BRAIN & BEHAVIOR

An Introduction to Biological Psychology

SECOND EDITION

Bob Garrett

SAGE

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SECOND EDITION

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Preface

A Message From the Author

A benefit of growing up poor was that I learned the value of an education. And it did not take long to discover that the real value of education is not just a ticket to a better job but all the learning along the way about life and the world and what makes both of them work. That is what led me, after trying one major after another, to discover psychology.

A child of Sputnik and enamored with science, I was especially attracted by the young and promising discipline of biological psychology. And as I pursued that promise, I was attracted to another—sharing my enthusiasm through teaching. For many years, I taught at DePauw University, where practically every student does two or three internships and the value of research is judged by what students learn from working alongside their mentors; similarly, the guiding principle at my current university, Cal Poly, San Luis Obispo, is that students should "learn by doing." I believe in knowledge for its own sake, but I value knowledge that is useful even more. Perhaps that is why I needed to write *Brain and Behavior*; it is my testimonial to the usefulness of scientific knowledge.

Now that the second edition is done, I can look forward to more leisurely ways of spending my time: beach walks and tennis with my wife, hiking the hillsides near our home, and watching our grandchildren grow. But you can be sure I'll be watching out of the corner of my eye to see whether students are enjoying what I have written and whether they are experiencing the same thrill of discovery I had when I was their age.

To the Instructor

When I first wrote *Brain and Behavior*, I had one goal, to entice students into the adventure of biological psychology. There are other good texts out there, but they read like they were written for serious junior and senior psychology majors who appreciate the importance of biological psychology in its own right. This book is for them, too, but I wrote it so any student who is interested in behavior, including the newly declared sophomore major or the curious student who has wandered over from the history department, could have the deeper understanding that comes from a biological perspective as they take other courses in psychology.

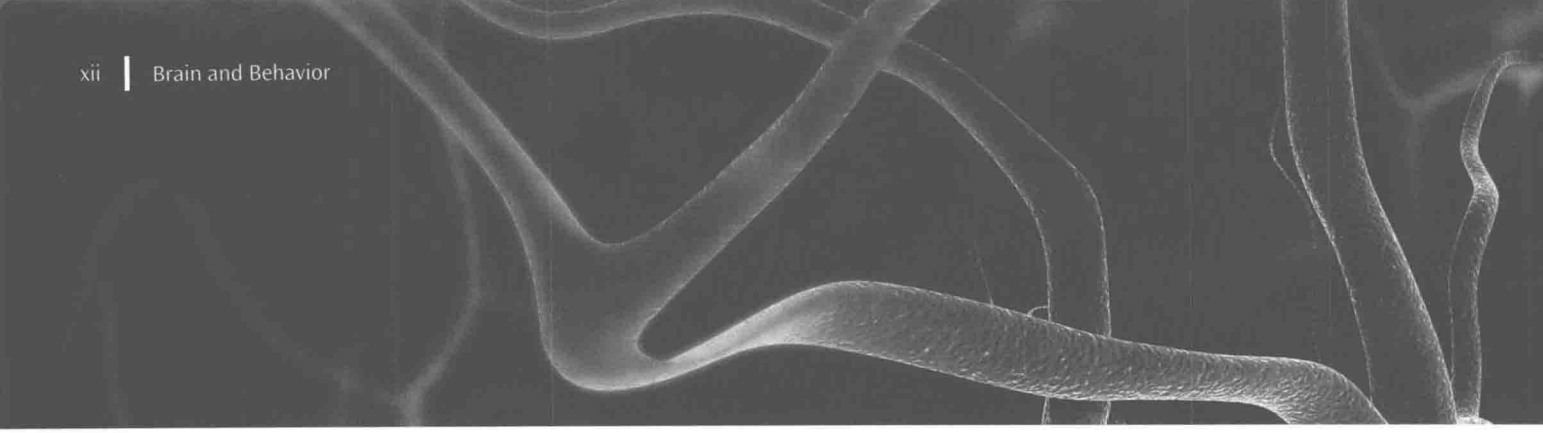
It is not enough to draw students in with lively writing or by piquing their interest with case studies and telling an occasional story along the way; unless they feel they are learning something significant, they won't stay—they'll look for excitement in more traditional places. As I wrote, I remembered the text I struggled with in my first biopsychology class; it wasn't very interesting because we knew much less about the biological underpinnings of behavior than we do now. Since that time, we have learned how the brain changes during learning, we have discovered some of the genes and brain deficiencies that cause schizophrenia, and we are beginning to understand how intricate networks of brain cells produce language, make us intelligent, and help us play the piano or find a mate. In other words, biopsychology has become a lot more interesting. So the material is there; now it is my job to communicate the excitement I have felt in discovering the secrets of the brain and to make a convincing case that biopsychology has the power to answer the questions *students* have about behavior.

A good textbook is all about teaching, but there is no teaching if there is no learning. Over the years, my students taught me a great deal about what they needed to help them learn. For one thing, I realized how important it is for students to build on their knowledge throughout the course, so I made several changes from the organization I saw in other texts. First, the chapter on neuronal physiology precedes the chapter on the nervous system, because I believe that you cannot understand how the brain works unless you know how its neurons work. And I reversed the usual order of the vision and audition chapters, because I came to understand that audition provides a friendlier context for introducing the basic principles of sensation and perception. The chapters on addiction, motivation, emotion, and sex follow the introduction to neurophysiology; this was done to build student motivation before tackling sensation and perception. Perhaps more significantly, some topics have been moved around among chapters so they can be developed in a more behaviorally meaningful context. So language is discussed along with audition, the body senses with the mechanisms of movement, the sense of taste in the context of feeding behavior, and olfaction in conjunction with sexual behavior. Most unique, though, is the inclusion of a chapter on the biology of intelligence and another on consciousness. The latter is a full treatment of recent developments in the field, rather than limited to the usual topics of sleep and split-brain behavior. These two chapters strongly reinforce the theme that biopsychology is personally relevant and capable of addressing important questions.

Brain and Behavior has several features that will motivate students to learn and encourage them to take an active role in their learning. It engages the student with interest-grabbing opening vignettes, illustrative case studies, and In the News items and Application boxes that take an intriguing step beyond the chapter content. Throughout each chapter, questions in the margins keep the student focused on key points, a Concept Check at the end of each section serves as a reminder of the important ideas, and On the Web icons point the way to related information on the Internet. At the end of the chapter, In Perspective emphasizes the importance and implications of what the student has just read, a summary helps organize that information, and Testing Your Understanding assesses the student's conceptual understanding as well as factual knowledge. Then, For Further Reading is a guide for students who want to explore the chapter's topics more fully. I have found over the years that students who use the study aids in a class are also the best performers in the course.

New in the Second Edition

As you would expect, the second edition of *Brain and Behavior* includes a number of changes. Foremost, and reflecting the rapid advances in biological psychology and neuroscience, this edition contains 500 new references. More than 60 illustrations have been added, and 25 others were significantly revised to increase their informational and educational value. In addition, new tables have been added where there was a need to organize or summarize complex material. In addition, most of the In the News and Application features have been either replaced or updated with more recent information. The material on research techniques that



was previously in the appendix has been expanded and combined with two topics from the first edition's introductory chapter, Science, Research, and Theory and Research Ethics, to form the new chapter "The Methods and Ethics of Research." This provides research methodology the emphasis it deserves while giving the introductory chapter a sharper focus.

The new edition continues its theme of showcasing our rapidly increasing understanding of genetic influences on behavior with discussions of numerous recent findings, particularly with regard to obesity, hostility and aggression, Parkinson's disease, Alzheimer's disease, autism, and schizophrenia. Another theme that has been strengthened is the broader societal relevance of biopsychology, from the ethical implications of stem cell research to the cost of addictions and disorders, to new strategies for treating brain and spinal cord damage.

To the Student

Brain and Behavior is my attempt to reach out to students, to open a door and beckon them inside to experience the fascinating world of biological psychology. These are exceptionally exciting times, comparable in many ways to the renaissance that thrust Europe from the Middle Ages into the modern world. In Chapter 1, I quote Kay Jamison's comparison of neuroscience, which includes biopsychology, to a "romantic, moon-walk sense of exploration." I know of no scientific discipline with greater potential to answer the burning questions about ourselves than neuroscience in general and biopsychology in particular. I hope this textbook will convey that kind of excitement as you read about discoveries that will revolutionize our understanding of what it means to be human.

I want you to succeed in this course, but, more than that, I want you to learn more than you ever imagined you could and to go away with a new appreciation of the promise of biological psychology. So now I'm going to start sounding like a parent. I want you to sit near the front of the class, because those students usually get the best grades. That is probably because they stay more engaged and ask more questions; but to ask good questions you should *always* read the text assignment before you go to class. And so you'll know where you're going before you begin to read, take a look at "In this chapter you will learn," then skim the chapter subheadings, and read the summary. Use the questions in the margins as you go through, answer the Concept Check questions, and be sure to test yourself at the end. Computer icons like the one you see here will tell you which figures have been animated on the text's Web site to help sharpen your understanding, and numbered WWW icons in the margins will direct you to a wealth of additional information on the web. Then don't forget to look up some of the books and articles in For Further Reading. If you do all of these things you won't just do better in this course; you will leave saying, "I really got something out of that class!"

I wrote *Brain and Behavior* with you in mind, so I hope you will let me know where I have done things right and, especially, where I have not (bgarrett@calpoly.edu).) I wish you the satisfaction of discovery and knowledge as you read what I have written *for you.*

Supplemental Material

Student Study Guide

This affordable student study guide and workbook to accompany Bob Garrett's *Brain and Behavior, Second Edition* will help students get the added review and practice they need to improve their skills and master their course. Each part of the study guide corresponds to the appropriate chapter in the text and includes the following: chapter outline, chapter summary, study quiz, and a chapter posttest.

Student Study Site

This free student study site provides additional support to students using *Brain and Behavior, Second Edition.* The Web site includes e-flashcards, study quizzes (students can receive their score immediately), relevant SAGE journal articles with critical thinking questions, and relevant Internet resources. Also included are animations of key figures in the text. Visit the study site at www.sagepub.com/garrettbb2study.

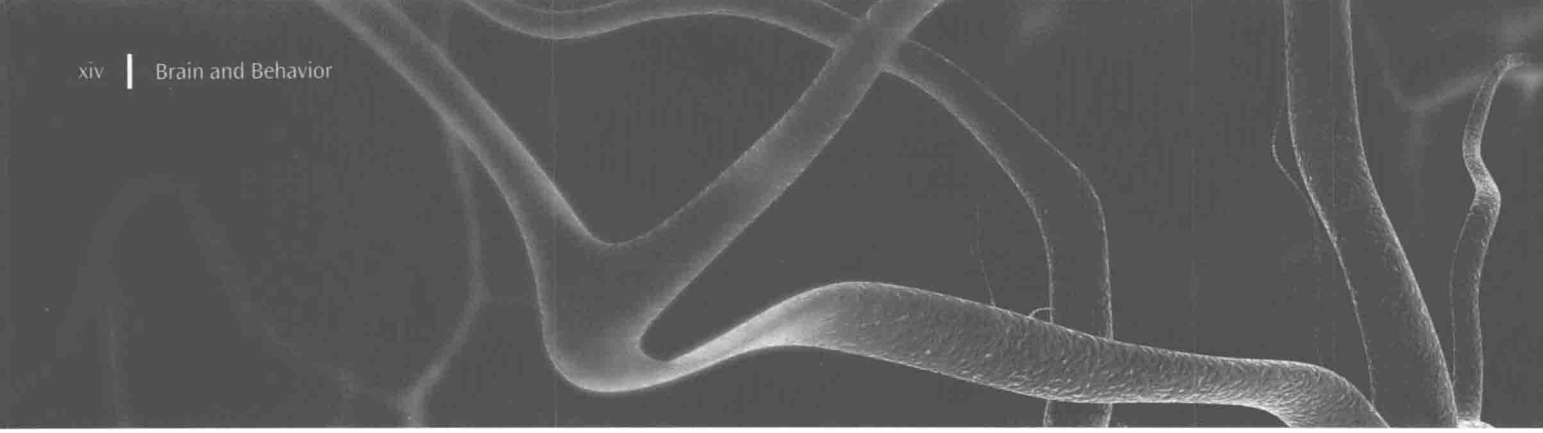
Instructor's Resources on CD-ROM

This set of instructor's resources provides a number of helpful teaching aids for professors new to teaching biological psychology and to using *Brain and Behavior, Second Edition.* Included on the CD-ROM are PowerPoint slides, a computerized test bank to allow for easy creation of exams, lecture outlines, suggested class activities and critical thinking questions, and video and Internet resources for each chapter of the text.

Acknowledgments

I have had a number of mentors along the way, to whom I am forever grateful. A few of those special people are Wayne Kilgore, who taught the joys of science along with high school chemistry and physics; Garvin McCain, who introduced me to the satisfactions of research; Roger Kirk, who taught me that anything worth doing is worth doing over and over until it's right; and Ellen Roye and Ouilda Piner, who shared their love of language. These dedicated teachers showed me that learning was my responsibility, and they shaped my life with their unique gifts and quiet enthusiasm.

My most important supporter has been my wife, Duejean; love and thanks to her for her patient understanding and her appreciation of how important this project is to me. And then, applause all around for Cheri Delello, Stephanie Adams, Deya Saoud, Lara Grambling, and Ravi Balasuriya, whose competence and professionalism convinced me that Sage is "the natural home for authors"; and a special thanks to Sarah Quesenberry for her patient and tireless work as project editor, to Kate Barnes for her exemplary developmental editing, to Marcy Lunetta and Sara van Valkenburg for their work on permissions and photos, to Eric Shrader for photo research, to Robert Stufflebeam for animations, and to Barry Burns for artwork.



But most of all, thanks to Vicki Knight, editor for both editions and the guiding force behind *Brain and Behavior*. Then, my gratitude to DePauw University for the sabbatical leave that started this whole project and to Cal Poly for all the resources it has so generously provided.

I would like to extend heartfelt kudos to the talented and forbearing supplement authors: Susan Fortenbury, University of Missouri-St. Louis: PowerPoint slides; Heather Patisaul, North Carolina State University: Instructor's Resources; Brady Phelps, South Dakota State University: Test Bank and Study Quizzes; and Sheila Steiner, Jamestown College: Student Study Guide.

In addition, the following reviewers gave generously of their time and expertise throughout the development of this text, and contributed immensely to the quality of *Brain and Behavior*:

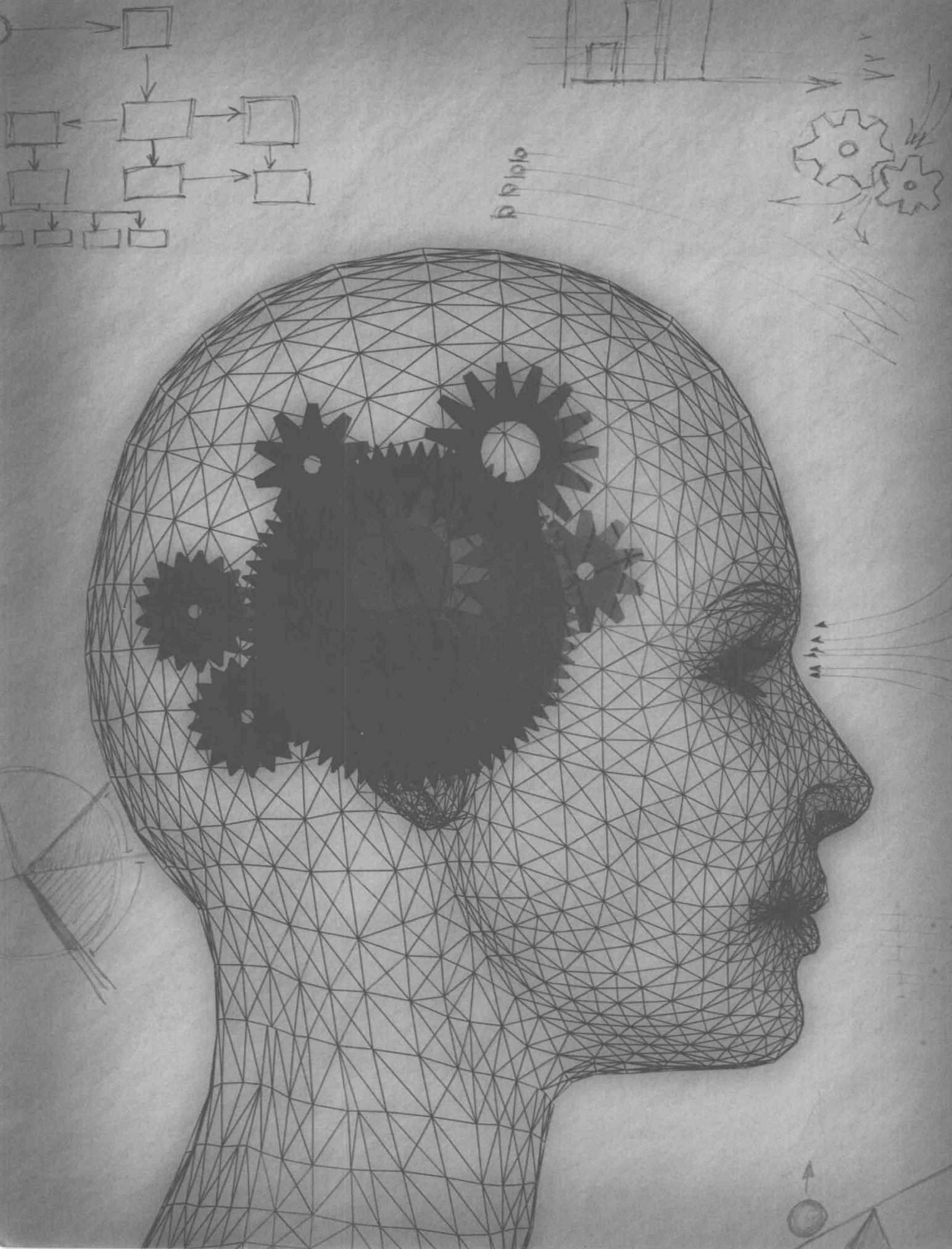
First Edition: Susan Anderson, University of South Alabama; Patrizia Curran, University of Massachusetts–Dartmouth; Lloyd Dawe, Cameron University; Tami Eggleston, McKendree College; James Hunsicker, Southwestern Oklahoma State University; Eric Laws, Longwood College; Margaret Letterman, Eastern Connecticut State University; Doug Matthews, University of Memphis; Grant McLaren, Edinboro University of Pennsylvania; Rob Mowrer, Angelo State University; Anna Napoli, University of Redlands; Robert Patterson, Washington State University; Joseph Porter, Virginia Commonwealth University; Jeffrey Stern, University of Michigan–Dearborn; Aurora Torres, University of Alabama in Huntsville; Michael Woodruff, East Tennessee State University; and Phil Zeigler, Hunter College.

Second Edition: M. Todd Allen, University of Northern Colorado; Patricia A. Bach, Illinois Institute of Technology; Wayne Brake, UC Santa Barbara; Steven I. Dworkin, University of North Carolina; Sean Laraway, San Jose State University; Mindy J. Miserendino, Sacred Heart University; Brady Phelps, South Dakota State University; Susan A. Todd, Bridgewater State College; and Elizabeth Walter, University of Oregon.

—Bob Garrett

About the Author

Bob Garrett is currently a visiting research scholar at California Polytechnic State University, San Luis Obispo. He was Professor of Psychology at DePauw University in Greencastle, Indiana, and held several positions there, including Chairperson of the Department of Psychology, Faculty Development Coordinator, and Interim Dean of Academic Affairs. He received his BA from the University of Texas at Arlington and his MA and PhD from Baylor University.



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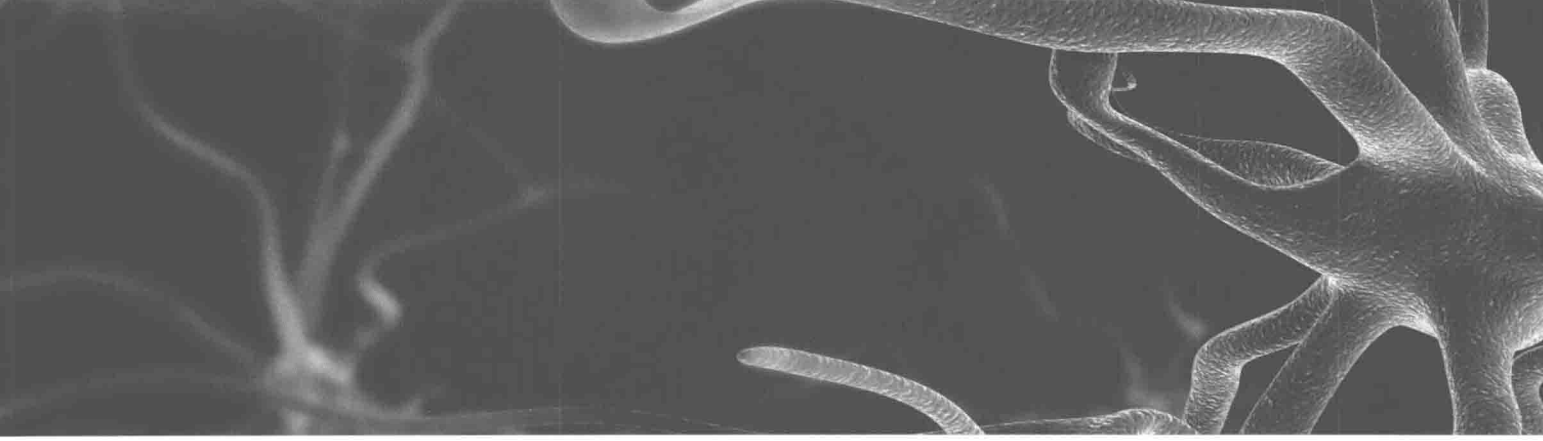
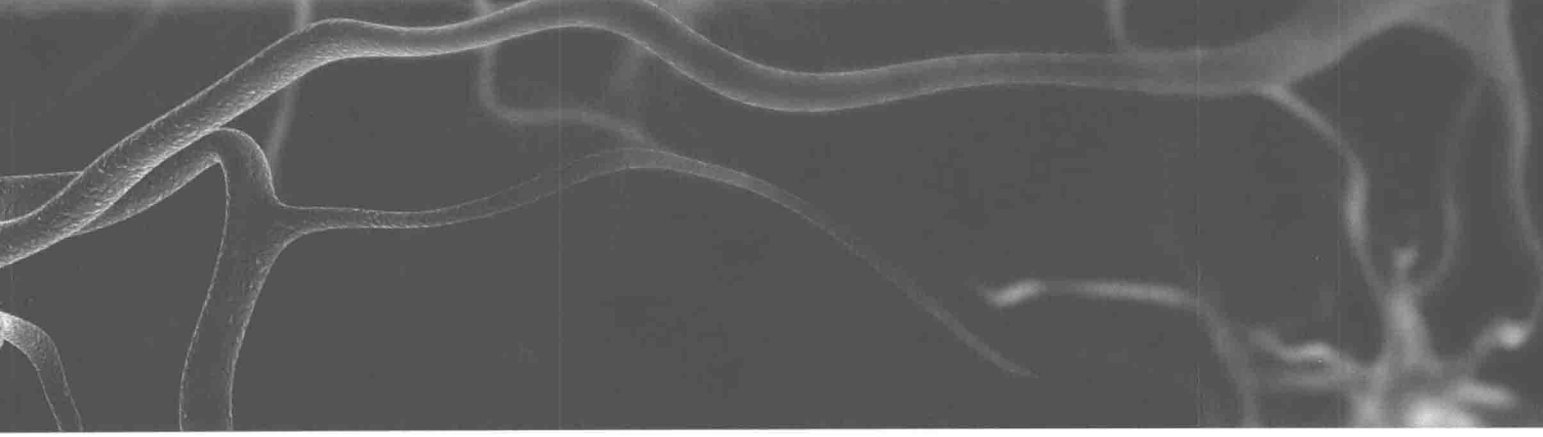
Detailed Contents

PART II. MOTIVATION AND EMOTION: WHAT MAKES US GO





PART IV. COMPLEX BEHAVIOR

What Is Biopsychology?

1

In this chapter you will learn

- How biological psychology grew out of philosophy and physiology
- How brain scientists think about the mind-brain problem
- How behavior is inherited and the relationship between heredity and environment

> *There is a wonderful kind of excitement in modern neuroscience, a romantic, moon-walk sense of exploration and setting out for new frontiers. The science is elegant . . . and the pace of discovery absolutely staggering.*
>
> —*Kay R. Jamison,* An Unquiet Mind

Neuroscience is the multidisciplinary study of the nervous system and its role in behavior. An interesting topic, surely, but *neuroscience is a romantic moonwalk?* To understand why Kay Jamison chose this analogy, you would need to have watched in astonishment from your backyard on an October night in 1957 as the faint glint of reflected light from Sputnik crossed the North American sky. The American people were stunned and fearful as the Russian space program left them far behind. But as the implications of this technological coup sank in, the United States set

about constructing its own space program and revamping education in science and technology. Less than 4 years later, President Kennedy made his startling commitment to put an American astronaut on the moon by the end of the decade. But the real excitement would come on the evening of July 20, 1969, as you sat glued to your television set watching the *Eagle* lander settle effortlessly on the moon and the first human step onto the surface of another world (Figure 1.1). For Kay Jamison and the rest of us involved in solving the mysteries of the brain, there is a very meaningful parallel between the excitement of Neil Armstrong's "giant leap for mankind" and the thrill of exploring the inner space of human thought and emotion.

There is also an inescapable parallel between Kennedy's commitment of the 1960s to space exploration and Congress's declaration 30 years later that the 1990s would be known as the Decade of the Brain: Understanding the brain demands the same incredible level of effort, ingenuity, and technological innovation as landing a human on the moon. There were important differences between those two decades, though. President Kennedy acknowledged that no one knew what benefits would arise from space exploration. But as the Decade of the Brain began, we understood that we would not only expand the horizons of human knowledge but also advance the treatment of neurological diseases, emotional disorders, and addictions that cost the United States an estimated trillion dollars a year for care, lost productivity, and crime (Uhl & Grow, 2004).

Another difference was that the moon-landing project was born out of desperation and a sense of failure, while the Decade of the Brain was a celebration of achievements, both past and current. In the past few years, we have developed new treatments for depression, identified key genes responsible for the devastation of Alzheimer's disease, discovered agents that block addiction to some drugs, learned ways to hold off the memory impairment associated with old age, and produced a map of the human genes.

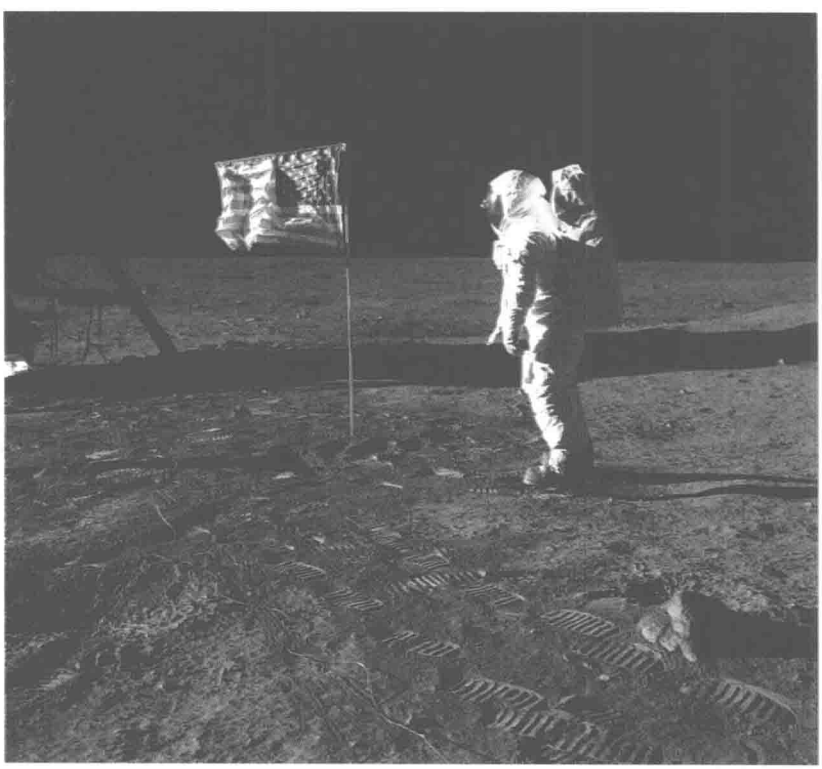


Figure 1.1

The Original Romantic Moonwalk.

Space exploration and solving the mysteries of the brain offer similar challenges and excitement. Which do you think will have the greater impact on your life?

SOURCE: Courtesy of NASA.