERIAL

Test Yourself Answer the following questions on your own first, then check your answers in Appendix E.

1. ____________ ____________ refers to our tendency to perceive events as obvious or inevitable after the fact.
2. As scientists, psychologists
   a. keep their methods private so others will not repeat their research.

b. assume the truth of articles published in leading scientific journals.

c. reject evidence that competes with traditional findings.

d. are willing to ask questions and to reject claims that cannot be verified by research.

3. A theory-based prediction is called a(n) ________.

4. Which of the following is NOT one of the *descriptive* methods psychologists use to observe and describe behavior?

    a. A case study

    b. Naturalistic observation

    c. Correlational research

    d. A phone survey

5. For your survey, you need to establish a group of people who represent your country's entire adult population. To do this, you will need to question a ________ sample of the population.

6. A study finds that the more childbirth training classes women attend, the less pain medication they require

during childbirth. This finding can be stated as a ____________ (positive/negative) correlation.

7. A ____________ provides a visual representation of the direction and the strength of a relationship between two variables.

8. In a ____________ correlation, the scores rise and fall together; in a(n) ____________ correlation, one score falls as the other rises.

   a. positive; negative

   b. positive; illusory

   c. negative; weak

   d. strong; weak

9. How can regression toward the mean influence our interpretation of events?

10. Knowing that two events are correlated provides

    a. a basis for prediction.

    b. an explanation of why the events are related.

    c. proof that as one increases, the other also increases.

    d. an indication that an underlying third factor is at work.

11. Here are some recently reported correlations, with interpretations drawn by journalists. Knowing just these correlations, can you come up with other possible explanations for each of these?

    a. Alcohol use is associated with violence. (One interpretation: Drinking triggers or unleashes aggressive behavior.)

    b. Educated people live longer, on average, than less-educated people. (One interpretation: Education lengthens life and enhances health.)

    c. Teens engaged in team sports are less likely to use drugs, smoke, have sex, carry weapons, and eat junk food than are teens who do not engage in team sports. (One interpretation: Team sports encourage healthy living.)

    d. Adolescents who frequently see smoking in movies are more likely to smoke. (One interpretation: Movie stars' behavior influences impressionable teens.)

12. To explain behaviors and clarify cause and effect, psychologists use ______________.

13. To test the effect of a new drug on depression, we randomly assign people to control and experimental

groups. Those in the control group take a pill that contains no medication. This pill is a __________.

14. In a double-blind procedure,

    a. only the participants know whether they are in the control group or the experimental group.

    b. experimental and control group members will be carefully matched for age, sex, income, and education level.

    c. neither the participants nor the researchers know who is in the experimental group or control group.

    d. someone separate from the researcher will ask people to volunteer for the experimental group or the control group.

15. A researcher wants to determine whether noise level affects workers' blood pressure. In one group, she varies the level of noise in the environment and records participants' blood pressure. In this experiment, the level of noise is the __________ __________.

16. The laboratory environment is designed to

    a. exactly re-create the events of everyday life.

b. re-create psychological forces under *controlled* conditions.

c. re-create psychological forces under *random* conditions.

d. minimize the use of animals and humans in psychological research.

17. In defending their experimental research with animals, psychologists have noted that

a. animals’ physiology and behavior can tell us much about our own.

b. animal experimentation sometimes helps animals as well as humans.

c. animals are fascinating creatures and worthy of study.

d. all of these statements are correct.

Continue testing yourself with **LearningCurve** or **Achieve Read & Practice** to learn and remember most effectively.

Statistical Reasoning in Everyday Life

In descriptive, correlational, and experimental research, statistics are tools that help us see and interpret what the unaided eye might miss. But accurate statistical understanding benefits everyone. To be an educated person today is to be able to apply simple statistical principles to everyday reasoning. One needn't memorize complicated formulas to think more clearly and critically about data.

Off-the-top-of-the-head estimates often misread reality and mislead the public. Someone throws out a big, round number. Others echo it, and before long the big, round number becomes public misinformation. Three examples:

- ***Ten percent of people are gay***. Or is it 2 to 4 percent, as suggested by various national surveys (Chapter 11)?
- ***We ordinarily use only 10 percent of our brain***. Or is it closer to 100 percent (Chapter 2)?
- ***To be healthy, walk 10,000 steps a day.*** Or will 8,500 or 13,000 steps do the trick, or swimming or jogging (Mull, 2019)?

If you see an attention-grabbing headline presented without evidence—that nationally there are one million teen pregnancies, two million homeless seniors, or three million alcohol-related car accidents—you can be pretty sure that someone is guessing. If they want to emphasize the problem, they will be motivated to guess big. If they want to minimize the problem, they will guess small. *The point to remember:* Use critical thinking when presented with big, round, undocumented numbers.

When setting goals, we love big, round numbers. We're far more likely to want to lose 20 pounds than 19 or 21 pounds (or an even 10 kilograms rather than 9.07 kilograms). And batters try to improve their batting average shortly before the season's end, making them nearly four times more likely to finish with a .300 average than with a .299 average (Pope & Simonsohn, 2011).

Statistical illiteracy also feeds needless health scares (Gigerenzer, 2010). In the 1990s, the British press reported a study showing that women taking a particular contraceptive pill had a 100 percent increased risk of blood clots that could produce strokes. The story went viral, causing thousands of women to stop taking the pill. What resulted? A wave of unwanted pregnancies and an estimated 13,000 additional abortions (which also are associated with increased blood-clot risk). Distracted by big, round numbers, few people focused on the study's actual findings: A 100 percent increased risk, indeed—but only from 1 in 7000 to 2 in 7000. Such false alarms underscore the need to think critically, to teach statistical reasoning, and to present statistical information more transparently.

Describing Data

LOQ 1-12

How do we describe data using three measures of central tendency, and what is the relative usefulness of the two measures of variation?

Once researchers have gathered their data, they may organize that data using *descriptive statistics.* One way to do this is to convert the data into a simple *bar graph,* as in **FIGURE 1.8**, which displays a distribution of different brands of trucks still on the road after a decade. When reading statistical graphs such as this one, take care. It's easy to design a graph to make a difference look big (Figure 1.8a) or small (Figure 1.8b). The secret lies in how you label the vertical scale (the *y-axis*).

The point to remember: Think smart. When interpreting graphs, consider the scale labels and note their *range.*

ASK YOURSELF

Think of a time when you used statistics to make a point—maybe in class, in a paper, or in a discussion with a friend or family member. Looking back, were the data you cited credible and accurate? How do you know?

RETRIEVAL PRACTICE

RP-1 A truck manufacturer offered Figure 1.8's graph (a)—with actual brand names included —to suggest the much greater durability of its trucks. What does graph (b) make clear about the varying durability, and how is this accomplished?

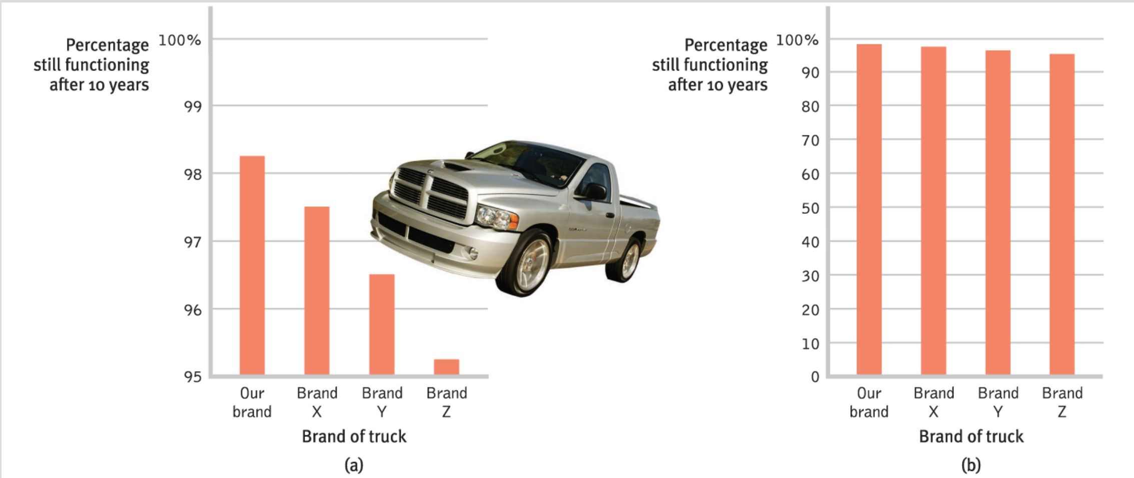


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FIGURE 1.8 Read the scale labels

ANSWERS IN APPENDIX E

Measures of Central Tendency

The next step is to summarize the data using a *measure of central tendency,* a single score that represents a whole set of scores. The simplest measure is the **mode**, the most frequently occurring score or scores. The most familiar is the **mean**, or arithmetic average—the total sum of all the scores divided by the number of scores. The midpoint—the 50th percentile—is the **median**. On a divided highway, the median is the middle. So, too, with data: If you arrange all the scores in order from the highest to the lowest, half will be above the median and half will be below it.

mode
the most frequently occurring score(s) in a distribution.
mean
the arithmetic average of a distribution, obtained by adding the scores and then dividing by the number of scores.
median
the middle score in a distribution; half the scores are above it and half are below it.

Measures of central tendency neatly summarize data. But consider what happens to the mean when a distribution is lopsided—when it's *skewed* by a few way-out scores. With income data, for example, the mode, median, and mean often tell very different stories (**FIGURE 1.9**). This happens because the mean is biased by a few extreme incomes. When Amazon founder Jeff Bezos sits down in a small café, its average (mean) customer instantly becomes a billionaire. But median customer wealth remains unchanged. Understanding this, you can see why, according to the 2010 U.S. Census, nearly 65 percent of U.S. households have "below average" income. The bottom half of earners receive much less than half of the total national income. So, most Americans make less than average (the mean). Mean and median tell different true stories.

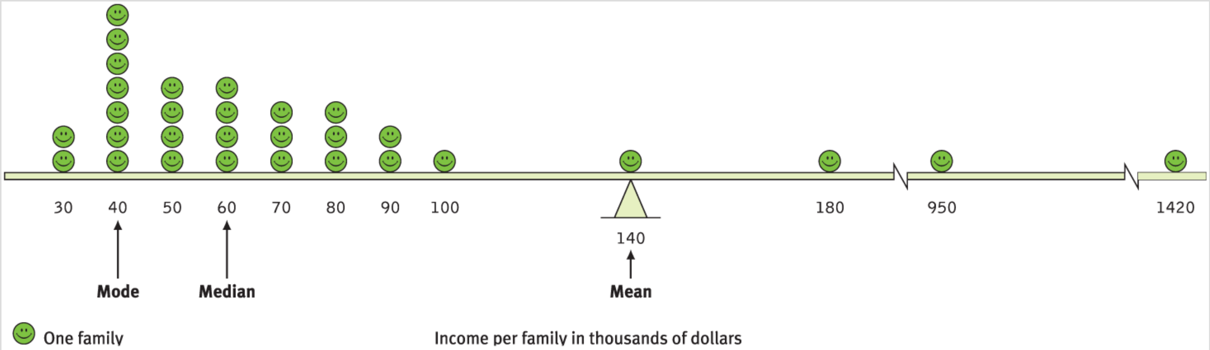

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FIGURE 1.9 A skewed distribution This graphic representation of the distribution of a village's incomes illustrates the three measures of central tendency—mode, median, and mean. Note how just a few high incomes make the mean—the fulcrum point that balances the incomes above and below—deceptively high.

The point to remember: Always note which measure of central tendency is reported. If it is a mean, consider whether a few atypical scores could be distorting it.

The average person has one ovary and one testicle.

Measures of Variation

Knowing the value of an appropriate measure of central tendency can tell us a great deal. But the single number omits other information. It helps to know something about the amount of *variation* in the data—how similar or diverse the scores are. Averages derived from scores with low variability are more reliable than averages based on scores with high variability. Consider a basketball player who scored between 13 and 17 points in each of the season's first 10 games. Knowing this, we would be more confident that she would score near 15 points in her next game than if her scores had varied from 5 to 25 points.

The **range** of scores—the gap between the lowest and highest—provides only a crude estimate of variation. A couple of extreme scores in an otherwise similar group, such as the $950,000 and $1,420,000 incomes in Figure 1.9, will create a deceptively large range.

range
the difference between the highest and lowest scores in a distribution.

The more useful standard for measuring how much scores deviate (differ) from one another is the **standard deviation**. It better gauges whether scores are packed together or dispersed, because it uses information from each score. The computation[4] assembles information about how much individual scores differ from the mean, which can be very telling. Let's say test scores from Class A and Class B both have the same mean (75 percent correct), but very different standard deviations (5.0 for Class A and 15.0 for Class B). Have you ever had test experiences like that—where two-thirds of your classmates in one course score in the 70 to 80 percent range, with scores in another course more spread out (two-thirds between 60 and 90 percent)? The standard deviation, as well as the mean score, tell us about how each class is faring.

standard deviation

a computed measure of how much scores vary around the mean score.

You can grasp the meaning of the standard deviation if you consider how scores naturally tend to be distributed. Large numbers of data—heights, intelligence scores, life expectancy (though not incomes)—often form a symmetrical, *bell-shaped* distribution. Most cases fall near the mean, and fewer cases fall near either extreme. This bell-shaped distribution is so typical that we call the curve it forms the **normal curve**.

normal curve
a symmetrical, bell-shaped curve that describes the distribution of many types of data; most scores fall near the mean (about 68 percent fall within one standard deviation of it) and fewer and fewer near the extremes. (Also called a *normal distribution.*)

As **FIGURE 1.10** shows, a useful property of the normal curve is that roughly 68 percent of the cases fall within one standard deviation on either side of the mean. About 95 percent of cases fall within two standard deviations. Thus, as Chapter 10 notes, about 68 percent of people taking an intelligence test will score within ±15 points of 100. About 95 percent will score within ±30 points.

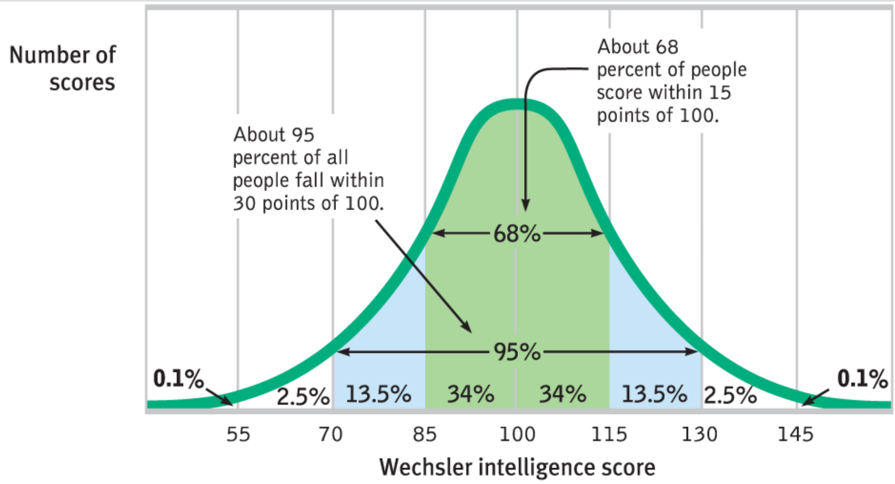

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FIGURE 1.10 The normal curve Scores on aptitude tests tend to form a normal, or bell-shaped, curve. The most commonly used intelligence test, the Wechsler Adult Intelligence Scale, calls the average score 100.

RETRIEVAL PRACTICE

RP-2 The average of a distribution of scores is the __________. The score that shows up most often is the __________. The score right in the middle of a distribution (half the scores above it; half below) is the __________. We determine how much scores vary around the average in a way that includes information about the __________ of scores (difference between highest and lowest) by using the __________ __________ formula.

ANSWERS IN APPENDIX E

For an interactive review of these statistical concepts, visit ***Topic Tutorial: PsychSim6, Descriptive Statistics.***

Significant Differences

LOQ 1-13

How do we know whether an observed difference can be generalized to other populations?

"The poor are getting poorer, but with the rich getting richer it all averages out in the long run."

Data are "noisy." The average score in one group (those who deactivated their Facebook account, in the experiment we mentioned earlier) could conceivably differ from the average score in another group (those who didn't) not because of any real difference, but merely because of chance fluctuations in the people sampled. How confidently, then, can we *infer* that an observed difference is not just a fluke—a chance result from the research sample? For guidance, we can ask how reliable and statistically significant the differences are. These *inferential statistics* help us determine if results can be generalized to a larger population (all those in a group being studied).

When Is an Observed Difference Reliable?

In deciding when it is safe to generalize from a sample, we should keep three principles in mind:

1. ***Representative samples are better than biased (unrepresentative) samples.*** The best basis for generalizing is not from the exceptional and memorable cases one finds at the extremes but from a representative sample of cases. Research never randomly samples the whole human population. Thus, it pays to keep in mind what population a study has sampled.
2. ***Less-variable observations are more reliable than those that are more variable.*** As we noted earlier in the example of the basketball player whose game-to-game points were consistent, an average is more reliable when it comes from scores with low variability.
3. ***More cases are better than fewer.*** An eager prospective student visits two universities, each for a day. At the first, the student randomly attends two classes and finds both instructors to be witty and engaging. At the second, the two sampled instructors seem dull and uninspiring. Returning home, the student (discounting the small sample size of only two teachers at each institution) tells friends about the "great teachers" at the first

> school and the "bores" at the second. Again, we know it but we ignore it: *Averages based on many cases are more reliable* (less variable) than averages based on only a few cases. After noticing that small schools were overrepresented among the most successful schools, several foundations invested in splitting larger schools into smaller ones—without realizing that small schools were also overrepresented among the *least* successful, because schools with fewer students have more variable outcomes (Nisbett, 2015). Again, more cases make for a more reliable average and a more replicable study.

The point to remember: Smart thinkers are not overly impressed by a few anecdotes. Generalizations based on a few unrepresentative cases are unreliable.

When Is an Observed Difference Significant?

Let's say you compared men's and women's scores on a laboratory test of aggression. You found that men behaved more aggressively than women. But individuals differ. How likely is it that your observed gender difference was just a fluke?

Researchers use statistical steps to answer this question. Statistical tests begin with the assumption that no differences exist between groups, an assumption called the *null hypothesis.* Using statistics we may conclude that the gender difference we observed is so large that it's unlikely to fit the null hypothesis. That's when we reject the null hypothesis of no differences, and we say that the result is **statistically significant**. Such a large difference would support an *alternative hypothesis*—that a difference (in aggression, for our example) does exist between the groups being studied (men and women).

statistical significance
a statement of how likely it is that a result (such as a difference between samples) occurred by chance, assuming there is no difference between the populations being studied.

How does the size of the difference between them—the *effect size*—determine statistical significance? First, when averages from two samples are each reliable measures of their respective populations (as when each is based on many observations that have low variability), then any difference between the two samples is more likely to be statistically significant. (For our example: The less the variability in women's and in men's aggression scores, the more confidence we would have that our observed gender difference is real.) When the difference between the sample averages is *large* (as long as the samples are based on many observations), we also have more confidence that the difference between them reflects a real difference in their populations.

In short, when samples are large, and when the difference between them is relatively large, we say the difference has statistical significance. This means that the observed difference is probably more than just chance variation between the samples, and we can reject the null hypothesis of no existing differences.

In judging statistical significance, psychologists are conservative. They are like juries that must presume innocence until guilt is proven. Many psychological tests provide *p*-values, which indicate the probability of the null hypothesis given the sample data. For most psychologists, proof beyond a reasonable doubt means not making much of a finding unless the probability (*p*-value) of the null hypothesis is less than 5 percent ($p < .05$). Some researchers argue that statistical significance is overemphasized, noting that a "nonsignificant" result does *not* mean—as people often assume—a complete lack of difference between the groups (Amrhein et al., 2019). It only indicates greater uncertainty. For now, many psychologists continue to use $p < .05$, but stay tuned.

When learning about research, you should remember that, given large enough or homogeneous enough samples, a difference between them may be "statistically significant" yet have little *practical* significance. They might be statistically significant but have a small effect size. Comparisons of intelligence test scores among hundreds of thousands of first-born and later-born individuals indicate a highly significant tendency for first-born individuals to have higher average scores than their later-born siblings (Rohrer et al., 2015; Zajonc & Markus, 1975). But because the scores differ only slightly, the "significant" difference has a small effect size and little practical importance.

The point to remember: Statistical significance indicates the *likelihood* that a result would happen by chance if the null hypothesis (of no difference) were true. But this does not say anything about the *importance* of the result.

ASK YOURSELF

Can you think of a situation where you were fooled by a writer or speaker's attempts to persuade you with statistics? What have you learned in this chapter that will be most helpful in the future to avoid being misled?

RETRIEVAL PRACTICE

RP-3 Can you solve this puzzle?

The registrar's office at the University of Michigan has found that about 100 students in Arts and Sciences usually have perfect marks at the end of their first term. However, only about 10 to 15 students graduate with perfect marks. What do you think is the most likely explanation for the fact that there are more perfect marks after one term than at graduation (Jepson et al., 1983)?

RP-4 ________ statistics summarize data, while ________ statistics determine if data can be generalized to other populations.

ANSWERS IN APPENDIX E

For a review, engage online with ***Concept Practice: Statistical Significance.***

REVIEW Statistical Reasoning in Everyday Life

LEARNING OBJECTIVES

Test Yourself Answer these repeated Learning Objective Questions on your own (before checking the answers in Appendix D) to improve your retention of the concepts (McDaniel et al., 2009, 2015).

LOQ 1-12: How do we describe data using three measures of central tendency, and what is the relative usefulness of the two measures of variation?
LOQ 1-13: How do we know whether an observed difference can be generalized to other populations?

TERMS AND CONCEPTS TO REMEMBER

Test Yourself Write down the definition in your own words, then check your answer.

mode
mean
median
range
standard deviation
normal curve
statistical significance

MASTER THE MATERIAL

Test Yourself Answer the following questions on your own first, then check your answers in Appendix E.

1. Which of the three measures of central tendency is most easily distorted by a few very high or very low scores?

    a. The mode

    b. The mean

    c. The median

    d. They are all equally vulnerable to distortion from atypical scores.

2. The standard deviation is the most useful measure of variation in a set of data because it tells us

   a. the difference between the highest and lowest scores in the set.

   b. the extent to which the sample being used deviates from the bigger population it represents.

   c. how much individual scores differ from the mode.

   d. how much individual scores differ from the mean.

3. Another name for a bell-shaped distribution, in which most scores fall near the middle and fewer scores fall at each extreme, is a ___________ ___________.

4. When sample averages are ___________ and the difference between them is ___________, we can say the difference is more likely to be statistically significant.

   a. reliable; large

   b. reliable; small

   c. due to chance; large

   d. due to chance; small

Continue testing yourself with **LearningCurve** or **Achieve Read & Practice** to learn and remember most effectively.

CHAPTER 2

The Biology of Mind

Laurence Dutton/Getty Images

Two transplant surgeons, Italy’s Sergio Canavero and China’s Xiaoping Ren, have built an international team for an audacious medical venture —a head transplant (Kean, 2016; Ren & Canavero, 2017; Ren et al., 2019). Wang Huanming, who is paralyzed from the neck down, volunteered to have his fully functioning head transferred to a brain-dead person’s still-functioning body.

"You're certainly a lot less fun since the operation."

Gahan Wilson/Cartoon Stock

Ignore for the moment the ethical issues of such an experiment, which some have called "reckless and ghastly" and part of the scientists' "ghoulish fantasies" (Illes & McDonald, 2017; Wolpe, 2018). Ignore the procedure's cost, estimated at up to $100 million (Hjelmgaard, 2019). And ignore the seeming impossibility of precisely connecting the head-to-spinal-cord nerves. Imagine, just imagine, that the procedure could work. With the same brain and a new body, would Wang still be Wang? To whose home should he return? If the old Wang was a skilled musician, would the new Wang conceivably retain that skill—or would that depend on the muscle memories stored in the new body? And if he (assuming the new body was male) later had a child, whom should the birth certificate list as the father?

Most of us twenty-first-century people (you, too?) presume that, even with a new body, Wang would still be Wang. We presume that our brain, designed by our genes and sculpted by our experiences, provides our identity and enables our mind. No brain, no mind.

We are, indeed, living brains, but more. We are bodies alive. No principle is more central to today's psychology, or to this book, than this: *Everything psychological is simultaneously biological.* Your every idea, every mood, every urge is a biological happening. You love, laugh, and cry with your body. To think, feel, or act without a body would be like running without legs. Without your body—your genes, your nervous system, your hormones, your appearance—you truly would be nobody. Moreover, your body and your brain influence and are influenced by your experiences. Throughout this book, you will find many examples of the interplay between biology and psychology.

As you will also see throughout this book, we humans share the same basic biological design. Yet thanks to our individual genes, experiences, and cultural traditions and teachings, we differ from one another. Our traits and behaviors arise from the interaction of nature and nurture. Our thoughts, feelings, and actions influence our blood pressure, hormones, health—and our brain. As we wend our way from cradle to grave, our biology changes in response to our behaviors and environments.

In this chapter, we explore the mind's biology. We start small and build from the bottom up—from nerve cells up to the brain. But we'll also discuss how our behavior and environment can influence our biology from the top down. Life changes us. You've heard it before and you'll hear it again: *Nurture works on what nature provides.*

Neural and Hormonal Systems

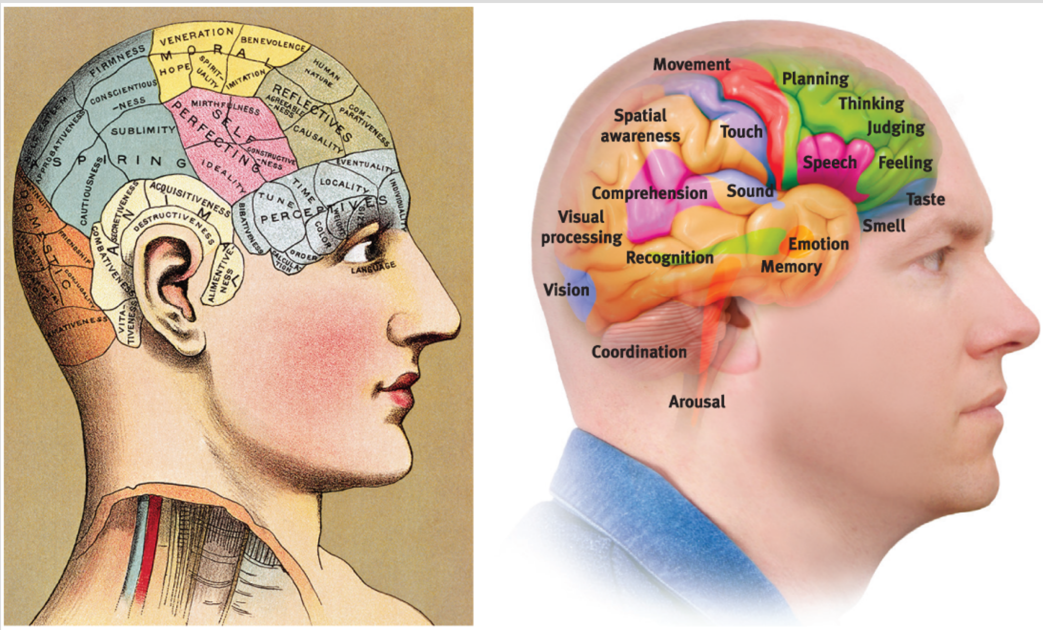
Biology, Behavior, and Mind

LEARNING OBJECTIVE QUESTION LOQ 2-1

Why are psychologists concerned with human biology?

Our understanding of how the brain gives birth to the mind has come a long way. The ancient Greek physician, Hippocrates, correctly located the mind in the brain. His contemporary, the philosopher Aristotle, believed the mind was in the heart, which pumps warmth and vitality to the body. The heart remains our symbol for love, but science has long since overtaken philosophy on this issue: It's your brain, not your heart, that falls in love.

In the early 1800s, German physician Franz Gall proposed that *phrenology*, studying bumps on the skull, could reveal a person's mental abilities and character traits (**FIGURE 2.1**). At one point, Britain had 29 phrenological societies, and phrenologists traveled North America giving skull readings (Dean, 2012; Hunt, 1993). Using a false name, humorist Mark Twain put one famous phrenologist to the test. "He found a cavity [and] startled me by saying that that cavity represented the total absence of the sense of humor!" Three months later, Twain sat for a second reading, this time identifying himself. Now “the cavity was gone, and in its place was … the loftiest bump of humor he had ever encountered in his life-long experience!” (Lopez, 2002). The “science” of phrenology remains known today as a reminder of our need for critical thinking and scientific analysis. Phrenology did at least succeed in focusing attention on the *localization of function*—the idea that various brain regions have particular functions.



(a) (b)

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(a): Bettmann/Getty Images

FIGURE 2.1 A wrongheaded theory (a) Despite initial acceptance of Franz Gall’s speculations, bumps on the skull tell us nothing about the brain’s underlying functions. Nevertheless, some of his assumptions have held true. Though they are not the functions Gall proposed, different parts of the brain do control different aspects of behavior, as suggested in (b) (from *The Human Brain Book*), and as you will see throughout this chapter.

Today, we are living in a time Gall could only dream about. **Biological psychologists** use advanced technologies to study the links between biological (genetic, neural, hormonal) processes and psychological processes. They and other researchers working from a biological perspective are announcing discoveries about the interplay of our biology and our behavior and mind at an exhilarating pace. Within little more than the past century, researchers seeking to understand the biology of the mind have discovered that

- our adaptive brain is wired by our experiences.
- among the body's cells are nerve cells that conduct electricity and "talk" to one another by sending chemical messages across a tiny gap that separates them.
- specific brain systems serve specific functions (though not the functions Gall supposed).
- we integrate information processed in these different brain systems to construct our experience of sights and sounds, meanings and memories, pain and passion.

biological psychology
the scientific study of the links between biological (genetic, neural, hormonal) and psychological processes. Some biological psychologists call themselves *behavioral neuroscientists, neuropsychologists, behavior geneticists, physiological psychologists,* or *biopsychologists.*

We have also realized that we are each a system composed of subsystems that are in turn composed of even smaller subsystems. Tiny cells organize to form body organs. These organs form larger systems for digestion, circulation, and information processing. And those systems are part of an even larger system—the individual, who in turn is a part of a family, community, and culture. Thus, we are *biopsychosocial* systems. To understand our behavior, we need to study how these biological, psychological, and social-cultural systems work and interact. Let's begin with the brain's ability to rewire itself as it adapts to experience.

RETRIEVAL PRACTICE

RP-1 What do phrenology and biological psychology have in common?

ANSWERS IN APPENDIX E

The Power of Plasticity

LOQ 2-2

How do biology and experience together enable neuroplasticity?

Your brain is sculpted not only by your genes but also by your life. Under the surface of your awareness, your brain is constantly changing, building new pathways as it adjusts to new experiences. This neural change is called **neuroplasticity**. Although neuroplasticity is greatest in childhood, it continues throughout life (Gutchess, 2014).

neuoroplasticity
the brain's ability to change, especially during childhood, by reorganizing after damage or by building new pathways based on experience.

To see neuroplasticity at work, consider London's taxi driver trainees. They spend years learning and remembering the city's 25,000 street locations and connections. For the half who pass the difficult final test, big rewards are in store: not only a better income but also an enlarged hippocampus, one of the brain's memory centers that processes spatial memories. London's bus drivers, who navigate a smaller set of roads, gain no similar neural rewards (Maguire et al., 2000, 2006; Woollett & Maguire, 2012).

World Access for the Blind

The mind's eye Daniel Kish, who is completely blind, enjoys going for walks in the woods. To stay safe, he uses echolocation—the same navigation method used by bats and dolphins. Blind echolocation experts such as Kish engage the brain's visual centers to navigate their surroundings (Thaler et al., 2011, 2014). Although Kish is blind, his flexible brain helps him "see."

We also see neuroplasticity in well-practiced pianists, who have a larger-than-usual auditory cortex area, a sound-processing region (Bavelier et al., 2000; Pantev et al., 1998). Practice likewise sculpts the brains of ballerinas, jugglers, and unicyclists (Draganski et al., 2004; Hänggi et al., 2010; Weber et al., 2019).

Your brain is a work in progress. The brain you were born with is not the brain you will die with. Even limited practice times may produce neural benefits. If you spend six weeks training your sense of smell, as did participants in one study, you may grow your smell-related brain areas (Al Aïn et al., 2019). Just an hour of learning produces subtle brain changes (Brodt et al., 2018). Remember that the next time you attend class!

Neuroplasticity is part of what makes the human brain exceptional (Gómez-Robles et al., 2015). Think of how much the world has changed over the past 50 years, and how much more it will change in the next 50. More than for any other species, our neuroplasticity enables us to adapt to our rapidly changing world (Roberts & Stewart, 2018).

Luna Productions

Marian Diamond (1926–2017) This ground-breaking neuroscientist's research fundamentally changed how we understand the brain. She pioneered the exploration of how experience changes the brain. Diamond also analyzed Albert Einstein's brain after his death, which helped unlock the neural mechanics of his mind.

RETRIEVAL PRACTICE

RP-2 How does learning a new skill affect the structure of our brain?

ANSWERS IN APPENDIX E

Neural Communication

For scientists, it is a happy fact of nature that the information systems of humans and other animals operate similarly—so much so that you could not distinguish between small samples of brain tissue from a human and a monkey. This similarity allows researchers to study much simpler animals, such as squids and sea slugs, to discover how our neural systems operate. It allows them to study other mammals' brains to understand the organization of our own. Cars differ, but all have accelerators, steering wheels, and brakes. A space alien could study any one of them and grasp the operating principles. Likewise, animals differ, yet their nervous systems operate similarly.

Neurons

LOQ 2-3

What are *neurons,* and how do they transmit information?

Our body's neural information system is complexity built from simplicity. Its building blocks are **neurons**, or nerve cells. Throughout life, new neurons are born and unused neurons wither away (O'Leary et al., 2014; Shors, 2014). To fathom our thoughts and actions, our memories and moods, we must first understand how neurons work and communicate.

neuron
a nerve cell; the basic building block of the nervous system.

Neurons differ, but all are variations on the same theme (**FIGURE 2.2**). Each consists of a **cell body** and its branching fibers. The often bushy **dendrite** fibers receive and integrate information, conducting it toward the cell body (Stuart & Spruston, 2015). From there, the cell's single lengthy **axon** fiber passes the message through its terminal branches to other neurons or to muscles or glands (**FIGURE 2.3**). *D*endrites listen. *A*xons speak.

cell body
the part of a neuron that contains the nucleus; the cell's life-support center.
dendrites
a neuron's often bushy, branching extensions that receive and integrate messages, conducting impulses toward the cell body.
axon
the segmented neuron extension that passes messages through its branches to other neurons or to muscles or glands.

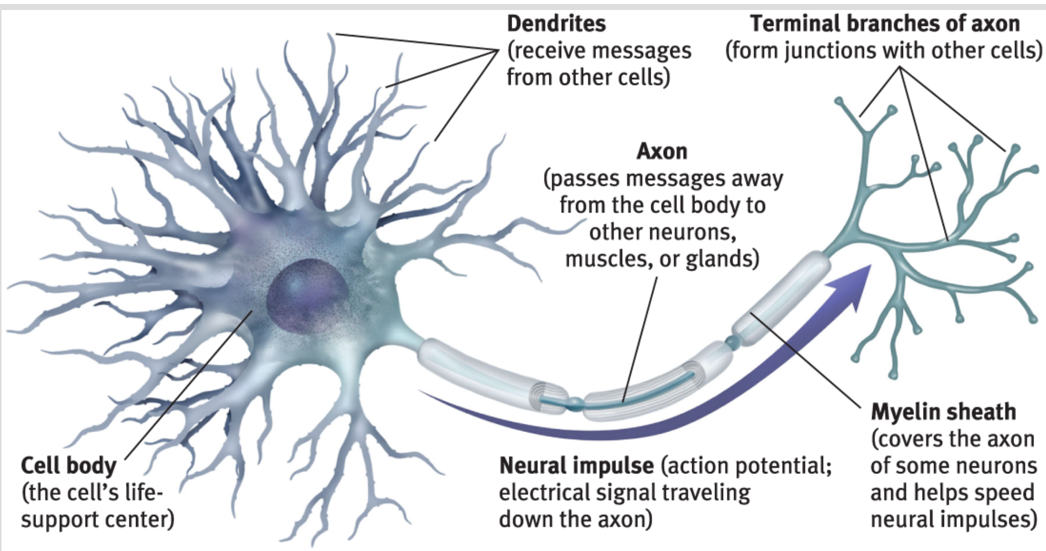
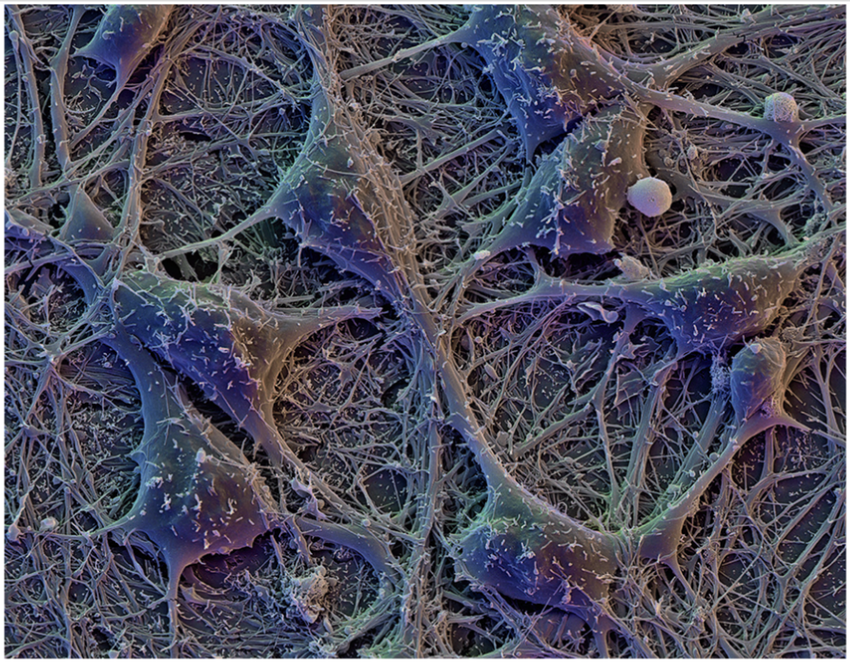


FIGURE 2.2 A motor neuron



David Scharf/Science Source

FIGURE 2.3 Neurons communicating Our billions of neurons exist in a vast and densely interconnected web. One neuron's terminal branches send messages to neighboring dendrites. Read on to learn more about this complex and fascinating electrochemical communication process.

Unlike the short dendrites, axons may be very long, projecting several feet through the body. A human neuron carrying orders to a leg muscle, for example, has a cell body and axon roughly on the scale of a basketball attached to a rope that's 4 miles (6.4 kilometers) long. Much as home electrical wire is insulated, some axons are encased in a **myelin sheath**, a layer of fatty tissue that insulates them and speeds their impulses. As myelin is laid down up to about age 25, neural efficiency, judgment, and self-control grow (Fields, 2008; Nakamura et al., 2018; Van Munster et al., 2015). If the myelin sheath degenerates, *multiple sclerosis* results:

Communication to muscles and brain regions slows, with diminished muscle control and sometimes impaired cognition.

myelin [MY-uh-lin] sheath
a fatty tissue layer segmentally encasing the axons of some neurons; enables vastly greater transmission speed as neural impulses hop from one node to the next.

John Shearer/Getty Images

Managing multiple sclerosis Actor Selma Blair’s multiple sclerosis results from a loss of the myelin sheath that insulates her motor axons and speeds their neural impulses. She has openly discussed her challenges, including difficulty speaking and walking. In 2018, Blair attended a Hollywood event walking with a cane.

Supporting these billions of nerve cells are spidery **glial cells** ("glue cells"). Neurons are like queen bees; on their own they cannot feed or sheathe themselves. Glial cells are worker bees. They provide nutrients and insulating myelin, guide neural connections, and mop up *ions* and *neurotransmitters*. Glia also play a role in learning, thinking, and memory. By "chatting" with neurons, they participate in information transmission and memory (Fields, 2011, 2013; Martín et al., 2015).

glial cells (glia)
cells in the nervous system that support, nourish, and protect neurons; they also play a role in learning, thinking, and memory.

In more complex animal brains, the proportion of glia to neurons increases. A postmortem analysis of Albert Einstein's brain did not find more or larger-than-usual neurons, but it did reveal a much greater concentration of glial cells than found in an average person's head (Fields, 2004). Einstein's glial cells kept his brain abuzz with activity.

The Neural Impulse

Neurons transmit messages when stimulated by our senses or by neighboring neurons. A neuron sends a message by firing an impulse, called the **action potential**—a brief electrical charge that travels down its axon.

action potential
a neural impulse; a brief electrical charge that travels down an axon.

> **"I sing the body electric."** — Walt Whitman, "Children of Adam," 1855

Depending on the type of fiber, a neural impulse travels at speeds ranging from a sluggish 2 miles (3 kilometers) per hour to more than 200 miles (320 kilometers) per hour. But even its top speed is 3 million times slower than that of electricity through a wire. We measure brain activity in milliseconds (thousandths of a second) and computer activity in nanoseconds (billionths of a second). Thus, unlike the nearly instantaneous reactions of a computer, your reaction to a sudden event, such as a child darting in front of your car, may take a quarter-second or more. Your brain is vastly more complex than a computer, but slower at executing simple responses. And if you were an elephant—whose round-trip message travel time from a yank on the tail to the brain and back to the tail is 100 times longer than that of a tiny shrew—your reflexes would be slower yet (More et al., 2010).

Like batteries, neurons generate electricity from chemical events. In the neuron's chemistry-to-electricity process, *ions* (electrically charged atoms) are exchanged. The fluid outside an axon's membrane has mostly positively charged sodium ions. A resting axon's fluid interior (which includes both large, negatively charged protein ions and smaller, positively charged potassium ions) has a mostly negative charge. Like a tightly guarded facility, the axon's surface is selective about what it allows through its gates. We say the axon's surface is *selectively permeable.* This positive-outside/negative-inside state is called the *resting potential.*

When a neuron fires, however, the security parameters change: The first section of the axon opens its gates, rather like a storm sewer cover flipping open, and positively charged sodium ions (attracted to the negative interior) flood in through the now-open channels (**FIGURE 2.4**). The loss of the inside/outside charge difference, called *depolarization*, causes the next section of axon channels to open, and then the next, like falling dominos. This temporary inflow of positive ions is the neural impulse—the action potential. Each neuron is itself a miniature decision-making device performing complex calculations as it receives signals from hundreds, even thousands, of other neurons. The mind boggles when imagining this electrochemical process repeating up to 100 or even 1000 times a second. But this is just the first of many astonishments.

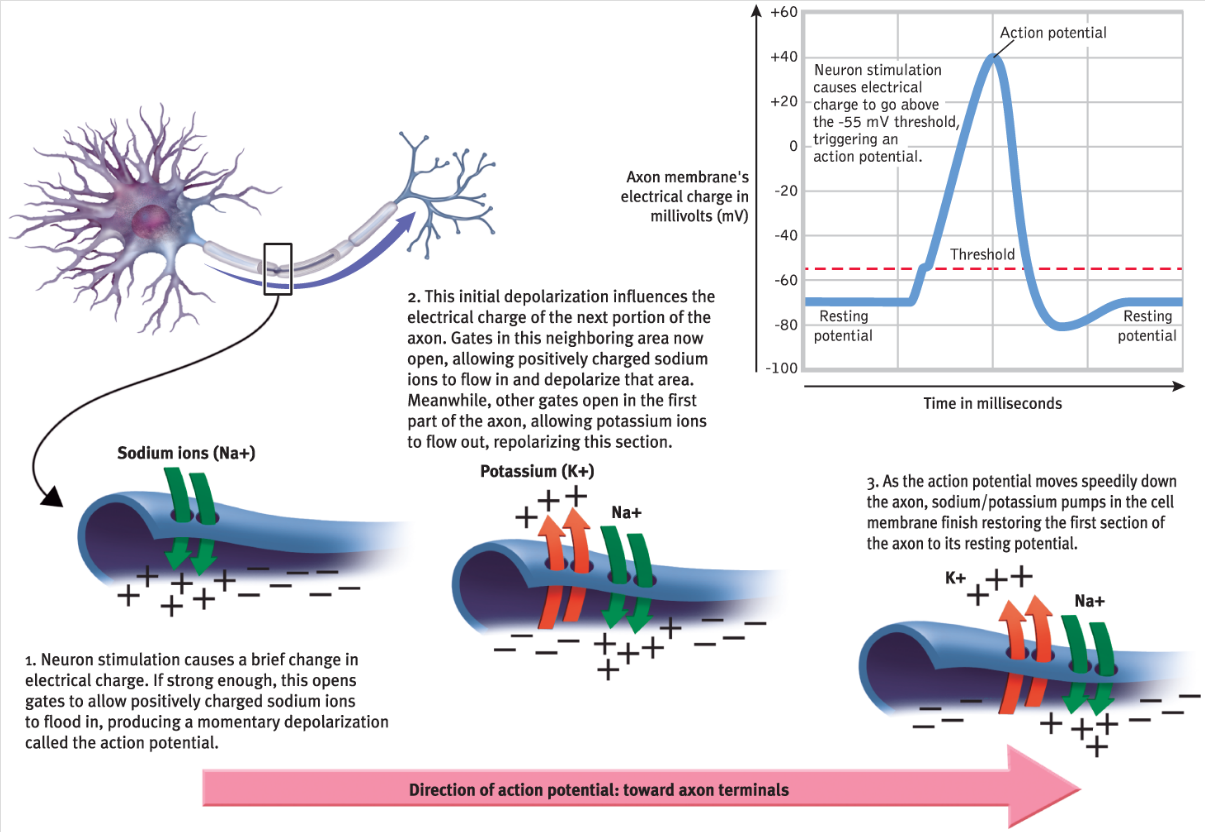


FIGURE 2.4 Action potential Bodily sensations and actions—detecting a hug or kicking a soccer ball—happen when our neurons are stimulated enough that their membrane's electrical charge reaches a threshold (–55 mV in this example—see graph). This prompts each of those neurons to "fire" an impulse—an action potential—which travels down its axon (see numbered drawings) and transmits a message to other neurons, muscles, or glands.

Most neural signals are *excitatory*, somewhat like pushing a neuron's accelerator. Some are *inhibitory*, more like pushing its brake. If excitatory signals exceed the inhibitory signals by a minimum intensity, or **threshold** (see Figure 2.4), the combined signals trigger an action potential. (Think of it this way: If the excitatory party animals outvote the inhibitory party poopers, the party's on.) The action potential then travels down the axon, which branches into junctions with hundreds or thousands of other neurons or with the body's muscles and glands.

threshold
the level of stimulation required to trigger a neural impulse.

> **"What one neuron tells another neuron is simply how much it is excited."** — Francis Crick, *The Astonishing Hypothesis*, 1994

Neurons need short breaks (a tiny fraction of an eyeblink). During a resting pause called the **refractory period**, subsequent action potentials cannot occur until the axon returns to its resting state. Then the neuron can fire again.

refractory period
in neural processing, a brief resting pause that occurs after a neuron has fired; subsequent action potentials cannot occur until the axon returns to its resting state.

Increasing the level of stimulation above the threshold will not increase the neural impulse's intensity. The neuron's reaction is an **all-or-none response**: Like guns, neurons either fire or they don't. How, then, do we detect the intensity of a stimulus? How do we distinguish a gentle touch from a big hug? A strong stimulus can trigger *more* neurons to fire, and to fire more often. But it does not affect the action potential's strength or speed. Squeezing a trigger harder won't make a bullet go faster.

all-or-none response
a neuron's reaction of either firing (with a full-strength response) or not firing.

ASK YOURSELF

Does it surprise you to learn that despite your brain's complexity, your reaction time is slower than a computer's? Does this suggest which tasks might be more readily performed by computers than by humans?

RETRIEVAL PRACTICE

RP-3 When a neuron fires an action potential, the information travels through the axon, the dendrites, and the cell body, but not in that order. Place these three structures in the correct order.

RP-4 How does our nervous system allow us to experience the difference between a slap and a tap on the back?

ANSWERS IN APPENDIX E

For an interactive, animated explanation of this process, engage online with ***Concept Practice: Action Potentials.***

How Neurons Communicate

LOQ 2-4

How do nerve cells communicate with other nerve cells?

Neurons interweave so intricately that even with a microscope, you would struggle to see where one neuron ends and another begins.

Scientists once believed that the axon of one cell fused with the dendrites of another in an uninterrupted fabric. Then British physiologist Sir Charles Sherrington (1857–1952) noticed that neural impulses were taking an unexpectedly long time to travel a neural pathway. Inferring that there must be a brief interruption in the transmission, Sherrington called the meeting point between neurons a **synapse**.

synapse [SIN-aps]
the junction between the axon tip of the sending neuron and the dendrite or cell body of the receiving neuron. The tiny gap at this junction is called the *synaptic gap* (or *synaptic cleft*).

> **"All information processing in the brain involves neurons 'talking to' each other at synapses."** —Neuroscientist Solomon H. Snyder (1984)

We now know that the axon terminal of one neuron is in fact separated from the receiving neuron by a tiny—less than a millionth of an inch wide—*synaptic gap* (or *synaptic cleft*). Spanish anatomist Santiago Ramón y Cajal (1852–1934) marveled at these near-unions of neurons, calling them "protoplasmic kisses." "Like elegant ladies air-kissing so as not to muss their makeup, dendrites and axons don't quite touch," noted poet Diane Ackerman (2004, p. 37). How do the neurons execute this protoplasmic kiss, sending information across the synaptic gap? The answer is one of the important scientific discoveries of our age.

When an action potential reaches the button-like terminals at an axon's end, it triggers the release of chemical messengers, called **neurotransmitters** (**FIGURE 2.5**). Within 1/10,000th of a second, the neurotransmitter molecules cross the synaptic gap and bind to receptor sites on the receiving neuron—as precisely as a key fits a lock. For an instant, the neurotransmitter unlocks tiny channels at the receiving site, and electrically charged atoms flow in, exciting or inhibiting the receiving neuron's readiness to fire. The excess neurotransmitters finally drift away, are broken down by enzymes, or are reabsorbed by the sending neuron—a process called **reuptake**. Some antidepressant medications partially block the reuptake of mood-enhancing neurotransmitters (**FIGURE 2.6**).

neurotransmitters
chemical messengers that cross the synaptic gap between neurons. When released by the sending neuron, neurotransmitters travel across the synapse and bind to receptor sites on the receiving neuron, thereby influencing whether that neuron will generate a neural impulse.
reuptake
a neurotransmitter's reabsorption by the sending neuron.

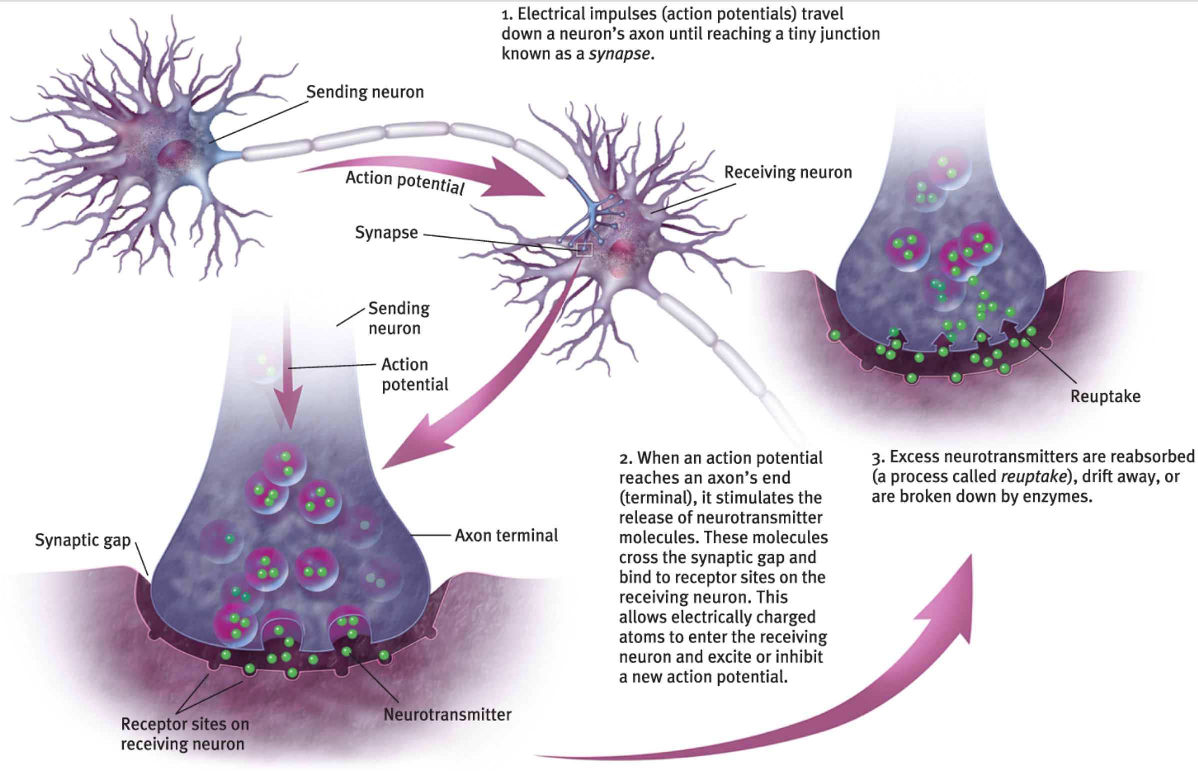


FIGURE 2.5 How neurons communicate

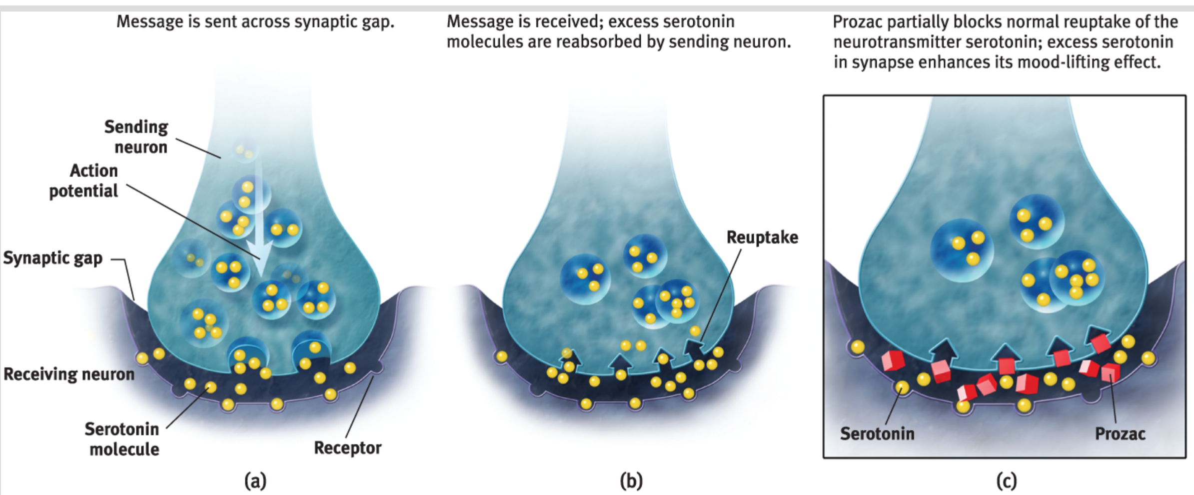


FIGURE 2.6 Biology of antidepressants Selective serotonin reuptake inhibitors (SSRIs) are popularly prescribed antidepressants. They are designed to relieve depression by partially blocking the reuptake of the neurotransmitter serotonin. Shown here is the action of the SSRI Prozac.

ASK YOURSELF

Why was the discovery of neurons' communication mechanism so important?

RETRIEVAL PRACTICE

RP-5 What happens in the *synaptic gap?*

RP-6 What is *reuptake?* What two other things can happen to excess neurotransmitters after a neuron reacts?

ANSWERS IN APPENDIX E

How Neurotransmitters Influence Us

LOQ 2-5

How do neurotransmitters influence behavior, and how do drugs and other chemicals affect neurotransmission?

In their quest to understand neural communication, researchers have discovered several dozen neurotransmitters and as many new questions: Are certain neurotransmitters found only in specific places? How do neurotransmitters affect our moods, memories, and mental abilities? Can we boost or diminish these effects through drugs or diet?

> **“When it comes to the brain, if you want to see the action, follow the neurotransmitters.”** — Neuroscientist Floyd Bloom (1993)

Other chapters explore neurotransmitter influences on hunger and thinking, depression and euphoria, addictions and therapy. For now, let’s glimpse how neurotransmitters influence our motions and emotions. A particular brain pathway may use only one or two neurotransmitters, such as serotonin and dopamine, and particular neurotransmitters affect specific behaviors and emotions (**TABLE 2.1**). But neurotransmitter systems don’t operate in isolation; they interact, and their effects vary with the receptors they stimulate.

TABLE 2.1 Commonly Studied Neurotransmitters and Their Functions

Neurotransmitter	Function	Examples of Malfunctions
Acetylcholine (ACh)	Enables muscle action, learning, and memory	With Alzheimer’s disease, ACh-producing neurons deteriorate.
Dopamine	Influences movement, learning, attention, and emotion	Oversupply linked to schizophrenia. Undersupply linked to tremors and decreased mobility in Parkinson’s disease.
Serotonin	Affects mood, hunger, sleep, and arousal	Undersupply linked to depression. Some drugs that raise serotonin levels are used to treat depression.
Norepinephrine	Helps control alertness and arousal	Undersupply can depress mood.
GABA (gamma-aminobutyric acid)	A major inhibitory neurotransmitter	Undersupply linked to seizures, tremors, and insomnia.
Glutamate	A major excitatory neurotransmitter;	Oversupply can overstimulate the brain, producing migraines or seizures.

	involved in memory	
Endorphins	Neurotransmitters that influence the perception of pain or pleasure	Oversupply with opiate drugs can suppress the body’s natural endorphin supply.

Top: Noam Galai/Getty Images;
bottom: ASSOCIATED PRESS

Dependent upon dopamine The neurotransmitter dopamine helps us move, think, and feel. Too little dopamine may produce the tremors and loss of motor control of Parkinson’s disease (NIA, 2019; Weinstein et al., 2018). More than 10 million people worldwide have Parkinson’s disease, including actor Michael J. Fox and the late boxing legend Muhammad Ali (Parkinson’s Foundation, 2018).

One of the best-understood neurotransmitters, *acetylcholine* (*ACh*), plays a role in learning and memory. ACh also enables muscle action, by acting as the messenger at every junction between motor neurons (which carry information from the brain and spinal cord to the body’s tissues) and skeletal muscles. When ACh is released to our muscle cell receptors, the muscle contracts. If ACh transmission is blocked, as happens during some kinds of anesthesia and with some poisons, the muscles cannot contract and we are paralyzed.

Candace Pert and Solomon Snyder (1973) made an exciting discovery about neurotransmitters when they attached a harmless radioactive tracer to morphine, an opiate drug that elevates mood and eases pain. As the researchers tracked the morphine in an animal’s brain, they noticed it was binding to receptors in areas linked with mood and pain sensations. But why would the brain have these “opiate receptors”? Why would it have a chemical lock, unless it also had a key—a natural painkiller—to open it?

Researchers soon confirmed that the brain does indeed produce its own naturally occurring opiates. Our body releases several types of neurotransmitter molecules similar to morphine in response to pain and vigorous exercise. These **endorphins** (short for *end*ogenous [produced within] m*orphin*e) help explain good feelings such as the "runner's high," the painkilling effects of acupuncture, and the indifference to pain in some severely injured people (Boecker et al., 2008; Fuss et al., 2015). But once again, new knowledge led to new questions.

endorphins [en-DOR-fins]
"morphine within"—natural, opiate-like neurotransmitters linked to pain control and to pleasure.

Physician Lewis Thomas, on the endorphins: "There it is, a biologically universal act of mercy. I cannot explain it, except to say that I would have put it in had I been around at the very beginning, sitting as a member of a planning committee." — *The Youngest Science*, 1983

ASK YOURSELF

Can you recall a time, perhaps after a workout, when you felt the effects of endorphins? How would you describe those feelings?

RETRIEVAL PRACTICE

RP-7 Serotonin, dopamine, and endorphins are all chemical messengers called ________.

ANSWERS IN APPENDIX E

HOW DRUGS AND OTHER CHEMICALS ALTER NEUROTRANSMISSION

If natural endorphins lessen pain and boost mood, why not increase this effect by flooding the brain with artificial opiates, thereby intensifying the brain's own "feel-good" chemistry? Because it would disrupt the brain's chemical balancing act. When flooded with opiate drugs such as heroin, morphine, and fentanyl (a powerful synthetic opioid), the brain—to maintain its chemical balance—may stop producing its own natural opiates. When the drug is withdrawn, the brain may then be deprived of *any* form of opiate, causing intense discomfort. For suppressing the body's own neurotransmitter production, nature charges a price.

Drugs and other chemicals affect brain chemistry, often by either exciting or inhibiting neurons' firing. **Agonist** molecules *increase* a neurotransmitter's action. Some agonists may increase the production or release of neurotransmitters, or block reuptake in the synapse. Other agonists may be similar enough to a neurotransmitter to bind to its receptor and mimic its excitatory or inhibitory effects. Some opiate drugs, then, are agonists and produce a temporary "high" by amplifying normal sensations of arousal or pleasure.

agonist
a molecule that increases a neurotransmitter's action.

Antagonists *decrease* a neurotransmitter's action by blocking production or release. Botulin, a poison that can form in improperly canned food, causes paralysis by blocking ACh release.

(Small injections of botulin—Botox—smooth wrinkles by paralyzing the underlying facial muscles.) These antagonists are enough like the natural neurotransmitter to occupy its receptor site and block its effect, but are not similar enough to stimulate the receptor (rather like foreign coins that fit into, but won't operate, a vending machine). Curare, a poison some South American Indigenous people have applied to hunting-dart tips, occupies and blocks ACh receptor sites on muscles, producing paralysis in their prey.

antagonist
a molecule that inhibits or blocks a neurotransmitter's action.

RETRIEVAL PRACTICE

RP-8 Curare poisoning paralyzes animals by blocking ACh receptors involved in muscle movement. Morphine mimics endorphin actions. Which is an agonist, and which is an antagonist?

ANSWERS IN APPENDIX E

For an illustrated review of neural communication, visit ***Topic Tutorial: PsychSim6, Neural Messages.***

The Nervous System

LOQ 2-6

What are the functions of the nervous system's main divisions, and what are the three main types of neurons?

Neurons communicating via neurotransmitters make up our body's **nervous system**, a communication network that takes in information from the world and the body's tissues, makes decisions, and sends back information and orders to the body's tissues (**FIGURE 2.7**).

nervous system
the body's speedy, electrochemical communication network, consisting of all the nerve cells of the peripheral and central nervous systems.

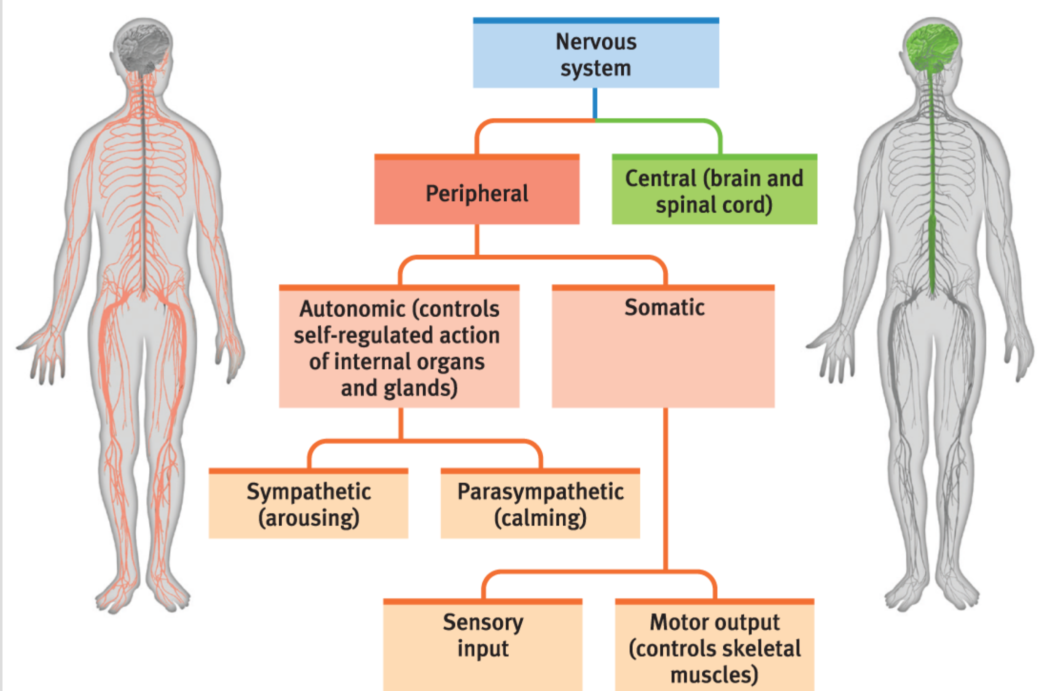


FIGURE 2.7 The functional divisions of the human nervous system

A quick overview: The brain and spinal cord form the **central nervous system (CNS)**, the body's decision maker. The **peripheral nervous system (PNS)** is responsible for gathering information and for transmitting CNS decisions to other body parts. **Nerves**, electrical cables formed from bundles of axons, link the CNS with the body's sensory receptors, muscles, and glands. The optic nerve, for example, bundles a million axons into a single cable carrying the messages from the eye to the brain (Mason & Kandel, 1991).

central nervous system (CNS)
the brain and spinal cord.
peripheral nervous system (PNS)
the sensory and motor neurons that connect the central nervous system (CNS) to the rest of the body.
nerves
bundled axons that form neural cables connecting the central nervous system with muscles, glands, and sensory organs.

Information travels in the nervous system through three types of neurons. **Sensory neurons** carry messages from the body's tissues and sensory receptors inward (thus, they are *afferent*) to the brain and spinal cord for processing. **Motor neurons** (which are *efferent*) carry instructions from the central nervous system outward to the body's muscles and glands. Between the sensory input and motor output, information is processed via **interneurons**. Our complexity resides mostly in these interneurons. Our nervous system has a few million sensory neurons, a few million motor neurons, and billions and billions of interneurons.

sensory (afferent) neurons

neurons that carry incoming information from the body's tissues and sensory receptors to the brain and spinal cord.
motor (efferent) neurons
neurons that carry outgoing information from the brain and spinal cord to the muscles and glands.
interneurons
neurons within the brain and spinal cord; they communicate internally and process information between the sensory inputs and motor outputs.

The Peripheral Nervous System

Our peripheral nervous system has two components—somatic and autonomic. Our **somatic nervous system** enables voluntary control of our skeletal muscles. As your friend taps your shoulder, your somatic nervous system reports to your brain the current state of your skeletal muscles and carries instructions back, triggering your head to turn toward her.

somatic nervous system
the division of the peripheral nervous system that controls the body's skeletal muscles. Also called the *skeletal nervous system.*

Our **autonomic nervous system (ANS)** controls our glands and our internal organ muscles. The ANS influences functions such as glandular activity, heartbeat, and digestion. (*Autonomic* means "self-regulating.") Like a self-driving car, this system may be consciously overridden, but usually operates on its own (autonomously).

autonomic [aw-tuh-NAHM-ik] nervous system (ANS)
the part of the peripheral nervous system that controls the glands and the muscles of the internal organs (such as the heart). Its *sympathetic* division arouses; its *parasympathetic* division calms.

The autonomic nervous system's subdivisions serve two important functions (**FIGURE 2.8**). The **sympathetic nervous system** arouses and expends energy. If something alarms or challenges you, such as a longed-for job interview, your sympathetic nervous system will accelerate your heartbeat, raise your blood pressure, slow your digestion, raise your blood sugar, and cool you with perspiration, making you alert and ready for action. When the stress subsides once the interview is over, your **parasympathetic nervous system** will produce the opposite effects, conserving energy as it calms you. The sympathetic and parasympathetic nervous systems work together, as accelerator and brake, to keep us in a steady internal state called *homeostasis* (more on this in Chapter 11).

sympathetic nervous system
the division of the autonomic nervous system that arouses the body, mobilizing its energy.
parasympathetic nervous system
the division of the autonomic nervous system that calms the body, conserving its energy.

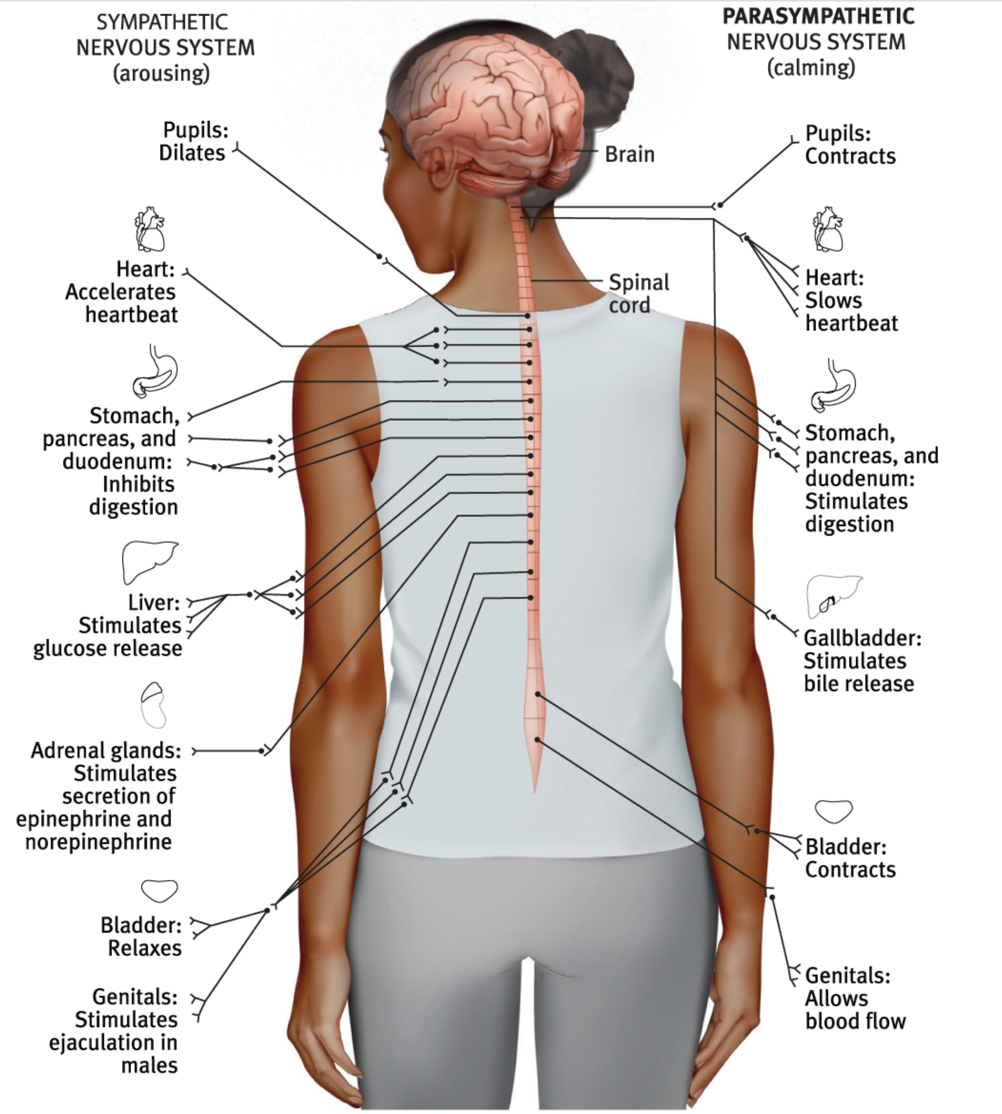


FIGURE 2.8 The dual functions of the autonomic nervous system The autonomic nervous system controls the more autonomous (or self-regulating) internal functions. Its sympathetic division arouses the body and expends energy. Its parasympathetic division calms the body and conserves energy, allowing routine maintenance activity. For example, sympathetic stimulation accelerates heartbeat, whereas parasympathetic stimulation slows it.

I [DM] recently experienced my ANS in action. Before sending me into an MRI machine for a shoulder scan, the technician asked if I had issues with claustrophobia. “No, I’m fine,” I assured her, with perhaps a hint of macho swagger. Moments later, as I found myself on my back, stuck deep inside a coffin-sized box and unable to move, my sympathetic nervous system had a different idea. Claustrophobia overtook me. My heart began pounding, and I felt a desperate urge to escape. Just as I was about to cry out for release, I felt my calming parasympathetic nervous system kick in. My heart rate slowed and my body relaxed, though my arousal surged again before the 20-minute confinement ended. “You did well!” the technician said, unaware of my ANS roller-coaster ride.

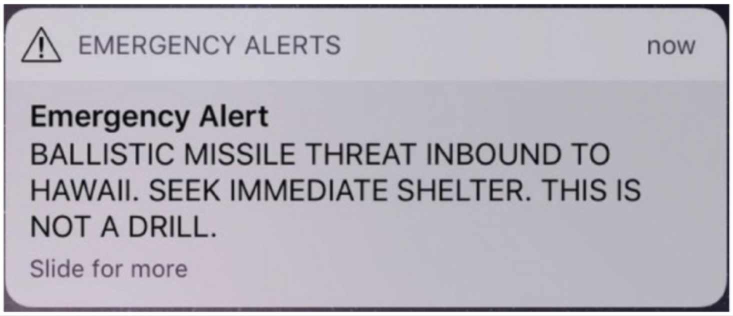
ASK YOURSELF

Think back to a stressful moment when you felt your sympathetic nervous system kick in. What was your body preparing you for? Were you able to sense your parasympathetic nervous system’s response when the challenge had passed?

RETRIEVAL PRACTICE

RP-9 Match the type of neuron (i–iii) to its description (a–c).

Type	Description
i. Motor neurons	a. Carry incoming messages from sensory receptors to the CNS.
ii. Sensory neurons	b. Communicate within the CNS and process information between incoming and outgoing messages.
iii. Interneurons	c. Carry outgoing messages from the CNS to muscles and glands.



Ballistic stress In 2018, Hawaiians received this terrifying alert, amid concerns about North Korean nuclear warheads. "We fully felt we were about to die," reported one panicked mother (Nagourney et al., 2018). Thirty-eight minutes later, the alert was declared a false alarm.

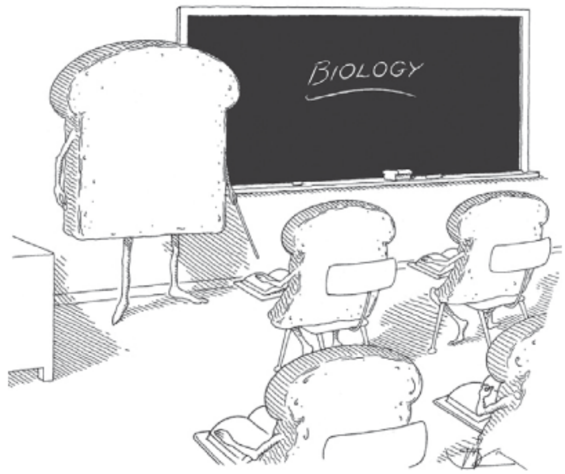
RP-10 How was the ANS involved in Hawaiians' terrified responses, and in calming their bodies once they realized it was a false alarm?

ANSWERS IN APPENDIX E

The Central Nervous System

From neurons "talking" to other neurons arises the complexity of the central nervous system's brain and spinal cord.

It is the brain that enables our humanity—our thinking, feeling, and acting. Tens of billions of neurons, each communicating with thousands of other neurons, yield an ever-changing wiring web. By one estimate—projecting from neuron counts in small brain samples—our brain has some 86 billion neurons (Azevedo et al., 2009; Herculano-Houzel, 2012).



"The body is made up of millions and millions of crumbs."

Just as individual pixels combine to form a picture, the brain's individual neurons cluster into work groups called *neural networks.* To understand why, Stephen Kosslyn and Olivier Koenig (1992, p. 12) have invited us to "think about why cities exist; why don't people distribute themselves more evenly across the countryside?" Like people networking with people, neurons network with nearby neurons with which they can have short, fast connections; each layer's cells connect with various cells in the neural network's next layer. Learning—to play the violin, speak a foreign language, or solve a math problem—occurs as experience strengthens connections. To paraphrase one neuropsychologist, neurons that fire together wire together (Hebb, 1949).

The other part of the CNS, the *spinal cord,* is a two-way information highway connecting the peripheral nervous system and the brain. Ascending neural fibers send up sensory information, and descending fibers send back motor-control information. The neural pathways governing our **reflexes**, our automatic responses to stimuli, illustrate the spinal cord's work. A simple spinal reflex pathway is composed of a single sensory neuron and a single motor neuron. These often communicate through an interneuron. The knee-jerk reflex, for example, involves one such simple pathway. A headless warm body could do it.

reflex
a simple, automatic response to a sensory stimulus, such as the knee-jerk reflex.

Another neural circuit enables the pain reflex (**FIGURE 2.9**). When your finger touches a flame, neural activity (excited by the heat) travels via sensory neurons to interneurons in your spinal cord. These interneurons respond by activating motor neurons leading to the muscles in your arm. Because the simple pain-reflex pathway runs through the spinal cord and right back out, your hand jerks away from the candle's flame *before* your brain receives and responds to the information that causes you to feel pain. That's why it feels as if your hand jerks away not by your choice, but on its own.

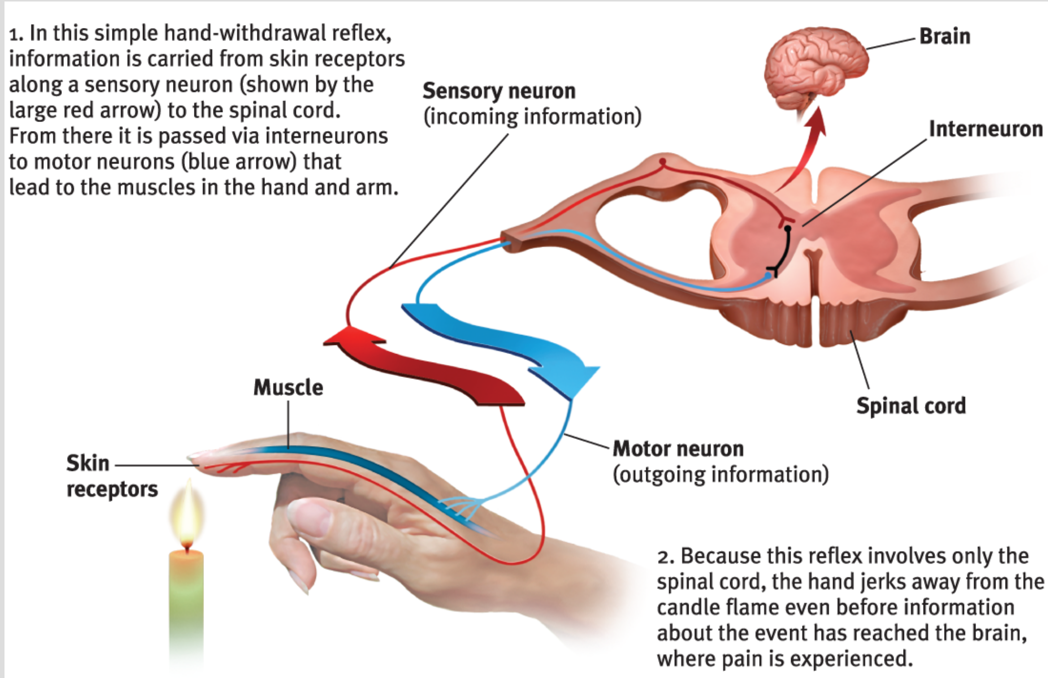


FIGURE 2.9 A simple reflex

Information travels to and from the brain by way of the spinal cord. Were the top of your spinal cord severed, you would not feel pain from your paralyzed body below. Nor would you feel pleasure. With your brain literally out of touch with your body, you would lose all sensation and voluntary movement in body regions with sensory and motor connections to the spinal cord below its point of injury. You would exhibit the knee-jerk reflex without feeling the tap. Men paralyzed below the waist may be capable of an erection (a simple reflex) if their genitals are stimulated (Gomes et al., 2017; Hess & Hough, 2012). Women who are similarly paralyzed may respond with vaginal lubrication. But, depending on where and how completely their spinal cord is severed, they may be genitally unresponsive to erotic images and have no genital feelings

(Kennedy & Over, 1990; Sipski et al., 1999). To produce bodily pain or pleasure, the sensory information must reach the brain.

> **"If the nervous system be cut off between the brain and other parts, the experiences of those other parts are nonexistent for the mind. The eye is blind, the ear deaf, the hand insensible and motionless."** — William James, *Principles of Psychology*, 1890

The Endocrine System

LOQ 2-7

How does the endocrine system transmit information and interact with the nervous system?

So far, we have focused on the body's speedy electrochemical information system. Interconnected with your nervous system is a second communication system, the **endocrine system** (**FIGURE 2.10**). The endocrine system contains glands and fat tissue that secrete another form of chemical messenger, **hormones**. Hormones travel through the bloodstream and affect other tissues, including the brain. When hormones act on the brain, they influence our interest in sex, food, and aggression.

endocrine [EN-duh-krin] system
the body's "slow" chemical communication system; glands and fat tissue that secrete hormones into the bloodstream.

hormonese
chemical messengers that are manufactured by the endocrine glands, travel through the bloodstream, and affect other tissues.

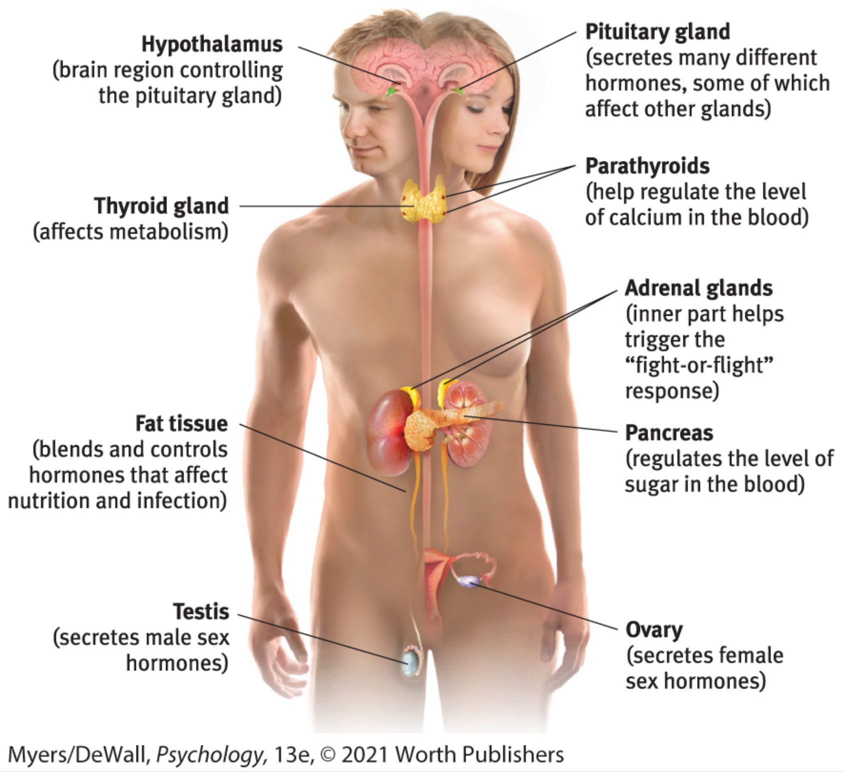


FIGURE 2.10 The endocrine system

Some hormones are chemically identical to neurotransmitters (the chemical messengers that diffuse across a synapse and excite or inhibit an adjacent neuron). The endocrine system and nervous system are therefore close relatives: Both produce molecules that act on receptors elsewhere. Like many relatives, they also differ. The speedier nervous system zips messages from eyes to brain to hand in a fraction of a second. Endocrine messages trudge along in the bloodstream, taking several seconds or more to travel from the gland to the target tissue. If the nervous system transmits information with text-message speed, the endocrine system delivers an old-fashioned letter.

But slow and steady sometimes wins the race. Endocrine messages tend to outlast the effects of neural messages. Have you ever felt angry long after the cause of your angry feelings was resolved (say, your friend apologized for her rudeness)? You may have experienced an "endocrine hangover" from lingering emotion-related hormones. The persistence of emotions—even without conscious awareness of what caused them—was dramatically evident in one ingenious experiment. Brain-damaged patients unable to form new conscious memories watched a sad film and later a happy film. After each viewing, they did not consciously recall the films, but the sad or happy emotion persisted (Feinstein et al., 2010).

In a moment of danger, the ANS orders the **adrenal glands** on top of the kidneys to release *epinephrine* and *norepinephrine* (also called *adrenaline* and *noradrenaline*). These hormones increase heart rate, blood pressure, and blood sugar, providing a surge of energy. When the emergency passes, the hormones—and the feelings—linger a while.

adrenal [ah-DREEN-el] glands
a pair of endocrine glands that sits just above the kidneys and secretes hormones (epinephrine and norepinephrine) that help arouse the body in times of stress.

The most influential endocrine gland is the **pituitary gland**, a pea-sized structure located in the core of the brain, where it is controlled by an adjacent brain area, the *hypothalamus* (more on that shortly). Among the hormones released by the pituitary is a growth hormone that stimulates physical development. Another is *oxytocin*, which enables labor contractions, milk flow while nursing, and orgasm. Oxytocin can also promote social bonding (Bartz et al., 2019; Kreuder et al., 2018; Tan et al., 2019). It strengthens our close relationships and alerts us to threats to our group (Nitschke et al., 2019; Sunahara et al., 2019; Zhang et al., 2019).

pituitary gland
the endocrine system's most influential gland. Under the influence of the hypothalamus, the pituitary regulates growth and controls other endocrine glands.

Pituitary secretions also direct other endocrine glands to release their hormones. The pituitary, then, is a *master gland* (whose own master is the hypothalamus). For example, under the brain's influence, the pituitary triggers your sex glands to release sex hormones. These in turn influence your brain and behavior (Goetz et al., 2014). So, too, with stress. A stressful event triggers your hypothalamus to instruct your pituitary to release a hormone that causes your adrenal glands to flood your body with *cortisol*, a stress hormone that increases blood sugar.

fizkes/Getty Images

Prejudice causes stress An experience of prejudice may trigger release of the stress hormone cortisol (Deer et al., 2018).

This feedback system (brain → pituitary → other glands → hormones → body and brain) reveals the intimate connection of the nervous and endocrine systems. The nervous system directs endocrine secretions, which then affect the nervous system. Conducting and coordinating this whole electrochemical orchestra is that flexible maestro we call the brain.

ASK YOURSELF

Do you remember feeling the lingering effects of a hormonal response, such as anger, after some particularly aggravating event? How did it feel? How long did it last?

RETRIEVAL PRACTICE

RP-11 Why is the pituitary gland called the *master gland*?

RP-12 How are the nervous and endocrine systems alike, and how do they differ?

ANSWERS IN APPENDIX E

REVIEW Neural and Hormonal Systems

LEARNING OBJECTIVES

Test Yourself Answer these repeated Learning Objective Questions on your own (before checking the answers in Appendix D) to improve your retention of the concepts (McDaniel et al., 2009, 2015).

LOQ 2-1: Why are psychologists concerned with human biology?
LOQ 2-2: How do biology and experience together enable neuroplasticity?
LOQ 2-3: What are *neurons*, and how do they transmit information?
LOQ 2-4: How do nerve cells communicate with other nerve cells?
LOQ 2-5: How do neurotransmitters influence behavior, and how do drugs and other chemicals affect neurotransmission?

LOQ 2-6: What are the functions of the nervous system's main divisions, and what are the three main types of neurons?
LOQ 2-7: How does the endocrine system transmit information and interact with the nervous system?

TERMS AND CONCEPTS TO REMEMBER

Test Yourself Write down the definition in your own words, then check your answer.

biological psychology
neuroplasticity
neuron
cell body
dendrites
axon
myelin [MY-uh-lin] sheath
glial cells (glia)
action potential
threshold
refractory period
all-or-none response
synapse [SIN-aps]
neurotransmitters
reuptake

endorphins [en-DOR-fins]
agonist
antagonist
nervous system
central nervous system (CNS)
peripheral nervous system (PNS)
nerves
sensory (afferent) neurons
motor (efferent) neurons
interneurons
somatic nervous system
autonomic [aw-tuh-NAHM-ik] nervous system (ANS)
sympathetic nervous system
parasympathetic nervous system
reflex
endocrine [EN-duh-krin] system
hormones
adrenal [ah-DREEN-el] glands
pituitary gland

MASTER THE MATERIAL

Test Yourself Answer the following questions on your own first, then check your answers in Appendix E.

1. What do psychologists mean when they say the brain is "plastic"?

2. The neuron fiber that passes messages through its branches to other neurons or to muscles and glands is the ______________.

3. The tiny space between the axon of one neuron and the dendrite or cell body of another is called the

    a. axon terminal.

    b. branching fiber.

    c. synaptic gap.

    d. threshold.

4. Regarding a neuron’s response to stimulation, the intensity of the stimulus determines

    a. whether or not an impulse is generated.

    b. how fast an impulse is transmitted.

    c. how intense an impulse will be.

    d. whether reuptake will occur.

5. In a sending neuron, when an action potential reaches an axon terminal, the impulse triggers the release of chemical messengers called ______________.

6. Endorphins are released in the brain in response to

a. morphine or heroin.

b. pain or vigorous exercise.

c. the all-or-none response.

d. all of the above.

7. The autonomic nervous system controls internal functions, such as heart rate and glandular activity. The word *autonomic* means

   a. calming.

   b. voluntary.

   c. self-regulating.

   d. arousing.

8. The sympathetic nervous system arouses us for action and the parasympathetic nervous system calms us down. Together, the two systems make up the __________ nervous system.

9. The neurons of the spinal cord are part of the __________ nervous system.

10. The most influential endocrine gland, known as the *master gland*, is the __________

a. pituitary.

b. hypothalamus.

c. thyroid.

d. pancreas.

11. The ______________ ______________ secrete(s) epinephrine and norepinephrine, helping to arouse the body during times of stress.

Continue testing yourself with **LearningCurve** or **Achieve Read & Practice** to learn and remember most effectively.

Tools of Discovery, Older Brain Structures, and the Limbic System

We are convinced that we live "somewhere north of the neck" (Fodor, 1999). And for good reason: The brain enables the mind—seeing, hearing, smelling, feeling, remembering, thinking, speaking, dreaming. An acquaintance of mine [DM's] received a new heart from a woman who, in a rare operation, had received a matched heart-lung transplant. When the two chanced to meet in their hospital ward, she introduced herself: "I think you have my heart." But only her heart. Her self, she assumed, still resided inside her skull. It is the brain that self-reflectively analyzes the brain. When you think *about* your brain, you're thinking *with* your brain—by releasing billions of neurotransmitter molecules across trillions of synapses. The effect of hormones on experiences such as love reminds us that we would not be of the same mind if we were a bodiless brain. Nevertheless, brain, behavior, and cognition are an integrated whole. But precisely where and how are the mind's functions tied to the brain? Let's first see how scientists explore such questions.

> **"I am a brain, Watson. The rest of me is a mere appendix."** — Sherlock Holmes, in Arthur Conan Doyle's "The Adventure of the Mazarin Stone," 1921

The Tools of Discovery: Having Our Head Examined

LOQ 2-8

How do neuroscientists study the brain's connections to behavior and mind?

For most of human history, scientists had no tools high-powered yet gentle enough to reveal a living brain's activity. Early case studies helped localize some brain functions. Damage to one side of the brain often caused numbness or paralysis on the body's opposite side, suggesting that the body's right side is wired to the brain's left side, and vice versa. Damage to the back of the brain disrupted vision, and to the left-front part of the brain produced speech difficulties. Gradually, these early explorers were mapping the brain.

Now the human brain has invented new ways to study itself. A new generation of neural mapmakers is charting the known universe's most amazing organ. Scientists can selectively **lesion** (destroy) tiny clusters of normal or defective brain cells, observing any effect on brain function. In the laboratory, such studies have revealed, for example, that damage to one area of the hypothalamus in a rat's brain reduces eating, to the point of starvation, whereas damage in another area produces overeating.

lesion [LEE-zhuhn]

tissue destruction. A brain lesion is a naturally or experimentally caused destruction of brain tissue.

CB2/ZOB/WENN.com/Newscom

A living human brain exposed Today's neuroscience tools enable us to "look under the hood" and glimpse the brain at work, enabling the mind.

Today's neuroscientists can *stimulate* various brain parts—electrically, chemically, or magnetically—and note the effect. Depending on the stimulated brain part, people may—to name a few examples—giggle, hear voices, turn their head, feel themselves falling, or have an out-of-body experience (Selimbeyoglu & Parvizi, 2010).

Scientists can even snoop on the messages of individual neurons. With tips small enough to detect the electrical pulse in a single neuron, modern microelectrodes can, for example, now detect exactly where the information goes in a cat's brain when someone tickles its belly (Ishiyama & Brecht, 2017). Promising new tools include *optogenetics*, a technique that allows neuroscientists to control the activity of individual neurons (Boyden, 2014). By programming neurons to become receptive to light, researchers can examine the biological basis of sensations, fear, depression, and substance use disorders (Dygalo & Shishkina, 2019; Firsov, 2019; Juarez et al., 2019; Nikitin et al., 2019).

Researchers can also eavesdrop on the chatter of billions of neurons. Right now, your mental activity is emitting telltale electrical, metabolic, and magnetic signals that would enable neuroscientists to observe your brain at work. Electrical activity in your brain's billions of neurons sweeps in regular waves across its surface. An **EEG (electroencephalogram)** is an amplified readout of such waves. Researchers record the brain waves through a shower-cap-like hat that is filled with electrodes covered with a conductive gel. Studying an EEG of the brain's activity is like studying a blender's motor by listening to its hum. With no direct access to the brain, researchers present a stimulus repeatedly and have a computer filter out brain activity unrelated to the stimulus. What remains is the electrical wave evoked by the stimulus.

EEG (electroencephalogram)

an amplified recording of the waves of electrical activity sweeping across the brain's surface. These waves are measured by electrodes placed on the scalp.

A related technique is **MEG (magnetoencephalography)**. To isolate the brain's magnetic fields, researchers create special rooms that cancel out other magnetic signals, such as the Earth's magnetic field. Participants sit underneath a head coil that resembles a hair salon hairdryer. While participants complete activities, tens of thousands of neurons create electrical pulses, which in turn create magnetic fields. The speed and strength of the magnetic fields enable researchers to understand how certain tasks influence brain activity (Eldar et al., 2018; Ruzich et al., 2019; Uhlhaas et al., 2018).

MEG (magnetoencephalography)
a brain-imaging technique that measures magnetic fields from the brain's natural electrical activity.

"You must look into people, as well as at them," advised Lord Chesterfield in a 1746 letter to his son. Newer neuroimaging techniques give us super hero-like ability to see inside the living brain. One such tool, the **PET (positron emission tomography)** scan (**FIGURE 2.11**), depicts brain activity by showing each brain area's consumption of its chemical fuel, the sugar glucose. Active neurons gobble glucose. Our brain, though only about 2 percent of our body weight, consumes 20 percent of our calorie intake. After a person receives temporarily radioactive glucose, the PET scan can track the gamma rays released by this "food for thought" as a task is performed. Rather like weather radar showing rain activity, PET-scan “hot spots” show the most active brain areas as the person does mathematical calculations, looks at images of faces, or daydreams.

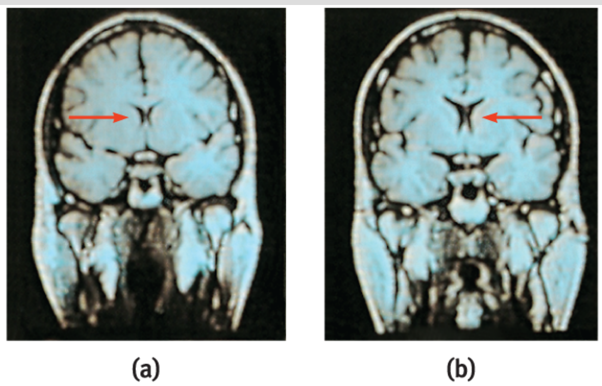
PET (positron emission tomography)
a technique for detecting brain activity that displays where a radioactive form of glucose goes while the brain performs a given task.

Voisin/Phanie/Science Source

FIGURE 2.11 The PET scan To obtain a PET scan, researchers inject volunteers with a low and harmless dose of a short-lived radioactive sugar. Detectors around the person’s head pick up the release of gamma rays from the sugar, which has concentrated in active brain areas. A computer then processes and translates these signals into a map of the brain at work.

In **MRI (magnetic resonance imaging)** brain scans, the person’s head is put in a strong magnetic field, which aligns the spinning atoms of brain molecules. Then, a radio-wave pulse momentarily disorients the atoms. When the atoms return to their normal spin, they emit signals that provide a detailed picture of soft tissues, including the brain. MRI scans have revealed a larger-than-average neural area in the left hemisphere of musicians who display perfect pitch (Schlaug et al., 1995). They have also revealed enlarged *ventricles*—fluid-filled brain areas (marked by the red arrows in **FIGURE 2.12**)—in some patients who have schizophrenia.

MRI (magnetic resonance imaging)
a technique that uses magnetic fields and radio waves to produce computer-generated images of soft tissue. MRI scans show brain anatomy.



From Daniel R. Weinberger, M.D., CBDB, NIMH

FIGURE 2.12 MRI scan of a healthy individual (a) and a person with schizophrenia (b) Note the enlarged ventricle—the fluid-filled brain region at the tip of the arrow in the image—in the brain of the person with schizophrenia (b).

A special application of MRI— **fMRI (functional MRI)**—can reveal the brain's functioning as well as its structure. Where the brain is especially active, blood goes. By comparing successive MRI scans, researchers can watch as specific brain areas activate, showing increased oxygen-laden blood flow. As a person looks at a scene, for example, the fMRI machine detects blood rushing to the back of the brain, which processes visual information. Another tool, *functional* *near-infrared spectroscopy (fNIRS),* uses infrared light that shines onto blood molecules to identify brain activity. The fNIRS equipment can fit in a large backpack, enabling researchers to study the biology of mind in difficult-to-reach populations (Burns et al., 2019; Perdue et al., 2019).

fMRI (functional MRI)
a technique for revealing blood flow and, therefore, brain activity by comparing successive MRI scans. fMRI scans show brain function as well as structure.

Mark Straccia/UCLA Social Cognitive Neuroscience Laboratory

Understanding the non-WEIRD brain Most neuroscience research studies people from Western, educated, industrial, rich, and democratic (WEIRD) populations (Falk et al., 2013). Using functional near-infrared spectroscopy (fNIRS), the researchers shown here were able to identify brain areas involved in persuasion among a Jordanian sample (Burns et al., 2019).

See TABLE 2.2 for a comparison of some of these imaging techniques.

TABLE 2.2 Common Types of Neural Measures

Name	How Does It Work?	Sample Finding
EEG (Electroencephalogram)	Electrodes placed on the scalp measure electrical activity in neurons.	Symptoms of depression and anxiety correlate with increased activity in the right frontal lobe, a brain area associated with behavioral withdrawal and negative emotion (Thibodeau et al., 2006).
MEG (Magnetoencephalography)	A head coil records magnetic fields from the brain's natural electrical currents.	Soldiers with posttraumatic stress disorder (PTSD), compared with soldiers who do not have PTSD, show stronger magnetic fields in the visual cortex when they view trauma-related images (Todd et al., 2015).
Positron emission tomography (PET)	Tracks where in the brain a temporarily radioactive form of glucose goes while the person given it performs a task.	Monkeys with an anxious temperament have brains that use more glucose in regions related to fear, memory, and expectations of reward and punishment (Fox et al., 2015).
Magnetic resonance imaging (MRI)	People sit or lie down in a chamber that uses magnetic fields and radio waves to provide a map of brain structure.	People with a history of violence tend to have smaller frontal lobes, especially in regions that aid moral judgment and self-control (Glenn & Raine, 2014).
Functional magnetic	Measures blood	Years after surviving a near plane crash,

resonance imaging (fMRI)	flow to brain regions by comparing continuous MRI scans.	passengers who viewed material related to their trauma showed greater activation in the brain's fear, memory, and visual centers than when they watched footage related to the 9/11 terrorist attacks (Palombo et al., 2015).

Such snapshots of the brain's changing activity provide new insights into how the brain divides its labor and reacts to changing needs. A mountain of recent fMRI studies tells us which brain areas are most active when people feel pain or rejection, listen to angry voices, think about scary things, feel happy, or become sexually aroused. fMRI can even reveal what happens if we deliberately suppress our own personality, as actors do. (Brown et al., 2019).

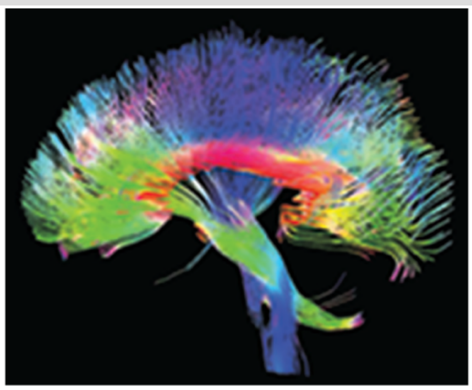
Can brain imaging enable mind reading? fMRI technology has enabled a crude eavesdropping on the mind. One neuroscience team scanned 129 people's brains as they did eight different mental tasks (such as reading, gambling, or rhyming). Later, they were able, with 80 percent accuracy, to identify which of these mental activities their participants had been doing (Poldrack, 2018). Other research has used the brain's activity to predict public health campaign effectiveness and future behavior, such as school performance, drug use, and who we choose as friends (Chung et al., 2017; Cooper et al., 2019; Kranzler et al., 2019; Zerubavel et al., 2018).

You've seen the pictures—of colorful brains with accompanying headlines, such as "your brain on music." Although brain areas don't actually "light up," vivid brain-scan images seem impressive. People rate scientific explanations as more believable and interesting when they contain neuroscience (Fernandez-Duque et al., 2015; Im et al., 2017). But "neuroskeptics" caution against overblown claims about any ability to predict customer preferences, to detect lies, and to foretell crime (Rose & Rose, 2016; Satel & Lilienfeld, 2013; Schwartz et al., 2016). Neuromarketing, neuroleadership, neurolaw, and neuropolitics are often neurohype. Imaging techniques illuminate brain structure and activity, and sometimes help us test different theories of behavior (Mather et al., 2013). But given that all human experience is brain-based, it's no surprise that different brain areas become active when one listens to a lecture or lusts for a lover.

To check your understanding of brain scans and their functions, engage online with ***Concept Practice: Scanning the Brain.***

***

Today's techniques for peering into the thinking, feeling brain are doing for psychology what the microscope did for biology and the telescope did for astronomy. From them we have learned more about the brain in the last 100 years than in the previous 10,000. And the next decade will reveal much more, as each year massive funding goes into brain research. To advance brain science, Europe's Human Brain Project has budgeted $1 billion between 2013 and 2023 (Salles et al., 2019). The $40 million Human Connectome Project seeks to map the brain's long-distance connections by harnessing the power of *diffusion spectrum imaging,* a type of MRI technology (Glasser et al., 2016; Wang & Olson, 2018) (**FIGURE 2.13**). Such efforts have produced a new brain map with 100 neural centers not previously described (Glasser et al., 2016). Building on this work, a new project seeks to understand typical brain aging from age 36 to 100+ (Bookheimer et al., 2019). Stay tuned for future fascinating findings.



Tom Barrick, Chris Clark, SGHMS/Science Source

FIGURE 2.13 Beautiful brain connections The Human Connectome Project is using cutting-edge methods to map the brain's interconnected network of neurons. Scientists created this multicolored "symphony" of neural fibers transporting water through different brain regions.

To learn about the neurosciences now is like studying world geography when Magellan explored the seas. This truly is the golden age of brain science.

“As heady as our progress has been … we have only discovered a tiny fraction of what there is to know about the human brain. But [it] makes for a story more exciting than any Sherlock Holmes novel.” — V. S. Ramachandran, *The Tell-Tale Brain*, 2011

ASK YOURSELF

Were you surprised to learn that there are so many technological tools to study the brain’s structures and functions? Which techniques do you find most interesting? Why?

RETRIEVAL PRACTICE

RP-1 Match the scanning technique (i–iii) with the correct description (a–c).

Technique	Description
i. fMRI scan	a. Tracks radioactive glucose to reveal brain *activity.*
ii. PET scan	b. Tracks successive images of brain tissue to show brain *function.*
iii. MRI scan	c. Uses magnetic fields and radio waves to show brain *anatomy.*

ANSWERS IN APPENDIX E

For an introductory 12.5-minute overview of the brain, see the ***Video: The Central Nervous System—Spotlight on the Brain.***

Older Brain Structures

LOQ 2-9

What structures make up the brainstem, and what are the functions of the brainstem, thalamus, reticular formation, and cerebellum?

An animal's capacities come from its brain structures. In primitive animals, such as sharks, a not-so-complex brain primarily regulates basic survival functions: breathing, resting, and feeding. In lower mammals, such as rodents, a more complex brain enables emotion and greater memory. In advanced mammals, such as humans, a brain that processes more information enables increased foresight as well.

The brain's increasing complexity arises from new systems built on top of the old, much as Earth's landscape covers the old with the new. Digging down, one discovers the fossil remnants of the past—brainstem components performing for us much as they did for our distant ancestors. Let's start with the brain's base and work up to the newer systems.

The Brainstem

The **brainstem** is the brain's oldest and innermost region. Its base is the **medulla**, the slight swelling in the spinal cord just after it enters the skull (**FIGURE 2.14**). Here lie the controls for your heartbeat and breathing. As some brain-damaged patients in a vegetative state illustrate, we need no higher brain or conscious mind to orchestrate our heart's pumping and lungs' breathing. The brainstem handles those tasks. Just above the medulla sits the *pons*, which helps coordinate movements and control sleep.

brainstem
the oldest part and central core of the brain, beginning where the spinal cord swells as it enters the skull; the brainstem is responsible for automatic survival functions.
medulla [muh-DUL-uh]
the base of the brainstem; controls heartbeat and breathing.

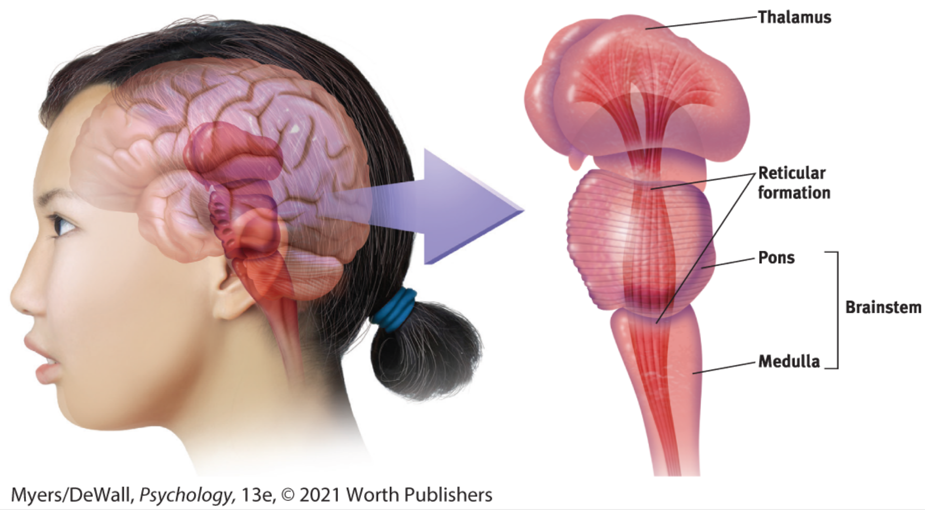


FIGURE 2.14 The brainstem and thalamus The brainstem, including the pons and medulla, is an extension of the spinal cord. The thalamus is attached to the top of the brainstem. The reticular formation passes through both structures.

If a cat's brainstem is severed from the rest of the brain above it, the animal will still breathe and live—and even run, climb, and groom (Klemm, 1990). But cut off from the brain's higher regions, it won't *purposefully* run or climb to get food.

The brainstem is a crossover point, where most nerves to and from each side of the brain connect with the body's opposite side (**FIGURE 2.15**). This peculiar cross-wiring is but one of the brain's many surprises.

FIGURE 2.15 The body's wiring

RETRIEVAL PRACTICE

RP-2 The ________ is a crossover point where nerves from the left side of the brain are mostly linked to the right side of the body, and vice versa.

ANSWERS IN APPENDIX E

The Thalamus

Sitting atop the brainstem is the **thalamus**, a pair of egg-shaped structures that acts as the brain's sensory control center (see Figure 2.14). The thalamus receives information from all the senses except smell, and routes that information to the higher brain regions that deal with seeing, hearing, tasting, and touching. The thalamus also receives some of the higher brain's replies, which it then directs to the medulla and to the *cerebellum*. For sensory information, your thalamus is something like what Seoul is to South Korea's trains, a hub through which traffic passes on its way to various destinations.

thalamus [THAL-uh-muss]
the brain's sensory control center, located on top of the brainstem; it directs messages to the sensory receiving areas in the cortex and transmits replies to the cerebellum and medulla.

The Reticular Formation

Inside the brainstem, between your ears, lies the **reticular** ("netlike") **formation**, a nerve network extending from the spinal cord right up through the thalamus. As the spinal cord's sensory input flows up to the thalamus, some of it travels through the reticular formation, which filters incoming stimuli and relays important information to other brain areas. Have you multitasked today? You can thank your reticular formation (Wimmer et al., 2015).

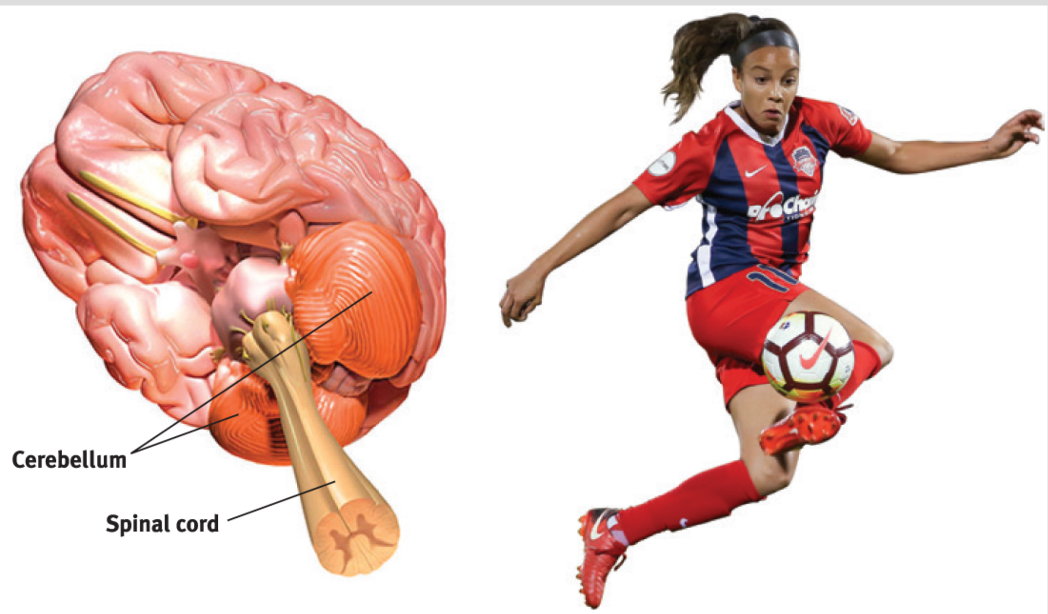
reticular formation
a nerve network that travels through the brainstem into the thalamus; filters information and plays an important role in controlling arousal.

The reticular formation also controls arousal, as Giuseppe Moruzzi and Horace Magoun discovered in 1949. Electrically stimulating a sleeping cat's reticular formation almost instantly produced an awake, alert animal. When Magoun *severed* a cat's reticular formation without damaging nearby sensory pathways, the effect was equally dramatic: The cat lapsed into a coma from which it never awakened.

The Cerebellum

Extending from the rear of the brainstem is the baseball-sized **cerebellum**, meaning "little brain," which is what its two wrinkled halves resemble (**FIGURE 2.16**). The cerebellum (along with the *basal ganglia,* deep brain structures involved in motor movement) enables nonverbal learning and skill memory. It plays an important role in a lot that happens just outside your awareness. Quickly answer these questions. How long have you been reading this text? Do your clothes feel soft or rough against your skin? How's your mood today? You probably answered easily, thanks to your cerebellum. This little brain, which actually has more than half your brain's neurons, helps you judge time, discriminate textures and sounds, and control your emotions and social behaviors (Bower & Parsons, 2003; Carta et al., 2019). It aids your vocabulary, reading, and ability to store information (Moore et al., 2017). With assistance from the pons, it also coordinates voluntary movement. When a soccer player masterfully controls the ball, give her cerebellum some credit. Under alcohol's influence, coordination suffers. And if you injured your cerebellum, you would have difficulty walking, keeping your balance, or shaking hands. Your movements would be jerky and exaggerated. Gone would be any dreams of being a dancer or guitarist.

cerebellum [sehr-uh-BELL-um]
the "little brain" at the rear of the brainstem; functions include processing sensory input, coordinating movement output and balance, and enabling nonverbal learning and memory.



Myers/DeWall, *Psychology*, 13e, © 2021 Worth Publishers
Tony Quinn/ZUMA Press/Newscom

FIGURE 2.16 The brain’s organ of agility Hanging at the back of the brain, the cerebellum coordinates our voluntary movements, as when soccer player Mallory Pugh controls the ball.

***

Note: These older brain functions all occur without any conscious effort. This illustrates another of our recurring themes: *Our brain processes most information outside of our awareness.* We are aware of the *results* of our brain’s labor—say, our current visual experience—but not *how* we construct the visual image. Likewise, whether we are asleep or awake, our brainstem manages its life-sustaining functions, freeing our newer brain regions to think, talk, dream, or savor a memory.

RETRIEVAL PRACTICE

RP-3 In what brain region would damage be most likely to (a) disrupt your ability to jump rope? (b) disrupt your ability to hear? (c) leave you in a coma? (d) cut off the very breath and heartbeat of life?

ANSWERS IN APPENDIX E

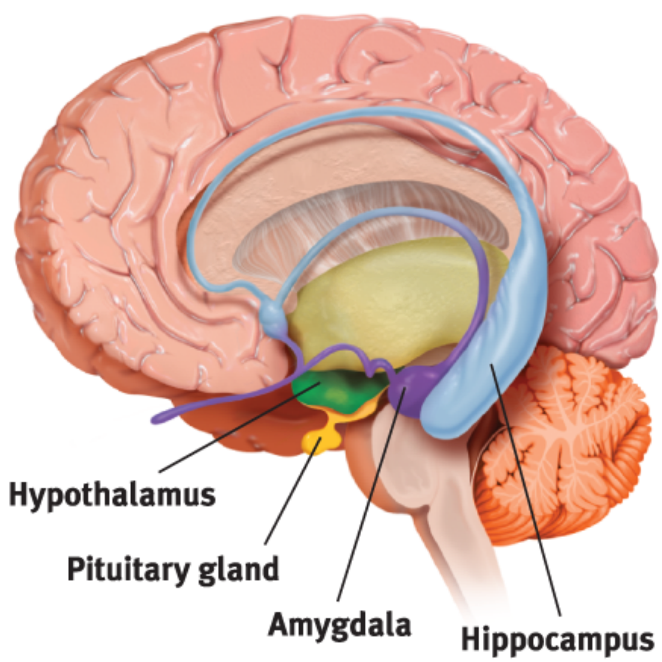
The Limbic System

LOQ 2-10

What are the limbic system’s structures and functions?

We’ve considered the brain’s oldest parts, but we’ve not yet reached its newest and highest regions, the *cerebral hemispheres* (the two halves of the brain). Between the oldest and newest brain areas lies the **limbic system** (*limbus* means “border”). This system, which is associated with emotions and drives, contains the *amygdala,* the *hypothalamus,* and the *hippocampus* (**FIGURE 2.17**).

limbic system
neural system (including the *amygdala, hypothalamus,* and *hippocampus*) located below the cerebral hemispheres; associated with emotions and drives.



Myers/DeWall, *Psychology,* 13e, © 2021 Worth Publishers

FIGURE 2.17 The limbic system This neural system sits between the brain’s older parts and its cerebral hemispheres. The limbic system’s hypothalamus controls the nearby pituitary gland.

The Amygdala

The **amygdala**—two lima-bean-sized neural clusters—enables aggression and fear. In 1939, psychologist Heinrich Klüver and neurosurgeon Paul Bucy surgically removed a rhesus monkey's amygdala, turning the normally ill-tempered animal into the most mellow of creatures. In studies with other wild animals, including the lynx, wolverine, and wild rat, researchers noted the same effect. So, too, with humans. One woman with an amygdala lesion, patient S. M., has been called "the woman with no fear," even if being threatened with a gun (Feinstein et al., 2013). Even healthy people who have a smaller-than-average amygdala display reduced arousal to threatening stimuli (Foell et al., 2019). Little amygdala, little fear.

amygdala [uh-MIG-duh-la]
two lima-bean-sized neural clusters in the limbic system; linked to emotion.

What then might happen if we electrically stimulated the amygdala of a normally placid domestic animal, such as a cat? Do so in one spot and the cat prepares to attack, hissing with its back arched, its pupils dilated, its hair on end. Move the electrode only slightly within the amygdala, cage the cat with a small mouse, and now it cowers in terror.

These and other experiments have confirmed the amygdala's role in fear and rage. Monkeys and humans with amygdala damage become less fearful of strangers (Harrison et al., 2015). Other studies link criminal behavior with amygdala dysfunction (da Cunha-Bang et al., 2017; Dotterer et al., 2017; Ermer et al., 2012). When people view angry and happy faces, only the angry ones increase activity in the amygdala (Mende-Siedlecki et al., 2013). And when negative events energize the amygdala, they become more memorable (Admon et al., 2018).

But we must be careful. The brain is not neatly organized into structures that correspond to our behavior categories. The amygdala is engaged with other mental phenomena as well. And when we feel afraid or act aggressively, there is neural activity in many areas of our brain—not just the amygdala. If you destroy a car's battery, the car won't run. But the battery is merely one link in an integrated system.

RETRIEVAL PRACTICE

GK Hart/Vikki Hart/Getty Images

RP-4 Electrical stimulation of a cat's amygdala provokes angry reactions. Which *autonomic nervous system* division is activated by such stimulation?

ANSWERS IN APPENDIX E

The Hypothalamus

Just below (*hypo*) the thalamus is the **hypothalamus** (**FIGURE 2.18**), an important link in the command chain governing bodily maintenance. Some neural clusters in the hypothalamus influence hunger; others regulate thirst, body temperature, and sexual behavior. Together, they help maintain a steady (*homeostatic*) internal state.

hypothalamus [hi-po-THAL-uh-muss]
a neural structure in the limbic system lying below (*hypo*) the thalamus; it directs several maintenance activities (eating, drinking, body temperature), helps govern the endocrine system via the pituitary gland, and is linked to emotion and reward.

ISM/Medical Images USA

FIGURE 2.18 The hypothalamus This small but important structure, colored yellow/orange in this MRI scan, helps keep the body's internal environment in a steady state.

To monitor your body state, the hypothalamus tunes in to your blood chemistry and any incoming orders from other brain parts. For example, picking up signals from your brain's cerebral cortex that you are thinking about sex, your hypothalamus will secrete hormones. These hormones will in turn trigger the adjacent "master gland" of the endocrine system, your pituitary (see Figure 2.17), to influence your sex glands to release *their* hormones. These hormones will intensify the thoughts of sex in your cerebral cortex. (Note the interplay between the nervous and endocrine systems: The brain influences the endocrine system, which in turn influences the brain.)

A remarkable discovery about the hypothalamus illustrates how progress in science often occurs—when curious, open-minded investigators make an unexpected observation. Two young McGill University neuropsychologists, James Olds and Peter Milner (1954), were trying to implant an electrode in a rat's reticular formation when they made a magnificent mistake: They placed the electrode incorrectly (Olds, 1975). Curiously, as if seeking more stimulation, the rat kept returning to the location where it had been stimulated by this misplaced electrode. On discovering that they had actually placed the device in a region of the hypothalamus, Olds and Milner realized they had stumbled upon a brain center that provides pleasurable rewards.

Later experiments located other "pleasure centers" (Olds, 1958). (What the rats actually experience only they know, and they aren't telling. Rather than attribute human feelings to rats, today's scientists refer to *reward centers.*) Just how rewarding are these reward centers? Enough to cause rats to self-stimulate these brain regions more than 1000 times per hour.

In other species, including dolphins and monkeys, researchers later discovered other limbic system reward centers, such as the *nucleus accumbens* in front of the hypothalamus (Hamid et al., 2016). Animal research has also revealed both a general dopamine-related reward system and specific centers associated with the pleasures of eating, drinking, and sex. Animals, it seems, come equipped with built-in systems that reward activities essential to survival.

Researchers have experimented with ways of using brain stimulation to control nonhuman animals' actions in search-and-rescue operations. By rewarding rats for turning left or right, one research team trained previously caged rats to navigate natural environments (Talwar et al., 2002). By pressing buttons on a laptop, the researchers were then able to direct the rat—which carried a receiver, power source, and video camera all in a tiny backpack—to turn on cue, climb trees, scurry along branches, and return.

Do humans have limbic centers for pleasure? Some evidence indicates we do. When we meet likable people, our brain bursts with reward center activity (Zerubavel et al., 2018). Ditto when we read kind messages from friends and family members, such as, "You light up my entire world" (Inagaki et al., 2019). Stimulating reward centers can also help control the cruelest individuals. But as one neurosurgeon found by implanting electrodes in violent patients' limbic system areas, the patients reported only mild pleasure. Unlike Olds and Milner's rats, the patients were not driven to a frenzy (Deutsch, 1972; Hooper & Teresi, 1986). Moreover, newer research reveals that stimulating the brain's "hedonic hotspots" (its reward circuits) produces more *desire* than pure enjoyment (Kringelbach & Berridge, 2012).

Experiments have also revealed the effects of a dopamine-related reward system in people. For example, experimentally boosting dopamine levels increases the pleasurable "chills" response to a favorite piece of music, whereas reducing dopamine levels decreases musical pleasure (Ferreri et al., 2019). Some researchers believe that many disordered behaviors may stem from malfunctions in natural brain systems for pleasure and well-being. People genetically predisposed to this *reward deficiency syndrome* may crave whatever provides that missing pleasure or relieves negative feelings, such as aggression, fattening food, or drugs and alcohol (Blum et al., 1996, 2014; Chester et al., 2016).

> **"If you were designing a robot vehicle to walk into the future and survive, ... you'd wire it up so that behavior that ensured the survival of the self or the species—like sex and eating—would be naturally reinforcing."** — Neuroscientist Candace Pert (1986)

The Hippocampus

The **hippocampus**—a seahorse-shaped brain structure—processes conscious, explicit memories. Variations in hippocampal development predict academic achievement (Wilkey et al., 2018). Humans who lose their hippocampus to surgery or injury lose their ability to form new memories of facts and events (Clark & Maguire, 2016). Those who survive a hippocampal brain tumor in childhood struggle to remember new information in adulthood (Jayakar et al., 2015). National Football League players who experience one or more loss-of-consciousness concussions may later have a shrunken hippocampus and poor memory (Strain et al., 2015; Tharmaratnam et al., 2018). Hippocampus size and function decrease as we grow older, which furthers cognitive decline (O'Callaghan et al., 2019). Chapter 8 explains how our two-track mind uses the hippocampus to process our memories.

hippocampus
a neural center located in the limbic system; helps process explicit (conscious) memories—of facts and events—for storage.

Elise Amendola/AP Images

Are football players' brains protected? When researchers analyzed the brains of 111 deceased National Football League players, 99 percent showed signs of degeneration related to frequent head trauma (Mez et al., 2017). In 2017, NFL player Aaron Hernandez (#81) died by suicide while imprisoned for murder. An autopsy revealed that his brain, at age 27, was already showing advanced degeneration (Kilgore, 2017). One small study showed that those who played even a single college football season, with or without experiencing a concussion, were more likely than not to exhibit brain damage (Hirad et al., 2019). In hopes of protecting players, today's teams and scientists use more protective gear and portable brain-imaging tools (Canadian Press, 2018).

***

FIGURE 2.19 locates the brain areas we've discussed, as well as the *cerebral cortex*—the body's ultimate control and information-processing center.

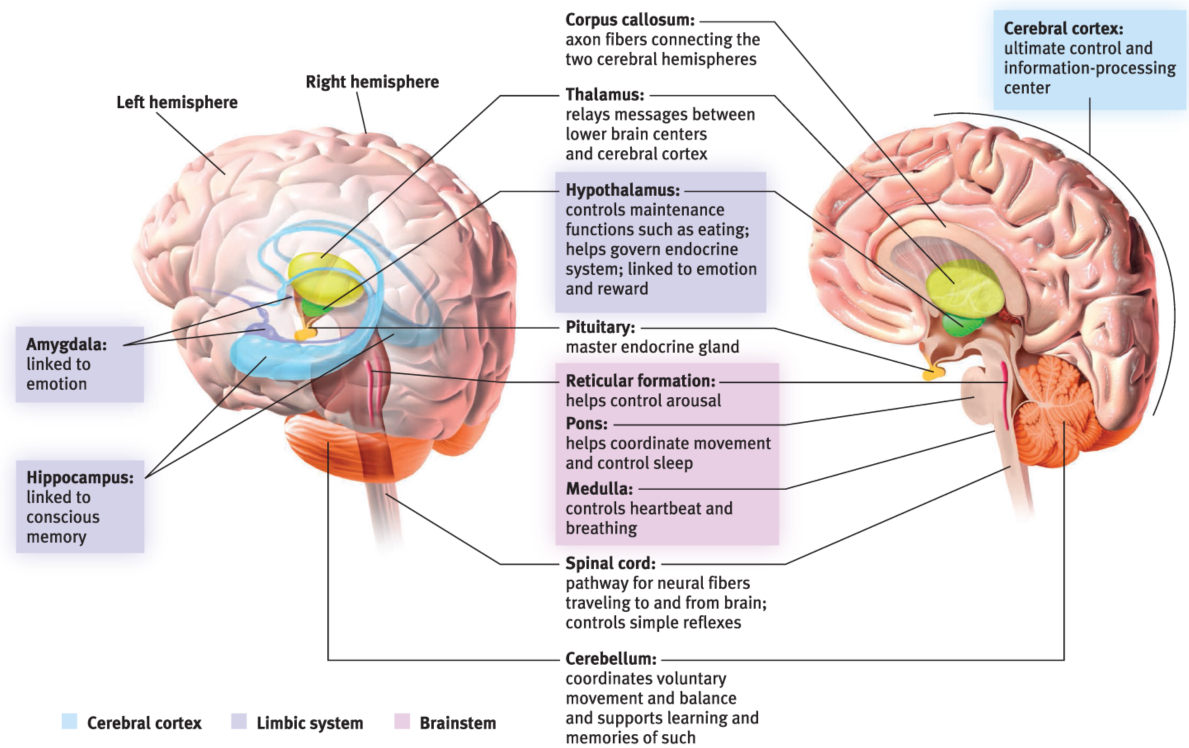


FIGURE 2.19 Brain structures and their functions

RETRIEVAL PRACTICE

RP-5 What are the three key structures of the limbic system, and what functions do they serve?

ANSWERS IN APPENDIX E

To review and assess your understanding, engage online with ***Concept Practice: The Limbic System.***

REVIEW Tools of Discovery, Older Brain Structures, and the Limbic System

LEARNING OBJECTIVES

Test Yourself Answer these repeated Learning Objective Questions on your own (before checking the answers in Appendix D) to improve your retention of the concepts (McDaniel et al., 2009, 2015).

LOQ 2-8: How do neuroscientists study the brain's connections to behavior and mind?

LOQ 2-9: What structures make up the brainstem, and what are the functions of the brainstem, thalamus, reticular formation, and cerebellum?

LOQ 2-10: What are the limbic system's structures and functions?

TERMS AND CONCEPTS TO REMEMBER

Test Yourself Write down the definition in your own words, then check your answer.

lesion [LEE-zhuhn]
EEG (electroencephalogram)
MEG (magnetoencephalography)
PET (positron emission tomography)
MRI (magnetic resonance imaging)
fMRI (functional MRI)
brainstem
medulla [muh-DUL-uh]
thalamus [THAL-uh-muss]
reticular formation
cerebellum [sehr-uh-BELL-um]
limbic system
amygdala [uh-MIG-duh-la]
hypothalamus [hi-po-THAL-uh-muss]
hippocampus

MASTER THE MATERIAL

Test Yourself Answer the following questions on your own first, then check your answers in Appendix E.

1. The part of the brainstem that controls heartbeat and breathing is the

   a. cerebellum.

   b. medulla.

   c. cortex.

   d. thalamus.

2. The thalamus functions as a

   a. memory bank.

   b. balance center.

   c. breathing regulator.

   d. sensory control center.

3. The lower brain structure that governs arousal is the

   a. spinal cord.

   b. cerebellum.

   c. reticular formation.

   d. medulla.

4. The part of the brain that coordinates voluntary movement and enables nonverbal learning and memory is the ________.

5. Two parts of the limbic system are the amygdala and the

   a. cerebral hemispheres.

   b. hippocampus.

   c. thalamus.

   d. pituitary.

6. A cat's ferocious response to electrical brain stimulation would lead you to suppose the electrode had touched the ________.

7. The neural structure that most directly regulates eating, drinking, and body temperature is the

   a. endocrine system.

   b. hypothalamus.

   c. hippocampus.

   d. amygdala.

8. The initial reward center discovered by Olds and Milner was located in the ________.

Continue testing yourself with **LearningCurve** or **Achieve Read & Practice** to learn and remember most effectively.

The Cerebral Cortex

LOQ 2-11

What four lobes make up the cerebral cortex, and what are the functions of the motor cortex, somatosensory cortex, and association areas?

Older brain networks sustain basic life functions and enable memory, emotions, and basic drives. Newer neural networks within the *cerebrum*—the two cerebral hemispheres contributing 85 percent of the brain's weight—form specialized work teams that enable our perceiving, thinking, and speaking. Like other structures above the brainstem (the oldest part of the brain)—including the thalamus, hippocampus, and amygdala—the cerebral hemispheres come as a pair. Covering those hemispheres, like bark on a tree, is the **cerebral cortex**, a thin surface layer of interconnected neural cells. In our brain's evolutionary history, the cerebral cortex—our brain's thinking crown—is a relative newcomer.

cerebral [seh-REE-bruhl] cortex
the intricate fabric of interconnected neural cells covering the cerebral hemispheres; the body's ultimate control and information-processing center.

The people who first dissected and labeled the brain used the language of scholars—Latin and Greek. Their words are actually attempts at graphic description: For example, *cortex* means "bark," *cerebellum* is "little brain," and *thalamus* is "inner chamber."

As we move up the ladder of animal life, the cerebral cortex expands, tight genetic controls relax, and the organism's adaptability increases. Frogs and other small-cortex amphibians operate extensively on preprogrammed genetic instructions. The larger cortex of mammals offers increased capacity for learning and thinking, enabling them to adapt to ever-changing environments. What makes us distinctively human is the size and interconnectivity of our cerebral cortex (Donahue et al., 2018). Let's take a look at its structure and function.

RETRIEVAL PRACTICE

RP-1 Which area of the human brain is most similar to that of less complex animals? Which part of the human brain distinguishes us most from less complex animals?

ANSWERS IN APPENDIX E

Structure of the Cortex

If you opened a human skull, exposing the brain, you would see a wrinkled organ, shaped somewhat like the meat of an oversized walnut. Without these wrinkles, a flattened cerebral cortex would require triple the area—roughly that of a large pizza. The brain's left and right hemispheres are filled mainly with axons connecting the cortex to the brain's other regions. The cerebral cortex—that thin surface layer—contains some 20 to 23 billion of the brain's nerve cells and 300 trillion synaptic connections (de Courten-Myers, 2005). Being human takes a lot of nerve.

Each hemisphere's cortex is subdivided into four *lobes,* separated by prominent *fissures,* or folds (**FIGURE 2.20**). Starting at the front of your brain and moving over the top, there are the **frontal lobes** (behind your forehead), the **parietal lobes** (at the top and to the rear), and the **occipital lobes** (at the back of your head). Reversing direction and moving forward, just above your ears, you find the **temporal lobes**. Each of the four lobes carries out many functions, and many functions require the interplay of several lobes.

frontal lobes
the portion of the cerebral cortex lying just behind the forehead; involved in speaking and muscle movements and in making plans and judgments.

parietal [puh-RYE-uh-tuhl] lobes
the portion of the cerebral cortex lying at the top of the head and toward the rear; receives sensory input for touch and body position.

occipital [ahk-SIP-uh-tuhl] lobes
the portion of the cerebral cortex lying at the back of the head; includes areas that receive information from the visual fields.

temporal lobes
the portion of the cerebral cortex lying roughly above the ears; includes the auditory areas, each receiving information primarily from the opposite ear.

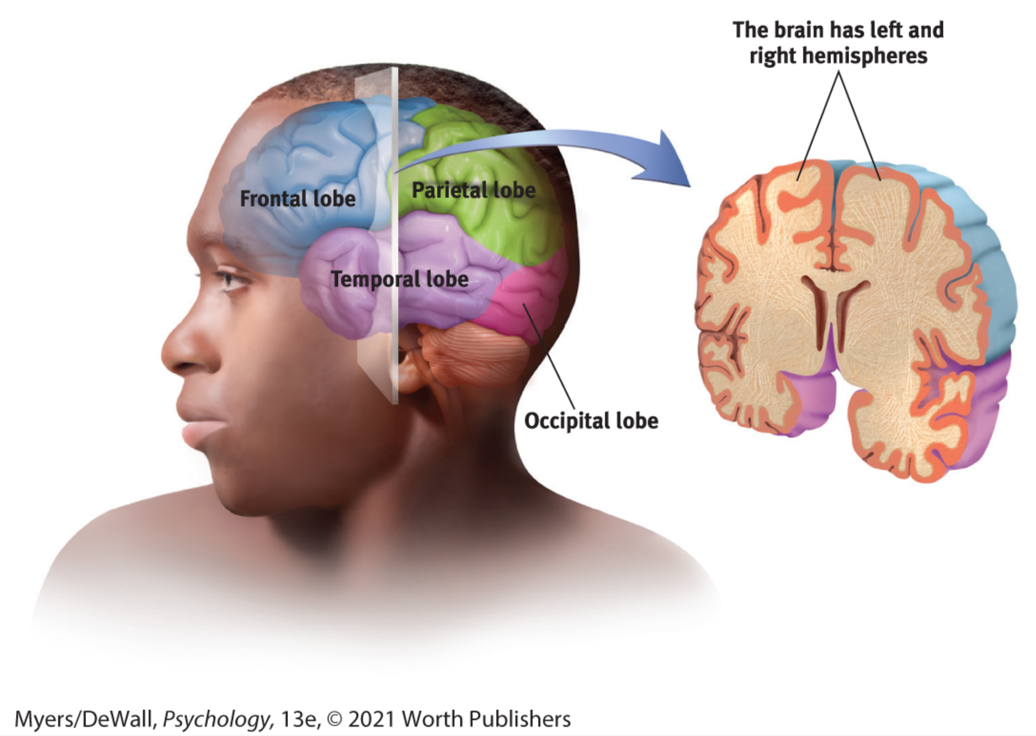


FIGURE 2.20 The cortex and its basic subdivisions

Functions of the Cortex

More than a century ago, surgeons found damaged cortical areas during autopsies of people who had been partially paralyzed or speechless. This rather crude evidence did not prove that specific parts of the cortex control complex functions like movement or speech. A laptop with a broken power cord might go dead, but we would be fooling ourselves if we thought we had “localized” the internet in the cord.

Motor Functions

Scientists had better luck in localizing simpler brain functions. For example, in 1870, German physicians Gustav Fritsch and Eduard Hitzig made an important discovery: Mild electrical stimulation to parts of an animal's cortex made parts of its body move. The effects were selective: Stimulation caused movement only when applied to an arch-shaped region at the back of the frontal lobe, running roughly ear to ear across the top of the brain. Moreover, stimulating parts of this region in the left or right hemisphere caused movements of specific body parts on the *opposite* side of the body. Fritsch and Hitzig had discovered what is now called the **motor cortex**.

motor cortex
a cerebral cortex area at the rear of the frontal lobes that controls voluntary movements.

MAPPING THE MOTOR CORTEX

Lucky for brain surgeons and their patients, the brain has no sensory receptors. Knowing this, in the 1930s, Otfrid Foerster and Wilder Penfield were able to map the motor cortex in hundreds of wide-awake patients by stimulating different cortical areas and observing responses. They discovered that body areas requiring precise control, such as the fingers and mouth, occupy the greatest amount of cortical space (**FIGURE 2.21**). In one of his many demonstrations of motor behavior mechanics, Spanish neuroscientist José Delgado stimulated a spot on a patient's left motor cortex, triggering the right hand to make a fist. Asked to keep the fingers open during the next stimulation, the patient, whose fingers closed despite his best efforts, remarked, “I guess, Doctor, that your electricity is stronger than my will” (Delgado, 1969, p. 114).

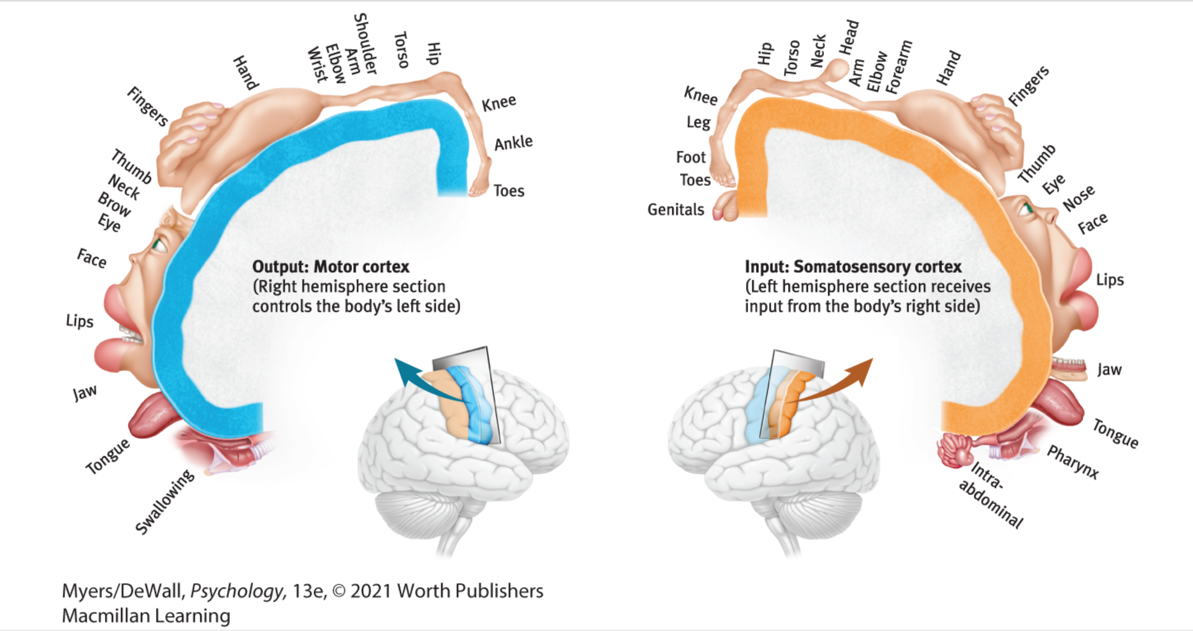


FIGURE 2.21 Motor cortex and somatosensory cortex tissue devoted to each body part As you can see from this classic though inexact representation, the amount of cortex devoted to a body part in the motor cortex (in the frontal lobes) or in the somatosensory cortex (in the parietal lobes) is not proportional to that body part's size. Rather, the brain devotes more tissue to sensitive areas and to areas requiring precise control. So, your fingers have a greater representation in the cortex than does your upper arm.

Scientists can predict a monkey's arm motion *just before* it moves—by repeatedly measuring motor cortex activity preceding specific arm movements (Livi et al., 2019). Scientists have also observed monkeys' motor cortex neurons responding differently when executing a social act (putting an object in an experimenter's hand) rather than a nonsocial act (putting something in a container or in their own mouth) (Coudé et al., 2019). Such findings have opened the door to research on brain-controlled computer technology.

RETRIEVAL PRACTICE

RP-2 If you are able, try moving your right hand in a circular motion, as if cleaning a table. Then start your right foot doing the same motion, synchronized with your hand. Now reverse the right foot's motion, but not the hand's. Finally, try moving the *left* foot opposite to the right hand.

a. Why is reversing the right foot's motion so hard?
b. Why is it easier to move the left foot opposite to the right hand?

ANSWERS IN APPENDIX E

BRAIN-MACHINE INTERFACES

Researchers wondered: By eavesdropping on the brain, could we enable a paralyzed person to move a robotic limb? Could a brain-machine interface help people learn to command a cursor to write email or work online? To find out, they implanted 100 tiny recording electrodes in the motor cortexes of three monkeys (Nicolelis, 2011; Serruya et al., 2002). As the monkeys gained rewards by using a joystick to follow a moving red target, the researchers matched the brain signals with the arm movements. Then they programmed a computer to monitor the signals and operate the joystick. When a monkey merely thought about a move, the mind-reading computer moved the cursor with nearly the same proficiency as had the reward-seeking monkey. Monkey think, computer do.

Clinical trials of such *cognitive neural prosthetics* have since been under way with people who have severe paralysis or have lost a limb (Andersen et al., 2010; Nurmikko et al., 2010; Rajangam et al., 2016; Velliste et al., 2008). The first patient, a 25-year-old man with paralysis, was able to mentally control a TV, draw shapes on a computer screen, and play video games—all thanks to an aspirin-sized chip with 100 microelectrodes recording activity in his motor cortex (Hochberg et al., 2006). Others with paralysis who have received implants have learned to direct robotic arms with their thoughts (Clausen et al., 2017).

And then there is Ian Burkhart, who lost the use of his arms and legs at age 19. Ohio State University brain researchers implanted recording electrodes in his motor cortex (Schwemmer et al., 2018). Using computer *machine learning,* they instruct Burkhart to stare at a screen that shows a moving hand. Next, Burkhart imagines moving his own hand. Brain signals from his motor cortex begin feeding into the computer, which gets the message that he wants to move his arm and thus stimulates those muscles. The result? Burkhart, with his very own paralyzed arm, grasps a bottle, dumps out its contents, and picks up a stick. He can even play the video game *Guitar Hero.* By learning Burkhart's unique brain response patterns, the computer can predict his brain activity to help him make these movements. "It's really restored a lot the hope I have for the future to know that a device like this will be possible to use in everyday life," Burkhart says, "for me and for many other people" (Wood, 2018). (See tinyurl.com/ControlMotorCortex.)

In another demonstration of machine learning, researchers scanned the brains of physics students when they thought about 30 physics-relevant concepts, such as gravity and momentum (Mason & Just, 2016). A computer program learned to accurately identify the links between specific brain region activations and the concepts.

If everything psychological is also biological—if, for example, every thought is also a neural event—microelectrodes could someday detect complex thoughts well enough to enable many people to control their environment with ever-greater precision (see **FIGURE 2.22**). Scientists have even created a prosthetic voice. The virtual voice creates (mostly) understandable speech by reading the brain's motor commands that direct vocal movement (Anumanchipalli et al., 2019).

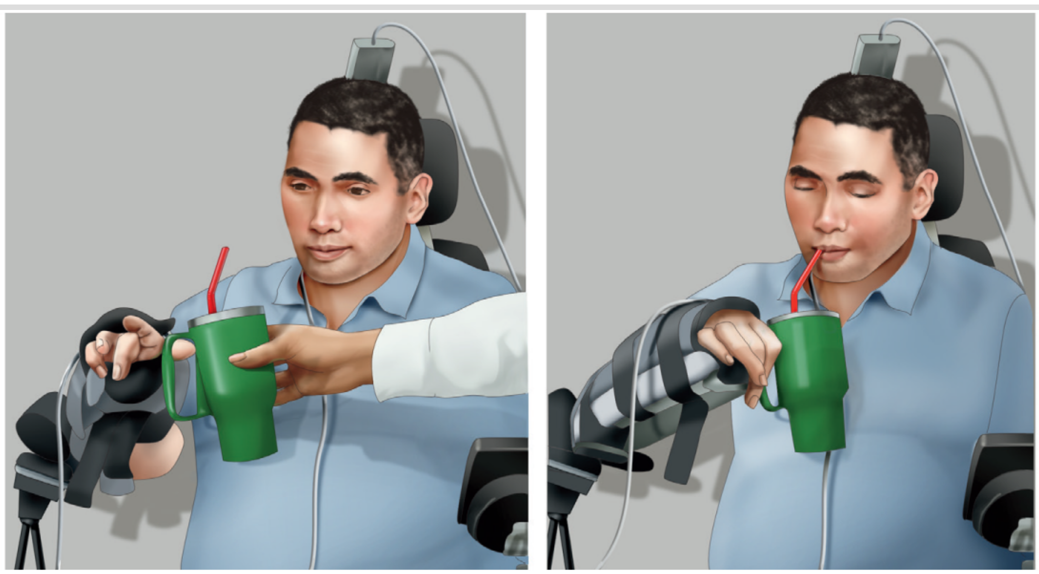


FIGURE 2.22 **Brain-machine interaction** Electrodes planted in the hand area of the motor cortex, and in the hand, elbow, and shoulder muscles helped a man with paralysis in all four limbs use his paralyzed arm to take a drink of coffee (Ajiboye et al., 2017). Such research advances are paving the way for restored movement in daily life, outside the controlled laboratory environment (Andersen, 2019; Andersen et al., 2010).

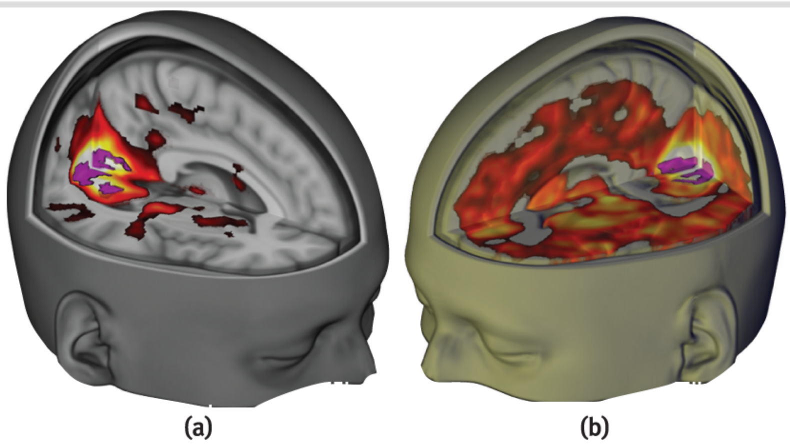
Sensory Functions

If the motor cortex sends messages out to the body, where does the cortex receive incoming messages? Wilder Penfield identified a cortical area—at the front of the parietal lobes, parallel to and just behind the motor cortex—that specializes in receiving information from the skin senses, such as touch and temperature, and from the movement of body parts. We now call this area the **somatosensory cortex**. Stimulate a point on the top of this band of tissue and a person may report being touched on the shoulder; stimulate some point on the side and the person may feel something on the face.

somatosensory cortex
a cerebral cortex area at the front of the parietal lobes that registers and processes body touch and movement sensations.

The more sensitive the body region, the larger the somatosensory cortex area devoted to it (see Figure 2.21). Your supersensitive lips project to a larger brain area than do your toes, which is one reason we kiss rather than touch toes. Rats have a large area of the brain devoted to their whisker sensations, and owls to their hearing sensations.

Scientists have identified additional areas where the cortex receives input from senses other than touch. Any visual information you are receiving now is going to the visual cortex in your occipital lobes, at the back of your brain (**FIGURES 2.23** and **2.24**). If you have normal vision, you might see flashes of light or dashes of color if stimulated in your occipital lobes. (In a sense, we *do* have eyes in the back of our head!) Having lost much of his right occipital lobe to a tumor removal, a friend of mine [DM's] was blind to the left half of his field of vision. Visual information travels from the occipital lobes to other areas that specialize in tasks such as identifying words, detecting emotions, and recognizing faces.



Imperial College London

FIGURE 2.23 Seeing without eyes The psychoactive drug LSD often produces vivid *hallucinations.* Why? Because it dramatically increases communication between the visual cortex (in the occipital lobe) and other brain regions. These fMRI (functional MRI) scans show (a) a research participant with closed eyes who has been given a placebo and (b) the same person under the influence of LSD. Color represents increased blood flow (Carhart-Harris et al., 2016). Other researchers have confirmed that LSD increases communication between brain regions (Preller et al., 2019; Timmermann et al., 2018).

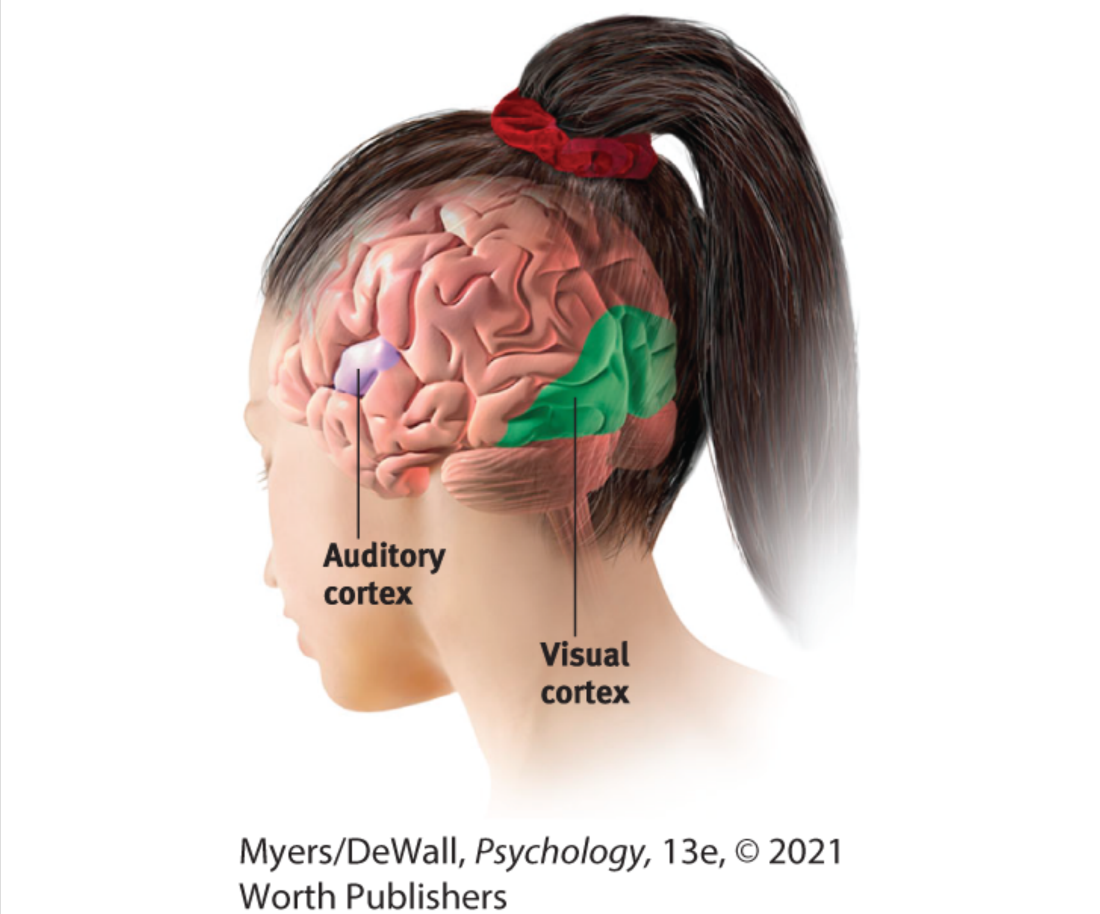


FIGURE 2.24 The visual cortex and auditory cortex The visual cortex in the occipital lobes at the rear of your brain receives input from your eyes. The auditory cortex in your temporal lobes—above your ears—receives information from your ears.

Any sound you now hear is processed by your auditory cortex in your temporal lobes (just above your ears; see Figure 2.24). Most of this auditory information travels a circuitous route from one ear to the auditory receiving area above your opposite ear. If stimulated in your auditory cortex, you might hear a sound. MRI scans of people with schizophrenia have revealed active auditory areas in the temporal lobes during the false sensory experience of auditory *hallucinations* (Lennox et al., 1999). Even the phantom ringing sound experienced by people with hearing loss (tinnitus) is—if heard in one ear—associated with activity in the temporal lobe on the brain's opposite side (Muhlnickel, 1998).

RETRIEVAL PRACTICE

RP-3 Our brain's __________ cortex registers and processes body touch and movement sensations. The __________ cortex controls our voluntary movements.

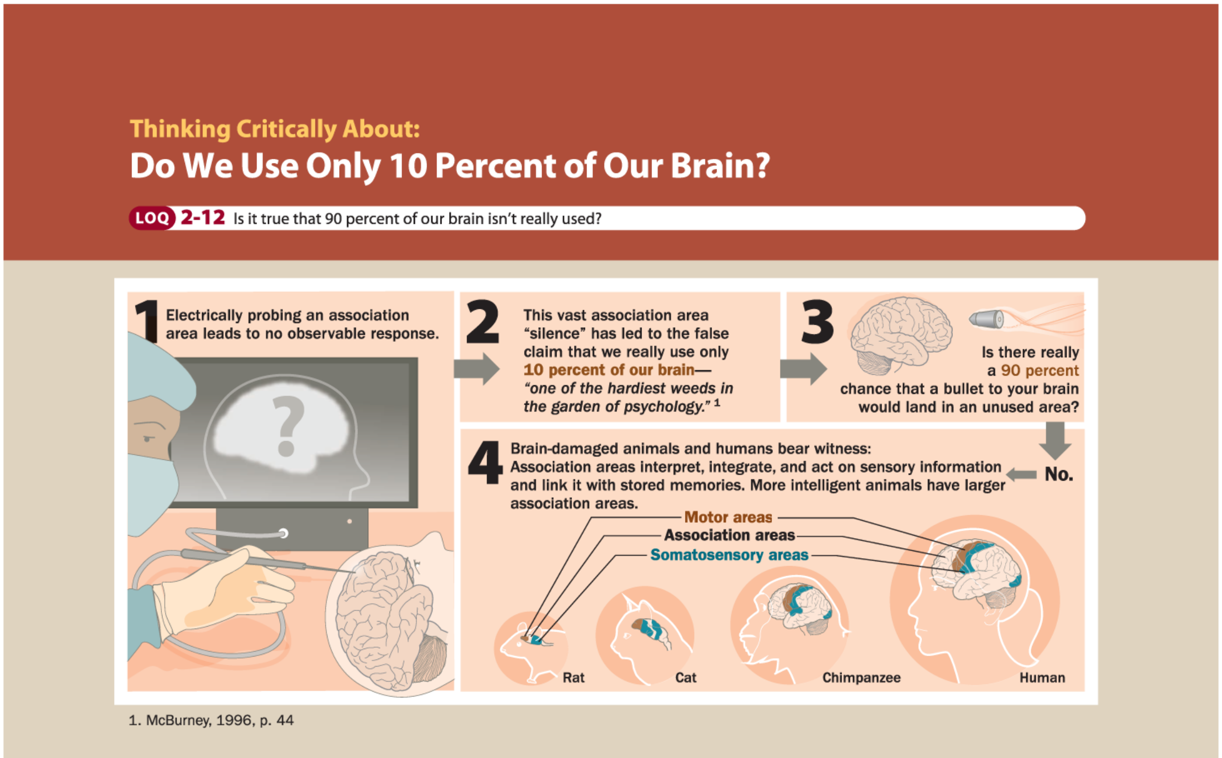
ANSWERS IN APPENDIX E

Association Areas

So far, we have pointed out small cortical areas that either receive sensory input or direct muscular output. Together, these occupy about one-fourth of the human brain's thin, wrinkled cover. What, then, goes on in the remaining vast regions of the cortex? In these **association areas**, neurons are busy with higher mental functions—many of the tasks that make us human. Electrically probing an association area won't trigger any observable response. So, unlike the somatosensory and motor areas, association area functions cannot be neatly mapped. Does this mean we don't use them—or that, as some 4 in 10 people agreed in two surveys, "We use only 10 percent of our brains" (Furnham, 2018; Macdonald et al., 2017)? (See Thinking Critically About: Do We Use Only 10 Percent of Our Brain?)

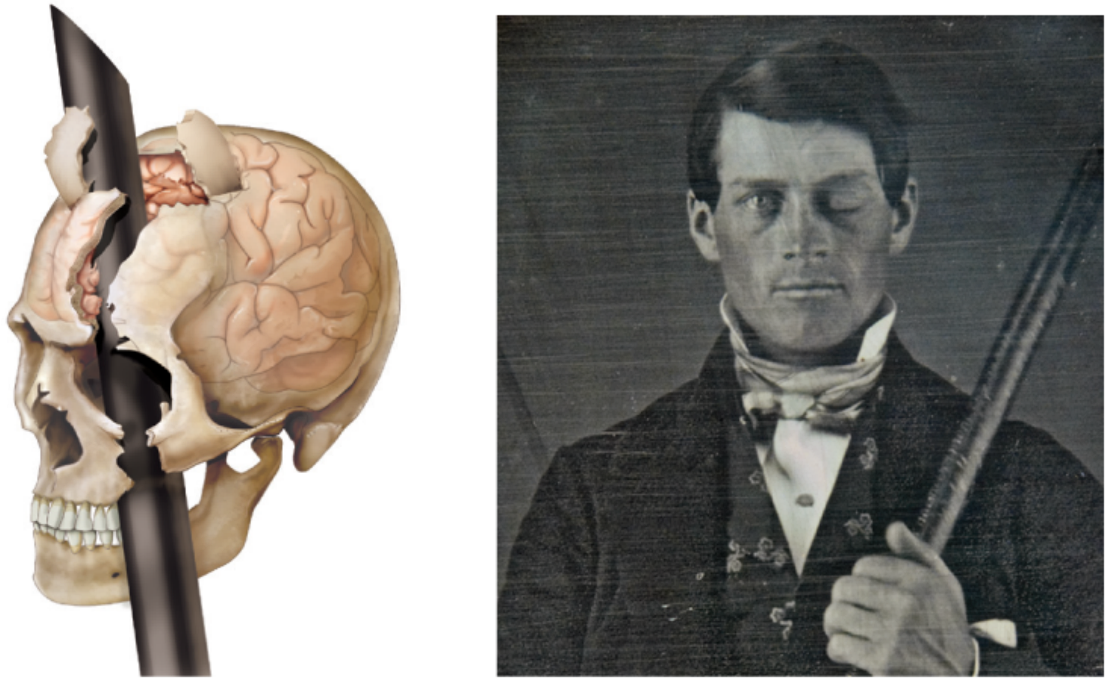
association areas

areas of the cerebral cortex that are not involved in primary motor or sensory functions; rather, they are involved in higher mental functions such as learning, remembering, thinking, and speaking.



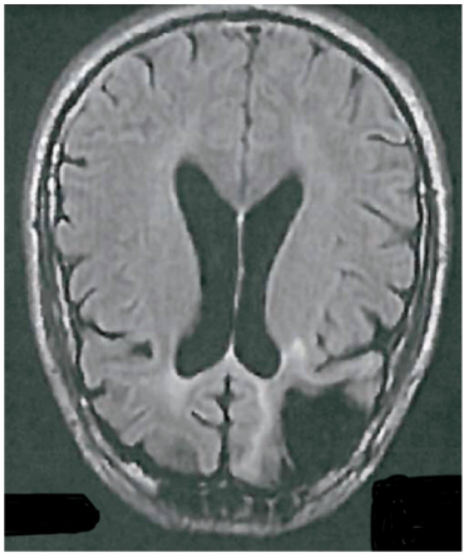
Association areas are found in all four lobes. The *prefrontal cortex* in the forward part of the frontal lobes enables judgment, planning, social interactions, and processing of new memories (de la Vega et al., 2016; Silwa & Frehwald, 2017; Yin & Weber, 2019). People with damage to this area may have high intelligence test scores and great cake-baking skills. Yet they would not be able to plan ahead to *begin* baking a cake for a birthday party (Huey et al., 2006). If they did begin to bake, they might forget the recipe (MacPherson et al., 2016). And despite being responsible for the absence of birthday cake at the party, they may fail to feel regret (Bault et al., 2019).

Frontal lobe damage also can alter personality and remove a person's inhibitions. Consider the classic case of railroad worker Phineas Gage. One afternoon in 1848, Gage, then 25 years old, was using a tamping iron to pack gunpowder into a rock. A spark ignited the gunpowder, shooting the rod up through his left cheek and out the top of his skull, leaving his frontal lobes damaged (**FIGURE 2.25**). To everyone's amazement, Gage was immediately able to sit up and speak, and after the wound healed, he returned to work. But the blast damaged connections between his frontal lobes and brain regions that enable emotion control and decision making (Thiebaut de Schotten et al., 2015; Van Horn et al., 2012). How did this damage affect Gage's personality? The normally friendly, soft-spoken man was now irritable, profane, and dishonest. Gage, said his friends, was "no longer Gage." Gage later lost his railroad job, but over time he adapted to his disability and found work as a stagecoach driver (Macmillan & Lena, 2010).



(a) (b)

FIGURE 2.25 A blast from the past (a) Phineas Gage's skull was kept as a medical record. Using measurements and modern neuroimaging techniques, researchers have reconstructed the probable path of the rod through Gage's brain (Van Horn et al., 2012). (b) This photo shows Gage after his accident. (The image has been reversed to show the features correctly. Early photos, including this one, were actually mirror images.)



Cecil Clayton's brain scan, included with request for stay of execution filed with the Supreme Court, showing a missing portion of his frontal lobe.

Missing frontal lobe brakes With part of his left frontal lobe (in this downward facing brain scan) lost to injury, Cecil Clayton became more impulsive and killed a deputy sheriff. Nineteen years later, his state executed him for this crime.

Studies of others with damaged frontal lobes have revealed similar impairments. Not only do they become less inhibited (without the frontal lobe brakes on their impulses), but their moral judgments also seem unrestrained. Cecil Clayton lost 20 percent of his left frontal lobe in a 1972 sawmill accident. Thereafter, his intelligence test score dropped to an elementary school level and he displayed increased impulsivity. In 1996, he fatally shot a deputy sheriff. In

2015, when he was 74, the State of Missouri executed him (Williams, 2015).

Would you advocate pushing one person in front of a runaway trolley to save five others? Most people would not, because of strong social norms against murder. But people with damage to the prefrontal cortex are often untroubled by such ethical dilemmas (Koenigs et al., 2007). The frontal lobes help steer us toward kindness and away from violence (Lieberman et al., 2019; Molenberghs et al., 2015; Yang & Raine, 2009). With their frontal lobes ruptured, people's moral compass seems separated from their actions. They know right from wrong but often don't care.

Association areas also perform other mental functions. The parietal lobes, parts of which were large and unusually shaped in Einstein's normal-weight brain, enable mathematical and spatial reasoning (Amalric & Dehaene, 2019; Wilkey et al., 2018). Stimulation of one parietal lobe area in brain-surgery patients produced a feeling of wanting to move an upper limb, the lips, or the tongue without any actual movement. With increased stimulation, patients falsely believed they *had* moved. Curiously, when surgeons stimulated a different association area near the motor cortex in the frontal lobes, the patients did move but had no awareness of doing so (Desmurget et al., 2009). These head-scratching findings suggest that our perception of moving flows not from the movement itself, but rather from our intention and the results we expected.

> **“We held Einstein’s brain in our hands and realized that this is the organ that was responsible for changing our perceptions of the universe … we were in awe.”** —Neuroscientist Sandra Witelson (2011)

On the underside of the right temporal lobe, another association area enables us to recognize faces. If a stroke or head injury destroyed this area of your brain, you would still be able to describe facial features and to recognize someone’s gender and approximate age, yet be strangely unable to identify the person as, say, Ariana Grande, or even your grandmother.

Nevertheless, to reemphasize, we should be wary of using pictures of brain “hot spots” to create a new phrenology that locates complex functions in precise brain areas (Beck, 2010; Shimamura, 2010; Uttal, 2001). During a complex task, a brain scan shows many islands of brain activity working together—some running automatically in the background, and others under conscious control (Chein & Schneider, 2012). Your memory, language, attention, and social skills result from *functional connectivity*—communication among distinct brain areas and neural networks (Bassett et al., 2018; Knight, 2007; Silston et al., 2018). What happens when brain areas struggle to communicate with each other? People are at increased risk for a variety of mental disorders (Baker et al., 2019; Zhang et al., 2019). *The point to remember:* Our mental experiences—and our psychological health—rely on coordinated brain activity.

RETRIEVAL PRACTICE

RP-4 Why are association areas important?

ANSWERS IN APPENDIX E

Check your understanding of the parts of the brain by engaging online with ***Concept Practice: Brain Areas Within the Head.*** And to learn more about case studies, such as the study of Phineas Gage, see the ***Video: Case Studies*** for a helpful tutorial animation.

Responses to Damage

LOQ 2-13

To what extent can a damaged brain reorganize itself, and what is *neurogenesis?*

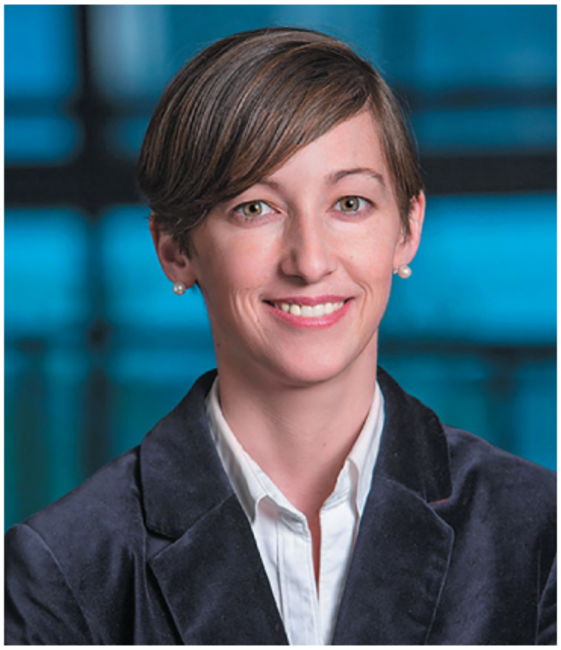
Earlier, we learned about *neuroplasticity*—how our brain adapts to new situations. What happens when we experience mishaps, big and little? Let's explore the brain's ability to modify itself after damage.

Most brain-damage effects can be traced to two hard facts: (1) Severed brain and spinal cord neurons, unlike cut skin, usually do not regenerate. (If your spinal cord were severed, you would probably be permanently paralyzed.) And (2) some brain functions seem preassigned to specific areas. One newborn who suffered damage to temporal lobe facial recognition areas was never able to recognize faces (Farah et al., 2000). But there is good news: Some neural tissue can *reorganize* in response to damage.

Neuroplasticity may also occur after serious damage, especially in young children (Kolb, 1989; see also **FIGURE 2.26**). *Constraint-induced therapy* aims to rewire brains and improve the dexterity of a brain-damaged child or even an adult stroke victim (Taub, 2004). By restraining a fully functioning limb, therapists force patients to use the "bad" hand or leg, gradually reprogramming the brain. One stroke victim, a surgeon in his fifties, was put to work cleaning tables, with his good arm and hand restrained. Slowly, the bad arm recovered its skills. As damaged-brain functions migrated to other brain regions, he gradually learned to write again and even to play tennis (Doidge, 2007).

Left: Joe McNally/Hulton Archive/Getty Images; right: Living Art Enterprises, LLC/ Science Source

FIGURE 2.26 Brain work is child's play This 6-year-old had surgery to end her life-threatening seizures. Although most of an entire hemisphere was removed (see MRI of hemispherectomy), her remaining hemisphere compensated by putting other areas to work. One Johns Hopkins medical team reflected on the child hemispherectomies they had performed. Although use of the opposite arm was compromised, the team reported being "awed" by how well the children had retained their memory, personality, and humor (Vining et al., 1997). The younger the child, the greater the chance that the remaining hemisphere can take over the functions of the one that was surgically removed (Choi, 2008; Danelli et al., 2013).



Courtesy of Dr. Danielle Bassett

Physics of the mind MacArthur Genius Award winner Danielle Bassett's work crosses disciplines. She applies concepts from physics and mathematics to explain the brain's neural network connections.

The brain's plasticity is good news for those blind or deaf. Blindness or deafness makes unused brain areas available for other uses, such as sound and smell (Amedi et al., 2005; Bauer et al., 2017). If a blind person uses one finger to read Braille, the brain area dedicated to that finger expands as the sense of touch invades the visual cortex that normally helps people see (Barinaga, 1992; Sadato et al., 1996). Neuroplasticity also helps explain why deaf people who learned sign language before another language may have enhanced peripheral and motion-detection vision (Bosworth & Dobkins, 1999;

Shiell et al., 2014). In deaf people whose native language is sign, the temporal lobe area normally dedicated to hearing waits in vain for stimulation. Finally, it looks for other signals to process, such as those from the visual system used to see and interpret signs.

Similar reassignment may occur when disease or damage frees up other brain areas normally dedicated to specific functions. If a slow-growing left hemisphere tumor disrupts language (which resides mostly in the left hemisphere), the right hemisphere may compensate (Thiel et al., 2006). When people who are born without hands use their feet to perform everyday tasks, their somatosensory cortex for the hand area becomes active—even though they have never had hands (Striem-Amit et al., 2018). So what do you suppose was the sexual intercourse experience of one patient whose lower leg had been amputated? "I actually experience my orgasm in my [phantom] foot. [Note that in Figure 2.21, the toes region is adjacent to the genitals.] And there it's much bigger than it used to be because it's no longer just confined to my genitals" (Ramachandran & Blakeslee, 1998, p. 36).

Although the brain often attempts self-repair by reorganizing existing tissue, researchers are debating whether it can also mend itself through **neurogenesis**—producing new neurons (Boldrini et al., 2018; Kempermann et al., 2018; Sorrells et al., 2018). Researchers have found baby neurons deep in the brain of adult mice, birds, monkeys, and humans (He & Jin, 2016; Jessberger et al., 2008). These neurons may then form connections with neighboring neurons (Gould, 2007; Luna et al., 2019). Neurogenesis varies among individuals, offering another example of how we experience a common process in our own unique way (Kempermann, 2019).

neurogenesis
the formation of new neurons.

Master *stem cells,* which can develop into any type of brain cell, have also been discovered in the human embryo. If mass-produced in a lab and injected into a damaged brain, might neural stem cells turn themselves into replacements for lost brain cells? Researchers at universities and biotech companies continue to break new ground on how to produce stem cells that resemble functioning human neurons (Lu et al., 2016; Paşca et al., 2015). Such stem cell research not only helps treat the diseased or damaged brain, but also aids understanding of brain development, memory, and other basic psychological processes (Mariani et al., 2012; Sun et al, 2015; Zhang et al., 2016). Might surgeons someday be able to rebuild damaged brains, much as we reseed damaged sports fields? Stay tuned. In the meantime, we can all benefit from natural promoters of neurogenesis, such as exercise, sleep, and nonstressful but stimulating environments (Liu & Nusslock, 2018; Monteiro et al., 2014; Nollet et al., 2019).

For more on how our brain responds to damage, see the ***Video—Brain Plasticity: Rewiring the Visual Cortex.***

The Divided Brain

LOQ 2-14

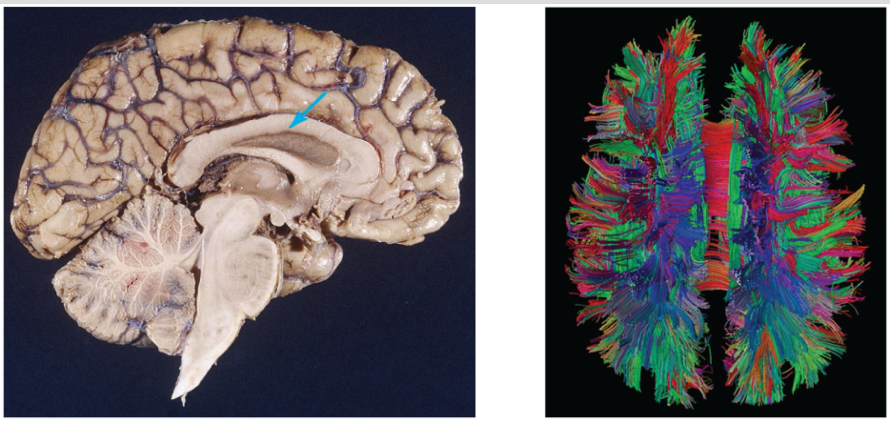
What do split brains reveal about the functions of our two brain hemispheres?

Our brain's look-alike left and right hemispheres serve differing functions. This *lateralization* is apparent after brain damage. Research spanning more than a century has shown that left hemisphere accidents, strokes, and tumors can impair reading, writing, speaking, arithmetic reasoning, and understanding. Similar right hemisphere damage has less visibly dramatic effects. Does this mean that the right hemisphere is just along for the ride? Many believed this was the case until the 1960s, when a fascinating chapter in psychology's history began to unfold: Researchers found that the "minor" right hemisphere was not so limited after all.

Splitting the Brain

In the early 1960s, two neurosurgeons speculated that major epileptic seizures were caused by an amplification of abnormal brain activity bouncing back and forth between the two cerebral hemispheres, which work together as a whole system (Bogen & Vogel, 1962). If so, they wondered, could they end this biological tennis match by severing the **corpus callosum**, the wide band of axon fibers connecting the two hemispheres and carrying messages between them (see FIGURE 2.27)? The neurosurgeons knew that psychologists Roger Sperry, Ronald Myers, and Michael Gazzaniga had divided cats' and monkeys' brains in this manner, with no serious ill effects.

corpus callosum [KOR-pus kah-LOW-sum]
the large band of neural fibers connecting the two brain hemispheres and carrying messages between them.



(a) (b)

(a): Martin M. Rotker/Science Source; (b): Dr. Patric Hagmann/CHUV, UNIL, Lausanne, Switzerland

FIGURE 2.27 The corpus callosum This large band of neural fibers connects the two brain hemispheres. (a) To photograph this half brain, a surgeon separated the hemispheres by cutting through the corpus callosum (see blue arrow) and lower brain regions. (b) This high-resolution diffusion spectrum image, showing a top-facing brain from above, reveals brain neural networks within the two hemispheres, and the corpus callosum neural bridge between them.

So the surgeons operated. The result? The seizures all but disappeared. The patients with these split brains were surprisingly normal, their personality and intellect hardly affected. Waking from surgery, one even joked that he had a "splitting headache"

(Gazzaniga, 1967). By sharing their experiences, these patients have greatly expanded our understanding of interactions between the intact brain's two hemispheres.

split brain
a condition resulting from surgery that separates the brain's two hemispheres by cutting the fibers (mainly those of the corpus callosum) connecting them.

To appreciate these findings, we need to focus for a minute on the peculiar nature of our visual wiring, illustrated in **FIGURE 2.28**. Note that each eye receives sensory information from the entire visual field. But in each eye, information from the left half of your field of vision goes to your right hemisphere, and information from the right half of your visual field goes to your left hemisphere, which usually controls speech. Information received by either hemisphere is quickly transmitted to the other across the corpus callosum. In a person with a severed corpus callosum, this information-sharing does not take place.

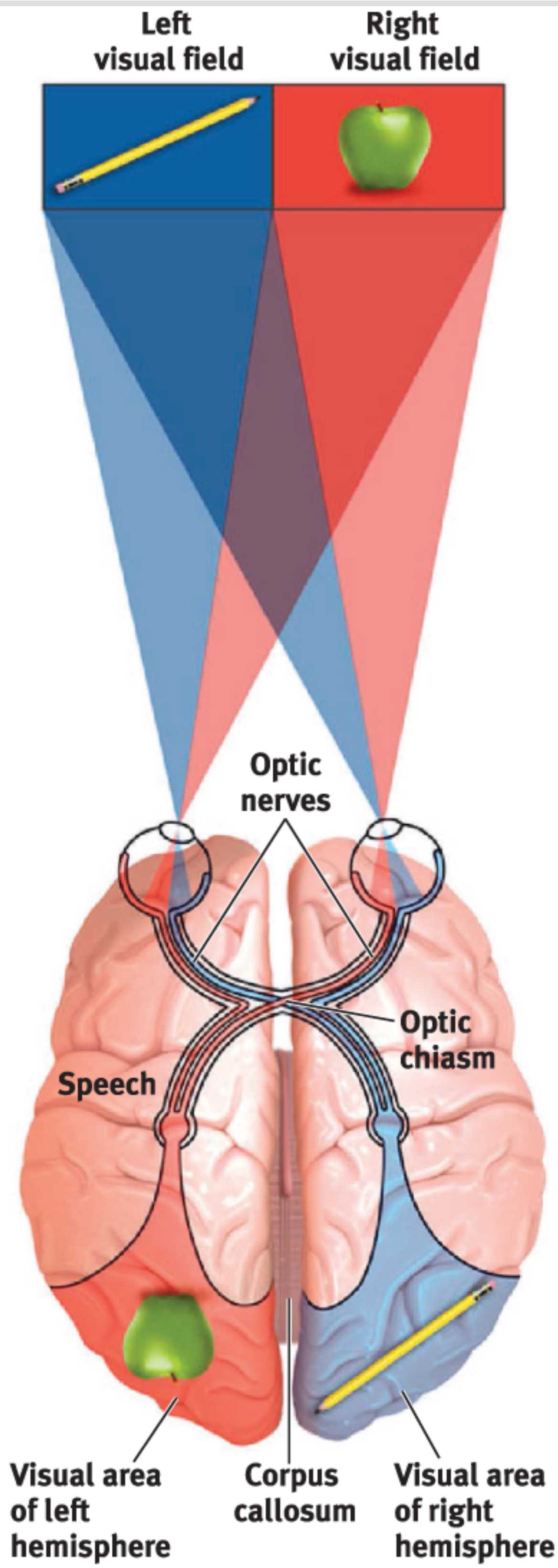

Left
visual field
Right
visual field
Optic
nerves
Optic
chiasm
Speech
Visual area
of left
hemisphere
Corpus
callosum
Visual area
of right
hemisphere

FIGURE 2.28 The information highway from eye to brain

Knowing these facts, Sperry and Gazzaniga could send information to a patient's left or right hemisphere. As the person stared at a spot, they flashed a stimulus to its right or left. They could do this with you, too, but in your intact brain, the hemisphere receiving the information would instantly pass the news to the other side. Because the split-brain surgery had cut the communication lines between the hemispheres, the researchers could, with these patients, quiz each hemisphere separately.

In an early experiment, Gazzaniga (1967) asked split-brain patients to stare at a dot as he flashed HE·ART on a screen (**FIGURE 2.29**). Thus, HE appeared in their left visual field (which transmits to the right hemisphere) and ART in the right field (which transmits to the left hemisphere). When he then asked them to *say* what they had seen, the patients reported that they had seen ART. But when asked to *point* to what they had seen, they were startled when their left hand (controlled by the right hemisphere) pointed to HE. Given an opportunity to express itself, each hemisphere indicated what it had seen. The right hemisphere (controlling the left hand) intuitively knew what it could not verbally report.

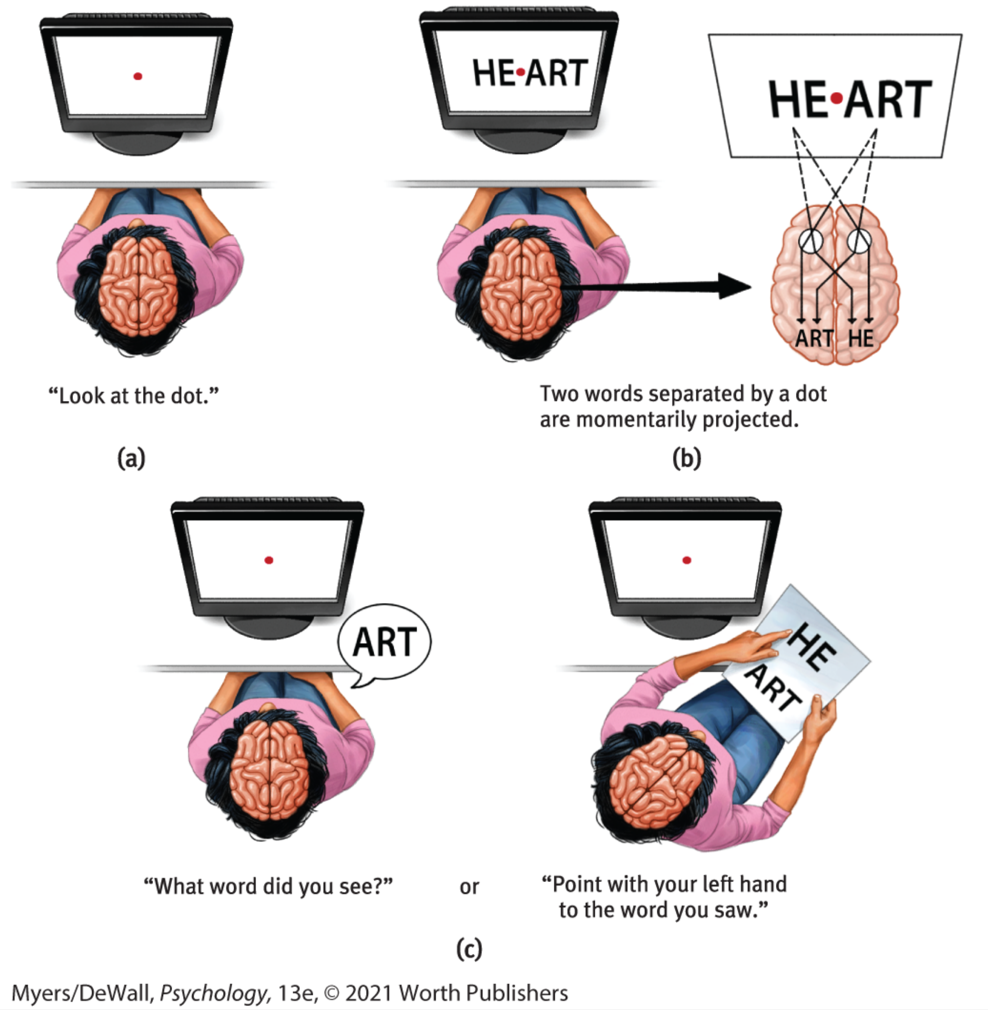


FIGURE 2.29 One skull, two minds When an experimenter flashes HE•ART across the visual field, a woman with a split brain verbally reports seeing the word transmitted to her left hemisphere. However, if asked to indicate with her left hand what she saw, she points to the word transmitted to her right hemisphere (Gazzaniga, 1983).

When a picture of a spoon was flashed to their right hemisphere, the patients could not *say* what they had viewed. But when asked to *identify* what they had viewed by feeling an assortment of hidden objects with their left hand, they readily selected the spoon. If the experimenter said, "Correct!" the patient might reply, "What?

Correct? How could I possibly pick out the correct object when I don't know what I saw?" It is, of course, the left hemisphere doing the talking here, bewildered by what the nonverbal right hemisphere knows.

> **"Do not let your left hand know what your right hand is doing."** — Matthew 6:3

A few people who have had split-brain surgery have been for a time bothered by the unruly independence of their left hand. It seemed the left hand truly didn't know what the right hand was doing. The left hand might unbutton a shirt while the right hand buttoned it, or put grocery store items back on the shelf after the right hand put them in the cart. It was as if each hemisphere was thinking, "I've half a mind to wear my green (blue) shirt today." Indeed, said Sperry (1964), split-brain surgery leaves people "with two separate minds." With a split brain, both hemispheres can comprehend and follow an instruction to copy—*simultaneously*—different figures with the left and right hands (Franz et al., 2000; see also **FIGURE 2.30**). Today's researchers believe that a split-brain patient's mind resembles a river that has branched into separate streams, each unaware of the other (Pinto et al., 2017). (Reading these reports, can you imagine a patient enjoying a solitary game of "rock, paper, scissors"—left versus right hand?)

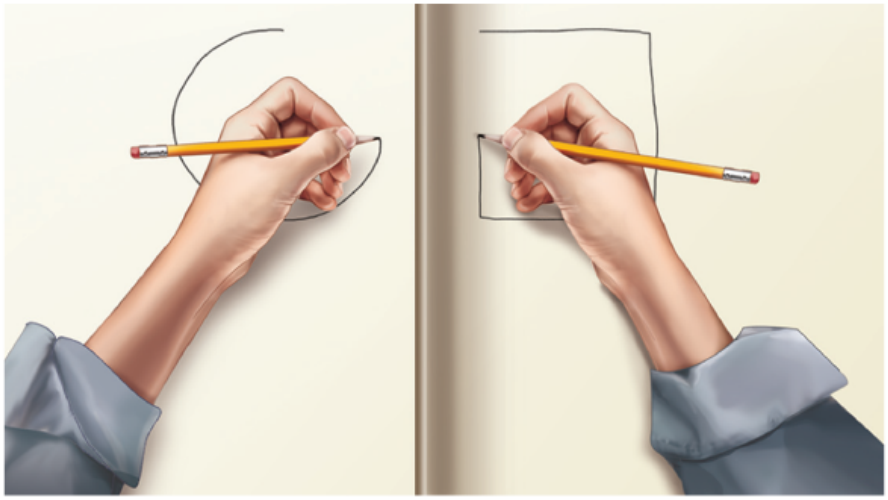


FIGURE 2.30 Try this! People who have had split-brain surgery can simultaneously draw two different shapes.

When the "two minds" are at odds, the left hemisphere does mental gymnastics to rationalize reactions it does not understand. If a patient follows an order ("Walk") sent to the right hemisphere, a strange thing happens. The left hemisphere, unaware of the order, doesn't know why the patient begins walking. But if asked, the patient doesn't reply, "I don't know." Instead, the left hemisphere improvises—"I'm going into the house to get a Coke." Gazzaniga (1988), who described these patients as "the most fascinating people on earth," realized that the conscious left hemisphere resembles an interpreter that instantly constructs explanations. The brain, he concluded, often runs on autopilot; it acts first and then explains itself.

RETRIEVAL PRACTICE

RP-5 (a) If we flash a red light to the right hemisphere of a person with a split brain, and flash a green light to the left hemisphere, will each observe its own color? (b) Will the person be aware that the colors differ? (c) What will the person verbally report seeing?

ANSWERS IN APPENDIX E

Have you ever been asked if you are "left-brained" or "right-brained"? Consider this popular misconception—supported by 64 percent of the public in one survey (Macdonald et al., 2017)—by engaging online with the activity ***How Would You Know If People Can Be "Left-Brained" or "Right-Brained"?***

Right-Left Differences in the Intact Brain

So, what about the 99.99+ percent of us with undivided brains? Does each of *our* hemispheres also perform distinct functions? The short answer is *Yes.* When a person performs a *perceptual* task, a brain scan often reveals increased activity (brain waves, blood flow, and glucose consumption) in the *right* hemisphere. When the person speaks or does a math calculation, activity usually increases in the *left* hemisphere.

A dramatic demonstration of hemispheric specialization happens before some types of brain surgery. To locate the patient's language centers, the surgeon injects a sedative into the neck artery feeding blood to the left hemisphere, which usually controls speech. Before the injection, the patient is lying down, arms in the air, chatting with the doctor. Can you predict what happens when the drug puts the left hemisphere to sleep? Within seconds, the person's right arm falls limp. If the left hemisphere is controlling language, the patient will be speechless until the drug wears off. If the drug is injected into the artery to the right hemisphere, the left arm will fall limp, but the person will still be able to speak.

Brain scans show that, like humans, dogs usually process words with their left hemisphere and intonation with a right hemisphere region. One study demonstrated that giving praise was ineffective if what the dogs heard didn't match *how* it was spoken (Andics et al., 2016).

To the brain, language is language, whether spoken or signed. (See Chapter 9 for more on how and where the brain processes language.) Just as hearing people usually use the left hemisphere to process spoken language, deaf people use the left hemisphere to process sign language (Corina et al., 1992; Hickok et al., 2001). Thus, a left hemisphere stroke disrupts a deaf person's signing, much as it would disrupt a hearing person's speaking (Corina, 1998).

Although the left hemisphere is skilled at making quick, literal interpretations of language, the right hemisphere

- *excels in making inferences* (Beeman & Chiarello, 1998; Bowden & Beeman, 1998; Mason & Just, 2004). Primed with the flashed word *foot,* the left hemisphere will be especially quick to recognize the closely associated word *heel.* But if given an insight-like problem—"What word goes with *boot, summer,* and *ground?"*—the right hemisphere more quickly comes to a reasoned conclusion and recognizes the solution: *camp.* As one patient explained after a right hemisphere stroke, "I understand words, but I'm missing the subtleties." The right side of the brain is also better than the left at copying drawings, recognizing faces, noticing differences, perceiving emotion, and expressing emotion through the more expressive left side of the face. Right hemisphere damage can greatly disrupt these abilities.

- *helps us modulate our speech* to make meaning clear—as when we say, "Let's eat, Grandpa!" instead of "Let's eat Grandpa!" (Heller, 1990).
- *helps orchestrate our self-awareness.* People who suffer partial paralysis will sometimes stubbornly deny their impairment—constantly claiming they can move a paralyzed limb—if the damage is to the right hemisphere (Berti et al., 2005).

Simply looking at the two hemispheres, so alike to the naked eye, who would suppose they each contribute uniquely to the harmony of the whole? Yet a variety of observations—of people with split brains, of people with normal brains, and even of other species' brains—converge beautifully, leaving little doubt that we have unified brains with specialized parts (Hopkins & Cantalupo, 2008; MacNeilage et al., 2009).

ASK YOURSELF

Why do you think our brain evolved into so many interconnected structures with varying functions?

For a helpful animated review of this research, see ***Topic Tutorial: PsychSim6, Hemispheric Specialization.***

***

In this chapter we have glimpsed an overriding principle: Everything psychological is simultaneously biological. We have focused on how our thoughts, feelings, and actions arise from our specialized yet integrated and wondrously adaptable brain. In chapters to come, we will further explore the significance of the biological revolution in psychology.

From nineteenth-century phrenology to today's neuroscience, we have come a long way. Knowing neuroscience helps us to understand ourselves and our fellow humans. As noted by one of the founders of modern neuroscience, Marian Diamond (2016), "Take away the brain, you take away the person." Yet psychological scientists need to practice intellectual humility: What is unknown still dwarfs what is known. We can describe the brain. We can learn the functions of its parts. We can study how the parts communicate. But how do we get mind out of meat? How does the electrochemical whir in a hunk of tissue the size of a small cabbage give rise to elation, a creative idea, or that memory of Grandmother?

Much as gas and air can give rise to something different—fire—so also does the complex human brain give rise to something different: *consciousness.* The mind, Roger Sperry argued, emerges from the brain's dance of ions, yet is not reducible to it. As neuroscientist Donald MacKay (1978) observed, "[My brain activity] reflects what I am thinking, as [computer] activity reflects the equation it is solving." Mind and brain activities are yoked, he noted, but are complementary and conceptually distinct.

Cells cannot be fully explained by the actions of atoms, nor minds by the activity of cells. Psychology is rooted in biology, which is rooted in chemistry, which is rooted in physics. Yet psychology is more than applied physics. As Jerome Kagan (1998) reminded us, the meaning of the Gettysburg Address is not reducible to neural activity. Sexual love is more than blood flooding to the genitals. Morality and responsibility become possible when we understand the mind as a "holistic system," said Sperry (1992). We are not mere jabbering robots. Brains make thoughts. And thoughts change brains.

The mind seeking to understand the brain—that is indeed among the ultimate scientific challenges. And so it will always be. To paraphrase cosmologist John Barrow, a brain simple enough to be fully understood is too simple to produce a mind able to understand it.

"All psychological phenomena are caused by the brain, but many are better understood at the level of the mind." — Tweet from psychologist Steven Pinker, 2013

REVIEW The Cerebral Cortex

LEARNING OBJECTIVES

Test Yourself Answer these repeated Learning Objective Questions on your own (before checking the answers in Appendix D) to improve your retention of the concepts (McDaniel et al., 2009, 2015).

LOQ 2-11: What four lobes make up the cerebral cortex, and what are the functions of the motor cortex, somatosensory cortex, and association areas?
LOQ 2-12: Is it true that 90 percent of our brain isn't really used?
LOQ 2-13: To what extent can a damaged brain reorganize itself, and what is *neurogenesis?*
LOQ 2-14: What do split brains reveal about the functions of our two brain hemispheres?

TERMS AND CONCEPTS TO REMEMBER

Test Yourself Write down the definition in your own words, then check your answer.

cerebral [seh-REE-bruhl] cortex
frontal lobes
parietal [puh-RYE-uh-tuhl] lobes
occipital [ahk-SIP-uh-tuhl] lobes
temporal lobes
motor cortex
somatosensory cortex
association areas
neurogenesis
corpus callosum [KOR-pus kah-LOW-sum]
split brain

MASTER THE MATERIAL

Test Yourself Answer the following questions on your own first, then check your answers in Appendix E.

1. If a neurosurgeon stimulated your right motor cortex, you would most likely

a. see light.

b. hear a sound.

c. feel a touch on the right arm.

d. move your left leg.

2. How do different neural networks communicate with one another to let you respond when a friend greets you at a party?
3. Which of the following body regions has the greatest representation in the somatosensory cortex?

a. Upper arm

b. Toes

c. Lips

d. All regions are equally represented.

4. Judging and planning are enabled by the ______________ lobes.
5. The “uncommitted” areas that make up about three-fourths of the cerebral cortex are called ______________ ______________.

6. The flexible brain's ability to respond to damage is especially evident in the brains of

   a. split-brain patients.

   b. young adults.

   c. young children.

   d. right-handed people.

7. An experimenter flashes the word HERON across the visual field of a man whose corpus callosum has been severed. HER is transmitted to his right hemisphere and ON to his left hemisphere. When asked to indicate what he saw, the man says he saw ____________ but his left hand points to ____________.

8. Studies of people with split brains and brain scans of those with undivided brains indicate that the left hemisphere excels in

   a. processing language.

   b. visual perceptions.

   c. making inferences.

   d. neurogenesis.

9. Damage to the brain's right hemisphere is most likely to reduce a person's ability to

   a. recite the alphabet rapidly.

   b. make inferences.

   c. understand verbal instructions.

   d. solve arithmetic problems.

Continue testing yourself with **LearningCurve** or **Achieve Read & Practice** to learn and remember most effectively.