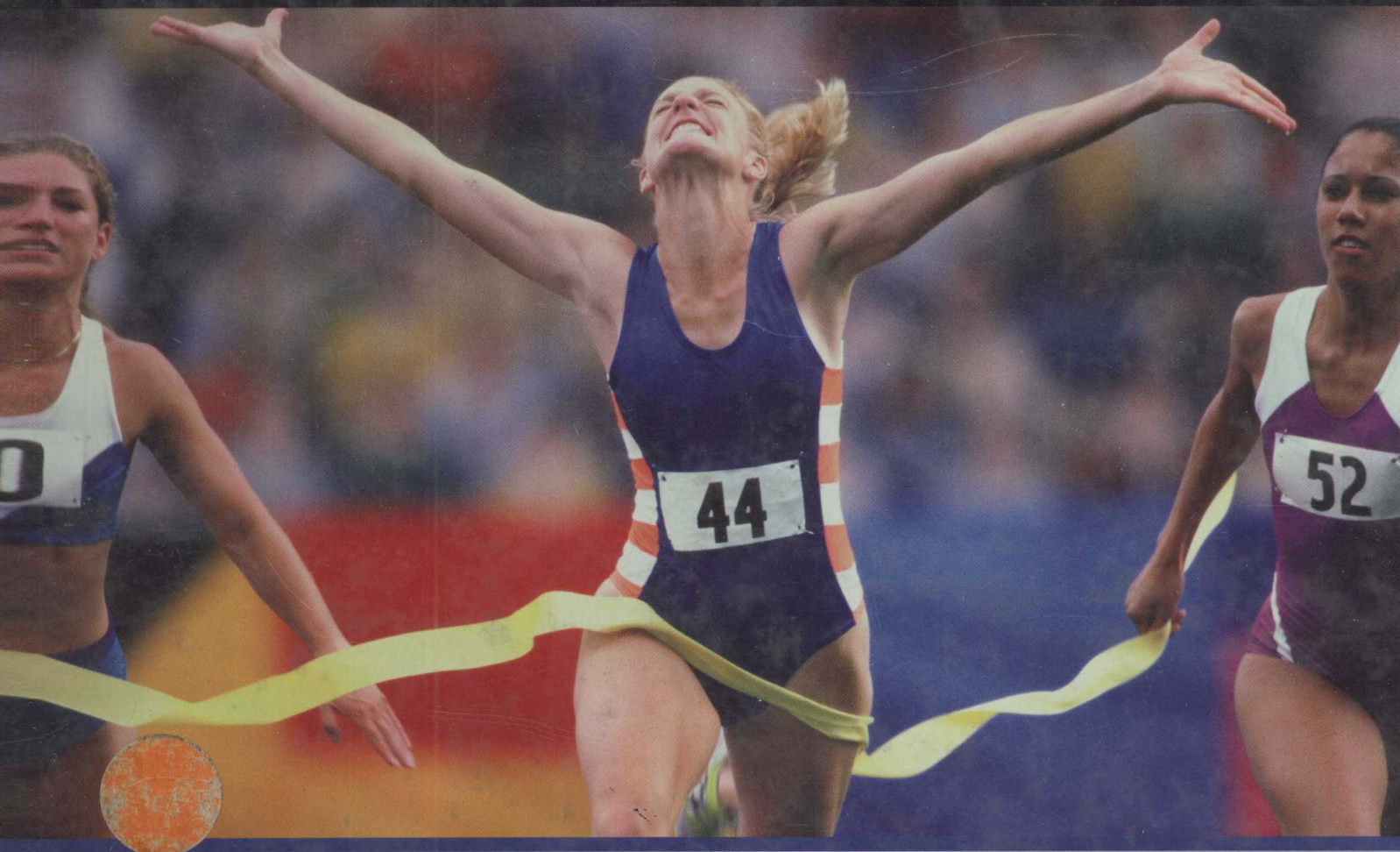


MIND, BRAIN,
AND
BEHAVIOR

Psychological Science

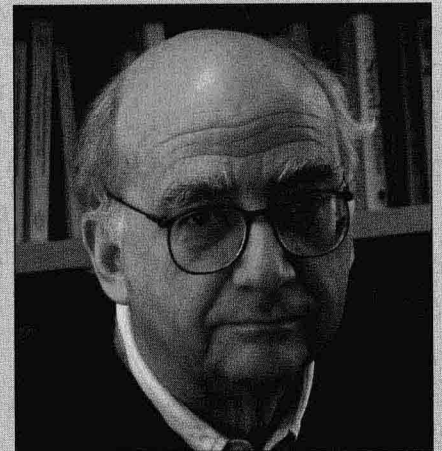


GAZZANIGA AND HEATHERTON

PSYCHOLOGICAL SCIENCE

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PREFACE

THE INSPIRATION AND GOALS

The idea to write this textbook emerged about five years ago during a series of casual conversations between two colleagues, one a brain scientist, the other a social/personality psychologist. In many psychology departments, these sorts of conversations are rare, as increasing specialization within subfields of psychological science has produced less and less common ground for discussion. As we talked, we discovered that we had a great deal to learn from one another—brain science uses exciting and innovative methods to explore the biological basis of the working mind; social psychology studies problems central to everyday human existence. As our regular conversations continued, it became clear that the perceived chasm between us was not so great and that we could begin to bridge the gap. Over time, we witnessed the common ground between us expanding, providing new insights that would not have been possible without integrating the biological with the social. We were energized by our discussions, as we came to realize that this was a model approach for twenty-first century psychological science.

Our most important point of agreement was that without cross-disciplinary interaction and communication among scientists there could be no full understanding of the workings of the human mind. For instance, social, personality, clinical, and developmental psychologists have developed elaborate theories and models of behavior, but most of these theories fail to consider underlying neurobiological functions or structures. At the same time, neuroscientists have made tremendous gains in understanding the link between brain and behavior, but too often these findings are not informed by the social and cultural contexts that shape and guide human lives. We believe that it is becoming increasingly important for so-

cial psychologists to recognize that brain mechanisms are involved in producing social behaviors, while neuroscientists must begin to appreciate that brains interact in social contexts, in which cultural values and beliefs shape the way that people perceive the world. We further believe that crossing traditional boundaries to consider the biological with the social will energize both approaches and provide new perspectives and ideas. This textbook presents our areas on equal footing, because both are indispensable to developing a rich and integrated understanding of the mind, brain, and behavior.

One of our early discussions focused on teaching introductory psychology. We are committed to providing students with material that invigorates as it informs, and we believe that students should learn about exciting new advances in psychological science. Yet, the traditional approach to teaching introductory psychology fails to reflect fully the dramatic changes that have occurred within the discipline. The field of psychology is undergoing a revolution. It now incorporates a much greater biological perspective within its scope. In this exciting time, traditional psychological questions are being examined by a rich mixture of scientists, including evolutionary biologists, cognitive scientists, neuroscientists, and computer scientists. We have found, as have many of our colleagues, that it is rewarding to introduce these new ideas to psychology students, who are fascinated with the workings of the human mind as it navigates a complex, social world.

One of the challenges in teaching this new approach to psychology is that few if any of the traditional texts available for introductory college courses present this paradigm shift and its accompanying interdisciplinary synthesis. There is pressing need for a book tailored to delve into the rigorous

sciences that comprise the essence of psychological thought. Books on the cutting edge in the 1970s (with their focus on information processing) and the 1980s (with their focus on cognition) do not reflect the field that emerged during this “decade of the brain.” The emphasis on brain mechanisms is reinvigorating research on classic questions as well as shaping the problems that psychologists are addressing. This emphasis can be seen throughout psychological science. For instance, many social and personality psychologists are now interested in the neuroscientific basis of person-perception, social cognition, and interpersonal behavior. At the same time, researchers in the brain sciences have gained a greater understanding of the neural basis of social cognition, emotion, and personality. The enthusiasm for these new perspectives is clear in the best psychological journals and in the priorities of granting agencies, but it is less well represented in traditional books that introduce students to psychology.

We therefore decided to try to produce an introductory text that would satisfy the goals we identified as the most important: to be scientific, integrative, fun to read, succinct, and less detailed. We have focused on theory and research that crosses various levels of analysis, considering each of psychology’s topic areas from multiple levels. Throughout the history of psychology, researchers have typically worked at one level of analysis, and they pursue their questions independently of researchers working at other levels. It is only recently that explanations for behavior are commonly reported in terms of several levels of analysis. It is this crossing of levels that many of us find so captivating. We believe that students benefit from considering research topics from multiple perspectives and dimensions.

In our attempt to write a concise rather than encyclopedic textbook, we chose to focus on the principles of psychological science that provide students with sufficient knowledge to understand research findings across areas of psychology, without inundating them with qualifications, exceptions, and complexities that are of greater interest to scholars conducting psychological research, graduate students completing their dissertations, or advanced psychology majors. It is challenging enough to consider the main areas of psychology within a quarter, semester, or even a full year, let alone to gain a comprehensive understanding of the entire field. Indeed, throughout writing this book we have continued to find that the greatest challenge is in deciding what *not* to include. There is so much fascinating research taking place around the globe that difficult choices had to be made in each section. Of course, we expect that instructors will supplement the text with more in-depth discussion of topics they find personally interesting and important, which in our experience brings vitality to the teaching of psychology.

We wrote this textbook first and foremost for the benefit of students. Like many instructors, we have had difficulty

finding a rigorously written text pitched perfectly for the typical undergraduate student. Most of today’s books are at too high or too low a level, too soft or too hard. In writing this text, therefore, we tried to strike the right balance. We made every effort to describe material that is occasionally technical and complex in terms that students can understand, believing that it is most important for introductory students to appreciate the basics before tackling the subtleties. As a rule, we tie behavioral examples and applications to the neuroscientific discussion throughout the text. We also tried to avoid jargon as much as possible, and to minimize the number of key terms that require formal definition, believing that the ideas are more important than the particular words used to describe them. Moreover, we chose to write in a declarative style, focusing on providing answers to the important questions within the topic areas of psychology. Our “ask and answer” approach serves as the pedagogical foundation for the book. Each chapter consists of a series of “big questions” that are answered in subsequent sections. Our use of declarative headings reflects our belief that psychological scientists have made headway in providing answers to these questions—perhaps not the final answers, as new research helps shape our thinking, but answers that summarize what psychological scientists have discovered about mind, brain, and behavior.

In writing this book for students, we also made a conscious decision to limit the number of citations in the text. We have talked with many of our colleagues who also teach introductory psychology. There is a growing consensus that, in teaching general psychology, long citation lists detract from the narrative and may well reinforce students’ natural tendency to memorize rather than comprehend ideas and concepts. We formulated a middle ground in which we cite specific studies, major controversies, and classic papers, without overloading the text with additional research citations. Students will find sufficient information to conduct literature searches on topics they find interesting. Especially with the growth in electronic resources available to many students, we believe that students who are captivated by specific topics will be able to find additional information from their libraries or the World Wide Web. Finally, in our attempt to reflect the past accurately, we cite the most relevant rather than the most recent examples of research findings. Even as we appreciate the value of providing the most up-to-date information on each issue, we believe that there is also value in keeping true to the historical record.

Our textbook is intended for both students who wish to pursue careers in psychology and those for whom this course will be their only exposure to psychology as a science. Students using this text will gain an integrated grounding in traditional psychology as well as an introduction to new approaches within psychological science. The material is by nature intellectually challenging, but we have tried to make it

accessible and enjoyable to undergraduates as well as directly applicable to their lives. Students will satisfy their curiosity about psychological phenomena and will learn to think critically about issues and themes in psychological science. Students also will develop greater self-understanding and understanding of others.

Four themes that characterize psychological science run through the chapters. (1) Psychological science is cumulative, in that principles are established based on incremental advances in knowledge obtained through research. (2) A biological revolution has been energizing psychological research. Increasing knowledge of the neurochemistry of mental disorders, the mapping of the human genome, and the invention of imaging technologies that allow researchers to observe the working brain in action have provided psychological scientists with the methods to examine how the brain enables the mind. (3) The mind is adaptive. The brain has evolved to solve everyday problems, and evolutionary psychology has had an increasing impact on the field in recent years. (4) Crossing the levels of analysis shows the various ways in which psychological scientists work on the same problem or issue, but from different levels of analysis and perspectives, from the molecular to the societal.

Although our book introduces a somewhat radical change in the scope of material, we did not want to sacrifice the rich tradition of psychological theory and research. We wanted to introduce students to the central themes and issues that have shaped the field's development, such as the questions of nature versus nurture, structure and function, determinism versus free will, and person versus situation. Thus, the organization of the textbook will be familiar to most psychology instructors, even if they do not teach the material in the specific order it is presented.

One of the joys of writing this book is that it provided a great reason to continue our ongoing conversations. We met regularly to discuss each section and we sought to make sure that we both contributed to each chapter, at a minimum providing commentary and suggestions for what ought to be included and where topics were most effectively discussed. Sometimes this meant presenting certain topics in chapters other than where they typically appear in introductory textbooks. Again, crossing the levels of analysis means that certain topics could conceivably appear in any number of chapters.

As the book started to take shape, we paused to reflect that it had shaped us as well. No longer pure brain scientist and pure social/personality psychologist, we now meet as psychological scientists. Indeed, we began collaborating on interdisciplinary research, such as examining the neural correlates of self using brain imaging and split-brain patients. We have taken to heart the message of our text that greater scientific progress will be made from crossing the levels of analysis. We

hope that our textbook helps narrow the gaps between areas in other departments, as psychological scientists come together to understand mind, brain, and behavior.

TOUR OF PSYCHOLOGICAL SCIENCE

Chapter 1 ("Introduction to Psychological Science") sets the stage for the book. We introduce students to psychological science by providing engaging examples of psychological questions that address central themes in psychology, and we briefly trace the historical background of psychological research to answer those questions. The overall orientation stresses the importance of considering the mind as an evolved mechanism for solving adaptive problems. To understand the mind, the student needs to understand how the brain works, how the mind interprets the environment, and how social environments and culture shape behavior. We end this provocative chapter with a section on potential careers in psychology and a discussion of the importance of critical thinking for consumers of psychological research.

Chapter 2 ("Research Methodology") covers the major methods in sufficient detail so that students understand the techniques and strategies used by psychological scientists to examine the working mind and its social consequences. We make the important point that the research question dictates the methods used to answer the question. In addition to basic experimental design, we introduce students to methods used to examine the brain, from neuropsychological assessment to new methods of brain imaging. This information serves as the foundation for understanding research findings and the importance of using empirical methods to assess brain and behavior. We also include a brief description of statistical techniques, here rather than in the appendix, because it is important for students to appreciate how researchers are able to draw conclusions based on their analysis of data.

Chapters 3 and 4 focus on genetic and biological foundations of psychological science. Many introductory textbooks try to cover all of this information in one chapter, presenting laundry lists of important anatomical and functional terms. By providing more information in two medium-length chapters, we give students more time to learn the material. Whereas most general psychology books leave the biological underpinnings of behavior behind after one chapter, *Psychological Science* draws on this foundational information in every chapter. Chapter 3 ("Genetic and Biological Foundations") provides students with an introduction to genetics and the basic processes of the nervous system. We enliven the discussion of the nervous system by focusing on neurotransmitter receptors

and their influence on emotions and behavior. We emphasize that all psychological activity results from the integration of billions of connections between nerve cells in different regions of the brain and body. We discuss how neurons form selective networks that underlie all psychological activity and serve the working mind. The interaction of the nervous system and endocrine system is also discussed. Chapter 4 (“The Brain”) introduces students to functional neuroanatomy, beginning with an historical view of brain function and dysfunction and progressing to the central issue of whether brain function is localized or distributed throughout the brain. The student is then introduced to gross anatomical and functional subdivisions of the brain. The emphasis, however, is on how the brain works rather than on what the various parts are called. We are not exhaustive with labels but rather introduce students to brain systems and regions that are important for understanding the mind. Considerable attention is given to cerebral lateralization and specialization, with vivid examples from split-brain patients. Common neurological impairments are also discussed.

Chapter 5 (“Sensation, Perception, and Attention”) provides a foundation for understanding how the brain senses and perceives the world. Following a discussion of historical approaches to understanding the basis of human knowledge, essential issues in sensation and perception are presented, with an emphasis on how the brain has evolved to make sense of the world. We then discuss how each of the senses work and describe typical dysfunctions within each sense. Finally, we consider how attentional processes influence people’s perceptions of the world.

Chapters 6 and 7 (“Learning and Reward” and “Memory”) discuss the foundations of learning and memory. Learning theory has a rich tradition in psychological science and is important for understanding most psychological phenomena. We consider the historical record in sufficient detail to provide students with the vocabulary necessary to understand the basic principles of classical and operant conditioning, and then we explore the way that contemporary cognitive neuroscience explains learning. We include a detailed discussion of the biological basis of reward in chapter 6 (rather than in the motivation chapter) in order for students to consider what it means for something to be reinforcing. We also consider recent evidence of the neuronal basis of conditioning. Finally, we consider examples of observational learning, including an in-depth discussion of the effects of media on aggressive and health behaviors. We should also note that various contemporary theories and findings involving learning can be found in chapters throughout the book, which reflects the universal quality of this fundamental behavioral phenomena. The memory chapter re-

views the many new and exciting approaches to understanding memory. Following a brief historical discussion of stages of memory, we explore the distinction between implicit and explicit memory. A central focus of the chapter is the neurological and neuronal basis of memory, with classic and contemporary examples of how brain injury interferes with explicit recall. We discuss false memories, including evidence suggesting that such memories are differentiable from authentic memories using brain-imaging techniques. We also consider the practical aspects of human memory, such as the ability to serve as eye-witnesses and the role of motivation and social context in shaping what we remember.

Chapter 8 (“Cognition”) considers how people think, including what it means to think intelligently. The cognitive sciences have advanced our basic understanding of how people acquire and use knowledge. Although rooted in psychological science, the study of cognition is central to the interests of philosophers, computer scientists, evolutionary biologists, and statisticians, among others. This chapter introduces students to the central themes that reflect how the mind thinks and solves adaptive problems. We discuss a variety of obstacles and shortcuts involved in problem solving, such as mental-set and heuristic processing, and we consider whether human decision making is rational or adaptive. We also discuss what is meant by the term *intelligence*, including a discussion of alternative conceptions of what it means to be smart.

Chapter 9 (“Motivation”) presents an overview of the factors that motivate behavior. This chapter demonstrates the need to consider biological, cognitive, and social factors in order to develop a satisfactory understanding of why people “choose” to engage in specific behaviors. We consider motivation in its adaptive context, with an interpretation based on evolutionary principles. This chapter also introduces the idea that societal and cultural preferences shape what is valued and dictate the goals that people pursue. This chapter examines human self-regulation and achievement motivation in a way that encourages students to think about their short-term and long-term goals. Eating and sleep are considered in detail, as they provide excellent examples of various aspects of motivation.

Chapter 10 (“Emotions, Stress, and Coping”) considers the foundations of emotional processes, as well as how people succeed and fail in coping with the stress of daily living. There has been an explosion of research in emotion over the past decade, and this chapter summarizes what has been learned, emphasizing cognitive neuroscience and evolutionary adaptiveness. We start by considering the functional nature of emotions, both the short-term functions for the person and

long-term adaptiveness for the species. For instance, social emotions such as guilt are viewed as adaptive mechanisms that strengthen social bonds and satisfy a fundamental need to belong. Most textbooks ignore guilt, even though most people report guilt as a major source of motivation and displeasure in their lives. This section encourages students to consider why negative interpersonal motives might have evolved. We then review classic theories of emotion with a thorough discussion of cognitive appraisal models. We also describe the physiology and neurochemistry of emotional experience, with an emphasis on the integration of cognition and emotion in the limbic system. Finally, we consider contemporary approaches to understanding stress and coping, including some provocative ideas about gender differences in coping with stress.

Chapters 11 and 12 ("Cognitive and Language Development" and "Social Development and Gender") look at how humans develop. We begin by examining the foundations of cognitive development and language. Chapter 11 focuses on the skills that exist at different times in development, without rigidly adhering to the notion of stages. Following a discussion of the capacities of newborns, we review what is known about cognitive development within specific domains. Such an approach is faithful to the research efforts of contemporary developmental psychologists. One of the most important developments in childhood is the capacity for language, and this topic receives careful consideration. Our focus is on how language facilitates communication rather than on lexical content. Finally, we consider how cognitive processes change during adolescence and aging. Chapter 12 begins our discussion of humans as social animals. We start with the assumption that evolution has adapted a fundamental need to belong. We consider the role of caregivers and discuss the influence of parenting styles while considering issues of temperament and genetics. We then spend considerable time discussing the scientific basis of friendships, a topic that is of utmost importance to undergraduates, but virtually ignored in most introductory textbooks. Finally, we consider the role of biology and culture in sex and gender differences. We review current evidence of cross-cultural consistency in sex differences while explaining how cultural expectations shape gender roles.

Chapters 13 and 14 ("Self and Social Cognition" and "Interpersonal Processes") focus on topics related to social psychology. These issues are some of the most interesting to undergraduates, especially because of the wonderful creativity associated with classic social psychology studies. The first of the two chapters focuses on how individuals perceive their social worlds. It begins with an examination of the personal sense of

self, including self-awareness and self-esteem. We discuss the literature demonstrating that humans have self-serving motivational biases and the possible negative interpersonal consequences of such biases. We also examine the influence of impression management and culture on self-concept. We then expand from attitudes about the self to attitudes about objects and other people. For instance, we examine possible reasons for racism and prejudice and discuss how they might be reduced. We include new perspectives on social psychological phenomena that share common theories and methods with cognitive neuroscience. Whereas Chapter 13 focuses on how individuals perceive their social worlds, Chapter 14 looks at interactions between individuals. This chapter emphasizes the important point that humans have evolved as social animals and that much of human behavior and experience is shaped by social contacts. This chapter is an in-depth look at social interaction and includes discussion of nonverbal communication and interpersonal relationships. We also consider how the need to belong to groups leaves people susceptible to influence from others and can lead to their acting in obedient and conforming ways. The essential theme is that human survival has long depended on group living, and therefore people are motivated to maintain their affiliation and status within the group.

Chapter 15 ("Personality") is a somewhat radical departure from historical treatments of personality. Most textbooks describe personality as it was conceived of more than 40 years ago, with an emphasis on unconscious Freudian processes and social-learning experiences. Yet, recent research has provided compelling evidence that human personality is determined to a large extent by genetic and physiological mechanisms. This chapter focuses on research by contemporary psychologists who have made considerable strides in understanding the development and structure of human personality. We cover traditional topics, such as Freudian and trait theory, but we emphasize a neuroscience approach to personality, examining genetic, biological, and cognitive factors. Finally, we consider whether people can change their basic personalities.

Chapters 16 and 17 consider mental disorders and their treatment. Chapter 16 ("Disorders of Mind and Body") introduces students to well-known and reasonably common forms of psychopathology. We begin by discussing and critiquing various philosophical, statistical, and functional approaches to characterizing mental illness. We then describe the essential features of each disorder and discuss various etiological theories. Vivid case studies are used to illustrate symptoms and assessment. We include expanded coverage of childhood disorders, as they are typically ignored in introductory textbooks and it is our experience that students find these disorders especially interest-

ing. The final chapter (“Treating Disorders of Mind and Body”) examines the theoretical basis of psychotherapy, as well as typical treatments and outcomes. Following a discussion of treatment goals, we introduce students to the most common types of therapy. Although we mention classic psychological treatments, we emphasize the types of treatments most widely used by contemporary therapists. We consider treatments for anxiety disorders, depression, and schizophrenia in detail, with special attention to the empirical evidence for successful outcomes. We also consider evidence that social context and familial influences play a major role in therapeutic success.

A PEDAGOGICAL PROGRAM THAT REINFORCES PSYCHOLOGICAL SCIENCE’S CORE PRINCIPLES

I. OVERVIEW

Psychological Science’s chapters are built around major principles, which are addressed through the “ask and answer” approach. Each chapter focuses on approximately 4–6 major principles, which are first raised in the form of questions (“ask”). Each major section in a chapter then discusses one of these questions (“answer”).

Outlining the Principles: This pedagogical feature at one level serves as a simple outline or road map for the chapter. At another level, it clarifies what major principles will be covered in the chapter. Major heads are questions. Minor heads are declarative statements that reveal the current state of knowledge about the larger principles and concepts.

Chapter Timelines: *Psychological Science* is built on cumulative knowledge and experience. This is one of the major themes of the text. Basic principles, both new and old, inspire and guide thinking and research in the field. The timelines highlight major developments within the various domains of psychology.

Research Questions for Studying. . . : *Psychological Science* captures the excitement of contemporary ideas and research driving the field today. The research questions highlighted in the opening pages of every chapter suggest the kinds of questions that researchers are exploring. These questions reappear in the margins throughout a given chapter to alert students when the relevant issues are being discussed. This is another dimension to the “ask and answer” approach.

“Ask and Answer” Running Heads: *Psychological Science*’s left-hand running heads emphasize the greater topics, as the right-hand running heads repeat the questions that are explored in each section. The heads help students stay focused on the larger issue as they try to see the forest for the trees.

Reviewing the Principles: These boxes are a critical component to the “ask and answer” approach and appear at the end of each major section. They repeat the question that governed the section and provide a basic answer that highlights key points for students to remember.

Defining the Principles: *Psychological Science* has a marginal glossary running throughout each chapter as well as a glossary at the end of the book and on the companion Web site. Many books highlight an overabundance of key terms for students to memorize. In keeping with this book’s focus on core principles and concepts, *Psychological Science* highlights approximately 30 key terms per chapter.

Summarizing the Principles: This is the last key component to the “ask and answer” approach. *Psychological Science*’s brief chapter conclusions highlight the big ideas and concepts covered and remind students how the book’s four key themes wove their way through the chapter. After reading the chapter conclusion, students may want to reread the “Reviewing the Principle” sections to emphasize what they have learned and what they haven’t.

II. PSYCHOLOGICAL SCIENCE’S USE OF ART AND CITATIONS

A Dynamic Art Program: The visual materials in *Psychological Science* add substantially to the students’ experience. The book contains a variety of visual materials, from photographs to tables and charts to drawn art. The emphasis in *Psychological Science*, however, is clearly on the drawn art. Having used many general psychology books ourselves, we wanted to take our text in a new direction. By featuring drawn art, *Psychological Science* is able to convey precisely, accurately, and meaningfully what the students need to gain from every image. This high level of precision can’t be gained from the use of the stock photographs common in many texts.

Selective Use of Citations: *Psychological Science* embraces the notion that students should be introduced to material in a narrative style that focuses on ideas, concepts, and empirical findings rather than on specific researchers. At the same time, the text includes sufficient citations so that students can pursue topics of interest and so that they appreciate that

psychological science is based on published empirical research. We have selected essential citations that we hope most teachers would agree are central to a first-year student's exploration of psychological science, and we have cited them in a way that should not distract from the narrative voice.

III. PSYCHOLOGICAL SCIENCE'S SPECIAL FEATURE BOXES

Every chapter following the introduction contains one of each of the following feature boxes, which are designed to amplify the text's basic strengths:

Studying the Mind feature boxes highlight examples of psychological phenomena that fascinate as well as inform. These often describe case studies that reveal intriguing aspects of the biological basis of the mind, such as the effect of brain injury on motivation, emotion, and personality.

Using Psychological Science feature boxes address questions relevant to students. For example, Is there such a thing as photographic memory? Why do New Year's resolutions often fail? What is the effect of birth order on personality?

Crossing the Levels of Analysis feature boxes explain how significant advances in our understanding of complex psychological phenomena have emerged from research that crosses interdisciplinary boundaries. We explore how psychological scientists are approaching each topic from molecular to societal levels, and how interdisciplinary teams of scientists are providing compelling new insights based on this synthesis.

PSYCHOLOGICAL SCIENCE'S ANCILLARIES REINFORCE THE TEXT'S BASIC STRENGTHS

STUDY GUIDE TO ACCOMPANY PSYCHOLOGICAL SCIENCE BY BRETT BECK (BLOOMBURG UNIVERSITY) AND JEFF HENRIQUES (UNIVERSITY OF WISCONSIN-MADISON)

Created by two highly successful instructors of large lecture classes, this carefully crafted study aid offers a guide to the reading with helpful study advice, completion questions, key figure exercises, multiple-choice self-tests, and thought questions.

STUDENT WEB SITE TO ACCOMPANY PSYCHOLOGICAL SCIENCE: WWW.WWNORTON.COM/PSYCHSCI

Designed to help students learn the basic principles of psychological science, this highly interactive Web site offers a rich array of exercises and opportunities to explore human behavior. Access is free to every student.

For every chapter there is

- an animated timeline that highlights research milestones
- a guide to the reading that offers helpful advice
- a list of key terms linked to an on-line glossary
- a crossword puzzle that tests recall for new vocabulary
- multiple-choice tests with answer feedback
- a rich collection of activities that features animations of hard-to-visualize concepts, media-enhanced essays with assignable thought questions, on-line labs, and topics for further reading.

INSTRUCTOR'S RESOURCE MANUAL TO ACCOMPANY PSYCHOLOGICAL SCIENCE BY GEORGE SPILICH (WASHINGTON COLLEGE)

Prepared by a master teacher from a small liberal arts college who cultivates an active learning environment. Available to all adopters.

Each chapter of the *Instructor's Resource Manual* includes the following:

- I. Chapter Objectives
- II. Key Concepts and Theories
- III. Lecture Resources
 - a. Ticket In/Ticket Out Assignments
 - b. Five-Minute Lecture Launchers
 - c. Classroom Demonstrations
 - d. Topics for Classroom Discussion
 - e. Link Library
- IV. Index of Norton Media Resources (see description below).
- V. Additional Resources (resources, citations, suggested films and readings).

NORTON TESTMAKER TO ACCOMPANY PSYCHOLOGICAL SCIENCE BY KATHLEEN VOHS (UNIVERSITY OF UTAH).

This carefully crafted test-item file includes over 2,000 multiple-choice questions of varying degrees of difficulty. The Norton TestMaker allows instructors to add and edit their

own questions, control test design and layout, print several versions of the same test, and create optional on-line testing modules. Available to all adopters.

NORTON MEDIA LIBRARY

This collection of PowerPoint slides for instructors includes lecture outlines, line art from the text, classroom demonstration resources, and animations optimized for classroom display. Available to all adopters.

TRANSPARENCIES TO ACCOMPANY PSYCHOLOGICAL SCIENCE

These full-color acetates reproduce a wide selection of the drawn art that appears throughout the text.

STUDYING THE MIND: INTERVIEWS TO ACCOMPANY PSYCHOLOGICAL SCIENCE (VHS)

Filmed at Dartmouth College's Summer Institute for Cognitive Neuroscience, and featuring original footage exclusive of Norton, this guest lecturer series was developed to help

bring examples of current brain-science research into the introductory psychology lecture. These five to seven minute segments feature well known neuroscientific researchers like Marcus Raichle • Robert Knight • Mark D'Esposito • Mike Gazzaniga • John Gabrieli • Elizabeth Phelps • Marcia Johnson • Morris Moscovitch • Helen Neville • Denise Parks • Patricia Reuter-Lorenz. Available October 2002. Free to qualified adopters.

NORTON RESOURCE LIBRARY ([HTTP://WWW.WWNORTON.COM/NRL](http://www.wwnorton.com/nrl))

An on-line site designed to house all available electronic *Psychological Science* resources from the test bank to PowerPoint slides to video clips. All of these resources are readily uploadable into WebCT and Blackboard environments. Available to all adopters.

NORTON VIDEO LIBRARY

A collection of first-rate documentary films focusing on psychological science drawn from the *Films for Sciences and Humanities* catalog and other fine video collections. Available to qualifying adopters.

ACKNOWLEDGMENTS

Writing this textbook has been both demanding and rewarding. Perhaps the most apt analogy is raising children, an all-consuming labor of love in which daily effort, occasional frustration, and frequent sacrifices yield to the joys of parental pride, as we watch in amazement as our children blossom and grow. This book is dedicated to our children, who have given us the strength and motivation to persevere. We are putting the final touches on this preface on a spectacular Sunday morning in New England, a time that is typically reserved for family. Our wives, Charlotte Gazzaniga and Patricia Heatherton, are, as ever, understanding of our absence. We begin by thanking them for their support, composure, and good humor. Both have advanced degrees in psychology and have listened patiently and provided helpful commentary when we have struggled to explain technical details in a manner comprehensible for students. Both are insightful and pragmatic, and the textbook has benefited greatly from their participation in the writing process.

We are grateful recipients of phenomenal support from our colleagues during all phases of writing this textbook. Many people were particularly helpful in developing and organizing the content of specific chapters. We especially wish to thank Margaret Funnell, Todd Handy, Paul Corballis, Kathleen Vohs, Ian Wickersham, Abigail Baird, and Marin Gazzaniga. Many of our colleagues in the Department of Psychological and Brain Sciences at Dartmouth read sections, gave advice, or provided expert commentary, notably Ann Clark, William Kelley, George Wolford, Robert Leaton, Jay Hull, Howard Hughes, and especially Laura Ann Petitto. We are grateful to them for their expertise. We also benefited from the astute guidance of Endel Tulving, Steve Marcus, Michael Ullman, Steven Pinker, Roy Baumeister, Thomas Joiner, David Funder, Jane Gillette, Mikki Hebl, Peter Ruscitti, George Spilich, and many others who were willing to discuss their teaching goals for introductory psychology and their beliefs about what works and what doesn't work in introductory textbooks. We are also grateful to our exceptionally talented supplements authors: George

Spilich (Washington College) who authored the Instructor's Resource Manual and developed activities for the companion Web site, Brett Beck (Bloomsburg University) and Jeff Henriques (University of Wisconsin-Madison) who authored the Study Guide, with George and Kathleen Vohs (University of Utah) who created the test item files. We are grateful to Bobbi Walling for pulling together materials for the glossaries, and Lisa Jones and Tina Wilcox for helping to keep us organized. We especially applaud the contributions of Rebecca Townsend, who not only administers the Center for Cognitive Neuroscience, but also happens to be an amazing proofreader.

There are many people at W.W. Norton who served critical roles in bringing this textbook to realization. First and foremost, we thank Jon Durbin, our editor and friend. Jon was a true believer from the earliest days of the book and has been essential at every step of the process. Jon walks a fine line between motivating and mercilessly badgering his authors, but he does so because he is committed to moving his authors to the highest levels they can attain. Jon pushed us to consider, reconsider, and reconsider again nearly every section of the textbook. His unflagging encouragement and frequent pep talks helped us stay true to the mission of producing a cutting-edge textbook that reflects the excitement of contemporary psychological science. The book would not have been possible without him and the inspiring energy and enthusiasm he brings to his work.

Our developmental editor, Joanne Tinsley, was superb. Every chapter benefited from her exceptional ability to understand the big picture and organize the material in the best possible fashion. She was brutal with us when she needed to be and she galvanized us to push the limits of traditional texts as we sought to achieve our goals. The copy editor, Kate Lovelady, made sure that not a single word was in the textbook that did not need to be there. Her ability to tighten text is stunning. Kim Yi, the project editor, kept the entire manuscript on track with her truly spectacular organizational skills and good humor. Aaron Javasicas performed essential editorial and production

duties flawlessly. Neil Hoos and his photo research team did an exceptional job conceiving of an integrated art program composed of the highest quality photography for the book. Rubina Yeh receives the highest credit for a lively and gorgeous book design that graphically serves both as the pattern and as the fabric that ties together all its individual components. We are also grateful to Frank Forney for his incredible art. His drawings are some of the finest to appear in any science textbook, and he managed to create many of these from vague ideas provided by the authors. As all general psychology instructors know, the quality of the supplements and media package play an ever-more-important role in the success of a textbook. We give special thanks to April Lange for all her creative talents and her ability to put together a high-quality team of front-line instructors to create a package that reinforces and builds upon the book's strengths. In each case, the final product is just what we wanted—first rate. Finally, we thank Roby Harrington, director of the College Division, and Drake McFeely, president of W.W. Norton, for their faith in us.

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PREFACE FOR STUDENTS

DEAR STUDENT:

Our most important overarching goal for this textbook was to write it first and foremost for you, the student reader. We know that many of you are drawn to psychology to find out more about what makes you and those you know tick. We also know from our own teaching experiences in recent years, that many of you are highly interested in learning more about how the human mind works and what that means for you in everyday life. Thus, as you search for insights into the human experience, we have made every effort to focus on core psychological principles and ideas to provide a starting point (and sometimes the end point) for your quest. Our focus on principles is reinforced by the “ask and answer” approach that serves as the pedagogical foundation for the book. Each chapter consists of a series of “big questions” that focus on major psychological principles and concepts. These questions are answered in subsequent sections. Our use of declarative headings reflects our belief that psychological scientists have made headway in providing answers to these questions—perhaps not the final answers, as new research helps shape our thinking, but answers that summarize what psychological scientists have discovered about mind, brain, and behavior.

Psychological Science is intended for both those of you who wish to pursue careers in psychology and those for whom this course will be your only exposure to psychology as a science. While using this text, you will gain an integrated grounding in traditional psychology as well as an introduction to new approaches within psychological science. The material is by nature intellectually challenging, but we have tried to make it accessible and enjoyable to you as well as directly applicable to your life. We hope that *Psychological Science* spurs on your curiosity about psychological phenomena and that you will learn to think critically about issues and themes in psychological science. In the end (or the beginning!), we hope that you will also develop greater self-understanding and understanding of others.

Before you begin to read the first chapter, please take a few minutes to study the following pages so that you can gain a full understanding of how to get the most out of reading *Psychological Science*.

— S. G. — — Todd Heathcote —

GUIDED CHAPTER TOUR FOR STUDENTS

1 OVERVIEW *Psychological Science's* chapters are built around core principles. The "ask and answer" approach serves as the structure and foundation for every chapter and is designed to reinforce these principles. Each chapter focuses on approximately 4–6 major principles, which are first raised in the form of questions ("ask"). Each major section in a chapter then looks to "answer" one of these questions. Here is how it works in action.

PUTTING COGNITIVE FUNCTIONS TO THE TEST
Over the decades, standardized tests, such as those given at the International Mathematical Olympiad, have been designed to measure intelligence. However, critics maintain that such tests ~~measure~~ *reflect* intelligence ~~not~~ *do not* predict the abilities of a given individual. Most researchers now agree that intelligence is determined by a combination of genetics and environment, and cannot be understood without considering a person's cultural and social background.

HOW DOES THE MIND REPRESENT INFORMATION?
Representations Can Take Different Forms
Distributed Representations Focus on Neural Implementation
Concept-Based Models Are About Classifying Things
Contextual Models Are About Interpreting Scenes

WHAT DOES INTELLIGENCE REFLECT?
Definitions and Measures Depend on Context
Intelligence Has a Modular Structure
Genes and Environment Both Influence Intelligence

HOW DO WE SOLVE PROBLEMS AND MAKE DECISIONS?
The Gestalt Model Emphasizes Insight and Structure
The Information-Processing Model Is Based on a Solution Space
Normative Theories Focus on Rational Behavior
Descriptive Theories Develop the Psychology of Decision Making

CAN WE STUDY CONSCIOUSNESS?
Philosophers Debate the Nature of Mind-Brain Relations
Definitions of Consciousness Allow Its Empirical Study
Unconscious Processing Influences Awareness
Awareness Has Many Seats in the Brain

CONCLUSION
FURTHER READINGS

TIMELINE

1600s
The Mind is a Substance
Frenchman René Descartes champions the philosophy of dualism, which develops the view that the mind and brain exist as two separate entities.

1884
Defining Intelligence
Sir Francis Galton opens his Anthropometric Laboratory, where people can measure the sensitivity of their sensory systems; the property that Galton proposes is the basis for intelligence.

1890
The Need to Study Consciousness
In *The Principles of Psychology*, William James argues that any complete account of the mind must consider the different states of consciousness commonly experienced by humans.

1905
Intelligence Quotient
Alfred Binet and Théodore Simon develop the first intelligence test. They later develop the concept of intelligence quotient, or IQ.

1931
Problem Solving Involves Insight
Wolfgang Köhler reports that after long contemplation, an ape joined two sticks together in order to reach a banana, suggesting that problem solving in animals involves more than random trial and error.

1947
Decisions Are Rational
John von Neumann and Oskar Morgenstern publish the seminal book *Theory of Games and Economic Behavior*, which presents the central ideas underlying early utility-based models of rational decision making.

1956
Decisions Are Less Than Optimal
Nobel laureate Herbert A. Simon introduces the notion of satisficing, which suggests that human decision making is based on finding approximations to the statistically optimal solution.

1972
Problems Have "Space"
Allen Newell and Herbert A. Simon, both at Carnegie-Mellon University, publish *Human Problem Solving*, which establishes the idea that problems have a definable solution space.

1973
Mental Representation
Through studies of how people mentally rotate objects, Roger Shepard demonstrates that people form mental images, or representations, of objects.

2 OUTLINING THE PRINCIPLES appears on the second page of every chapter. This pedagogical feature at one level serves as a simple outline or road map for the chapter. At another level, it reveals what major principles will be discussed in the chapter. By studying the major headings, you can see which major questions ("ask") will drive the chapter. It's also important to note that the subheadings appear in the form of declarative statements ("answer") that reveal our current state of knowledge about the question.

3 CHAPTER TIMELINES appear on the bottom of the first three pages of every chapter. *Psychological Science* is built on cumulative knowledge and experience. This is one of the major themes of the text. Basic principles, both new and old, inspire and guide thinking and research in the field. The timelines highlight major developments within the various domains of psychology. By studying them, you will see more clearly how various principles have been established, challenged, and modified.

4 CHAPTER OPENING VIGNETTES lead off each chapter. The vignettes are drawn from a variety of sources, including news media, research journals, and history. They highlight a major theme, issue, or tension point that will be discussed throughout a given chapter.

6 “ASK AND ANSWER” RUNNING HEADS are designed to reinforce the basic principles. The running heads that appear on each right-hand page repeat the question that is explored in each section. These innovative running heads will help you see the forest for the trees as you read through the chapters.

240 | CHAPTER 8 Cognition

RESEARCH QUESTIONS for Studying Cognition

Do mental representations exist in different forms?
How do we solve problems?
To what extent is human decision making rational?
How do our decisions deviate from statistically optimal choices?
On what aspects of mind is intelligence based?
To what degree is intelligence influenced by our genes?
What are the elementary properties of consciousness?
How does the brain give rise to phenomenal awareness?

1979

Decisions Are Relative
Daniel Kahneman and Amos Tversky propose prospect theory, which models the tendency of decision makers (1) to use points of reference, and (2) to give more weight to potential losses than to potential gains.

1982

We Try to Avoid Regret
David Bell, Graham Loomes, and Robert Sugden independently propose that making decisions about uncertain events is based on anticipating possible regret regarding the different possibilities.

1983

Multiple Intelligence
Howard Gardner expands the traditional definition of intelligence to recognize that people can excel, or show intelligence, in different ways.

1990s

Evolved Decision Making
Gerd Gigerenzer argues that decision making is best understood by considering how humans have solved problems over the course of evolution.

2000

The Seat of General Intelligence
Using brain imaging, researchers led by John Duncan report that “general intelligence” may be tied to the functioning of the frontal cortex.

In his book *An Anthropologist on Mars* (1995), neurologist Oliver Sacks tells the story of one of his more remarkable patients, a man in his fifties named Virgil. When Virgil was five years old, he developed a severe case of cataracts, which rendered him blind. Virgil soon adapted to a life without vision, and as the years passed by, his childhood memories of what it had been like to see faded from awareness.

When Virgil was in his fifties, he fell in love and got married. As a wedding gift, Virgil’s fiancée offered to pay for corneal transplant surgery to restore his vision. Apprehensive but hopeful, Virgil agreed to the operation.

One of the cataracts was removed, and a new lens was transplanted. A day later the bandages were removed, and for the first time in nearly 45 years, light fell unimpaired upon Virgil’s retina. What did he see? How did he react? Sacks tells the story best:

Virgil told me later that in this first moment he had no idea what he was seeing. There was light, there was movement, there was color, all mixed up, all meaningless, a blur. Then out of the blur came a voice that said, “Well?” Then, and only then, he said, did he finally realize that this chaos of light and shadow was a face—and, indeed, the face of his surgeon. (p. 114)

Virgil saw a kaleidoscope of color and light that had no connection with the world as he had known it. The sudden addition of “vision” felt confusing and awkward, and the joy that he and his wife had hoped for failed to materialize. As time went on, Virgil grew increasingly frustrated by his inability to adapt to this new aspect of his awareness. Only with the return of blindness due to other causes did Virgil find the peace he had had before the operation.

What went wrong? Why did Virgil fail to gain happiness from being able to see? Those who have vision have spent a lifetime learning how to use and understand visual information. We know that

looming objects are moving toward us and that shrinking objects are moving away, and that people’s moods can be gleaned from their faces. Those with vision are so practiced at using it that seeing seems absolutely effortless and automatic.

If Virgil’s difficulties stemmed from a lack of knowledge, what does it mean to have this knowledge? How do we represent it in our minds—and in our brains? Moreover, what would it be like to suddenly have an entirely new sensory experience enter our consciousness? This chapter explores such questions, first by considering the nature of mental representations. Building on this foundation, we then ask a series of questions: How do we represent and organize knowledge, and how do we use it in our thinking? Does intelligence stem only from our knowledge-based reasoning, or does it include a broader selection of mental capacities? Finally, what is consciousness? How does the brain give rise to the awareness of the world that we associate with being conscious?

HOW DOES THE MIND REPRESENT INFORMATION?

Cognitive psychology was originally predicated on the notion that the brain represents information, and that the act of thinking—that is, cognition—is directly associated with manipulating these representations. While these ideas were central to breaking the behaviorist zeitgeist that had dominated American psychology in the first half of the twentieth century, they immediately gave rise to an important new question: What is the nature of these representations? In the following section, we consider the different ways in which mental representations are characterized. The biological revolution has led to the development of new approaches that now allow us to study these representations empirically.

Over the last several decades, one of the more heated debates in cognitive psychology has been over the nature of mental representations: Are they like pictures, or are they based on more verbal-like descriptions? The topic is important because the representation of knowledge in the brain forms the basis of cognition, intelligence, and ultimately consciousness. As is often the case, the opposing views in this debate are not mutually exclusive.

REPRESENTATIONS CAN TAKE DIFFERENT FORMS

The popular view that mental representations are analogous to pictures holds much intuitive appeal in that, in our mind’s eye, we often appear to see visual images. For instance, it is difficult to think about a “lemon” without having some sort of image come to mind that resembles an actual lemon, with its yellow and somewhat waxy, dimpled skin.

Not surprisingly, several lines of evidence strongly suggest that representations can indeed take on such picturelike qualities. First, in a famous set of

Do mental representations exist in different forms?

5 RESEARCH QUESTIONS FOR STUDYING. . .

Psychological Science captures the excitement of contemporary ideas and research driving the field today. The research questions highlighted on the third page of every chapter suggest the kinds of questions that researchers are exploring. Many of these questions may be directly related to your own questions. These questions reappear in the margins throughout a given chapter to alert you when the relevant issues are being discussed. This is another dimension to the basic “ask and answer” approach.

7 **DEFINING THE PRINCIPLES** describes the marginal glossary that runs throughout each chapter. Many books highlight an overabundance of key terms for you to memorize. *Psychological Science* highlights approximately 30 key terms per chapter. This should be an excellent review tool, as are the glossaries at the end of the book and on the companion Web site.

NEUROTRANSMITTERS BIND TO RECEPTORS ACROSS THE SYNAPSE

Neurons do not touch one another; they are separated by a small space known as the **synaptic cleft**, which is the site of chemical communication between neurons. Action potentials cause neurons to release from their terminal buttons chemicals that travel across the synaptic cleft and are received by the dendrites of other neurons. The neuron that sends the signal is called **presynaptic** and the one that receives the signal is called **postsynaptic**.

How do these chemical signals work? Inside the terminal buttons are small packages, or **vesicles**, that contain chemical substances known as neurotransmitters. The term **neurotransmitter** is a generic word used for chemical substances that carry signals across the synaptic cleft. After an action potential travels to the terminal button, it causes the vesicles to spill their neurotransmitters into the synaptic cleft. These neurotransmitters then spread across the synaptic cleft and attach themselves, or bind, to receptors on the postsynaptic neuron (Figure 3.14).

Receptors are specialized protein molecules. The binding of neurotransmitter to receptor causes ion channels to open, which changes the membrane potential at that location, thus affecting the probability that the neuron will fire. If a neurotransmitter binds with a receptor and depolarizes the membrane, it is excitatory and increases the likelihood that the receiving neuron will fire. By contrast, if the neurotransmitter's binding hyperpolarizes the membrane, it is inhibitory and makes the receiving neuron less likely to fire.

Ionotropic and metabotropic receptors

Two basic types of receptors are **ionotropic** and **metabotropic**. They differ in the mechanism by which they affect the receiving neuron. **Ionotropic** receptors are fast-acting protein molecules that directly open ion channels. When excitatory neurotransmitters bind with ionotropic receptors, they open sodium channels, increase depolarization, and increase the likelihood that the neuron will fire. When inhibitory neurotransmitters bind with ionotropic receptors they open potassium channels, causing hyperpolarization and decreasing the likelihood that the neuron will fire.

Metabotropic receptors open ion channels indirectly. When a neurotransmitter binds with a metabotropic receptor, a nearby molecule of protein, called a **G protein**, breaks away from the membrane and does one of two things. Either the G protein itself opens relevant ion channels, or it forms a new substance that influences the opening of ion channels. This new substance is known as a "second messenger" (the neurotransmitter is considered the first messenger). It is the influence of the

HOW DOES THE NERVOUS SYSTEM OPERATE? | 77

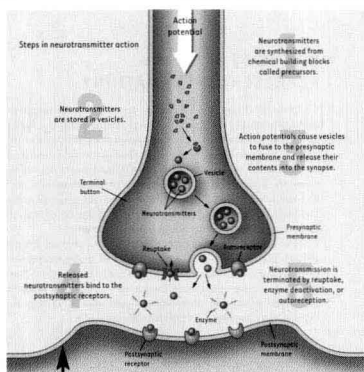
neurotransmitter Chemical substances that carry signals from one neuron to another.

receptors In neurons, specialized protein molecules on the postsynaptic membrane that neurotransmitters bind to after passing across the synaptic cleft.

RESEARCH QUESTION

How do nerve cells communicate with each other to influence mind and behavior?

3.14 An overview of how neurotransmitters work.



9 **REVIEWING THE PRINCIPLE** boxes are a key element in the "ask and answer" approach and appear at the end of each major section. They repeat the question that governed the section and provide a basic answer. The answer provided won't give you everything you need to understand the question, but it will highlight key points to remember.

308 | CHAPTER 9 Motivation

REVIEWING THE PRINCIPLE

What Is Sleep?

All animals experience sleep, an altered state of consciousness in which the sleeper loses most contact with the external world. Sleep has a number of stages that can be identified by different patterns on EEG recordings. There is a basic distinction between non-REM and REM sleep, and different neural mechanisms are responsible for producing each type, although the brainstem figures prominently in the regulation of sleep-wake cycles. Dreams occur in REM and non-REM sleep, although the content of those dreams differs. This may be due to differential activation of brain structures associated with emotion and cognition. Although a number of theories have been proposed to explain sleeping and dreaming, their biological function is currently unclear.

CONCLUSION

Motivation is the area of psychology concerned with determining why people engage in specific behaviors. Although motivational psychologists used to focus exclusively on either regulatory or purposive motives, an increasing emphasis on neuroscience has blurred the distinction between these approaches. For instance, the control of human eating involves both purposive and regulatory mechanisms, and the brain is involved in both types of motivation. Moreover, collaborative efforts across the levels of analysis between neuroscientists and social psychologists have led to new theories of motivation, such as the hot/cold model of delayed gratification, which build as cumulative principles. Neuroscientific approaches have also allowed researchers to reexamine important questions, such as how instincts and drives motivate behavior. Increasing knowledge about the brain may allow for a deeper understanding of important human motives, such as how people set and achieve personal goals, and also of the extent to which people can control or override basic biological processes, such as sleep and eating.

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8 **A DYNAMIC ART PROGRAM** The visual materials in *Psychological Science* should add substantially to your reading experience. The text contains a variety of visual materials, from photographs to tables and charts to drawn art. The emphasis in *Psychological Science*, however, is clearly on the drawn art. Having used many general psychology books ourselves, we wanted to take our text in a new direction. By featuring drawn art, *Psychological Science* is able to convey precisely, accurately, and meaningfully what you need to gain from every image. This high level of precision can't be gained from the use of stock photographs, which are common in many texts.

10 **SUMMARIZING THE PRINCIPLES** is the last key component of the "ask and answer" approach. *Psychological Science*'s brief chapter conclusions highlight the big ideas and concepts and remind you how the book's four key themes wove their way through the chapter. After reading the chapter conclusion, you may want to reread the "Reviewing the Principles" sections to check what you have learned and what you haven't.

11 **FURTHER READINGS** represent psychological writing at its best. If any of the topics in a given chapter interested you, we encourage you to followup with one of the suggested reading titles. There are many wonderful popular psychology books that provide keen insights and pleasurable excursions into human behavior.