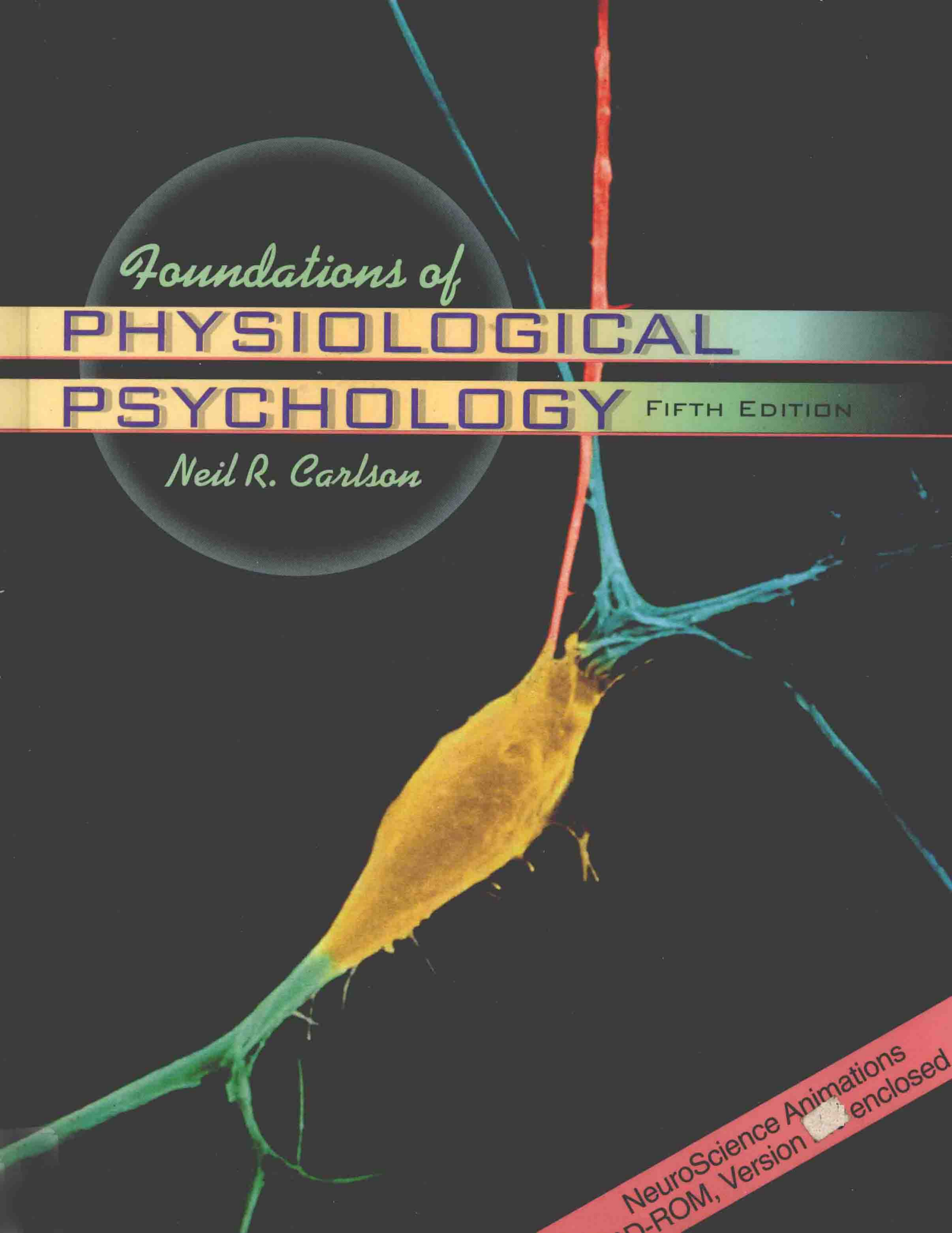
Foundations of PHYSIOLOGICAL PSYCHOLOGY

FIFTH EDITION

Neil R. Carlson



NeuroScience Animations
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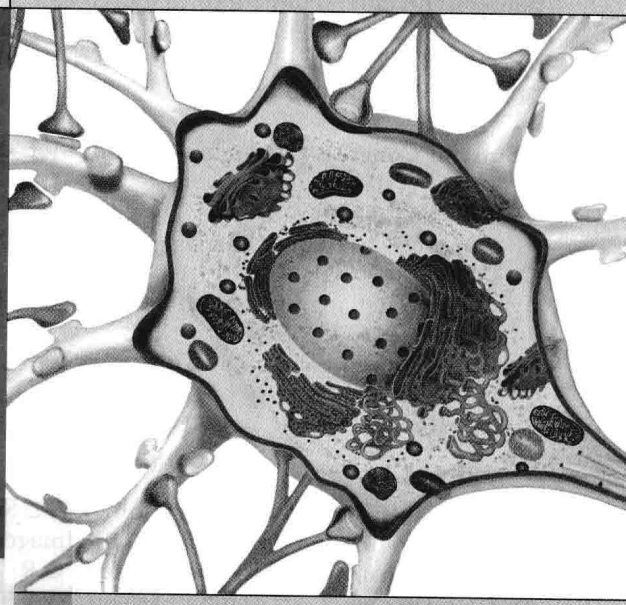

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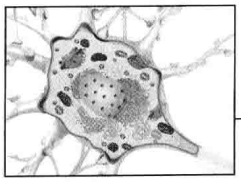

PREFACE

All my life I have wanted to know how things work. When I was a boy I took apart alarm clocks, radios, my mother's sewing machine, and other interesting gadgets, to see what was inside. Much to my parents' relief, I outgrew that habit (or at least got better at putting things back together), but my curiosity is still with me. Since my college days, I have been trying to find out all I can about the workings of the most intricate piece of machinery that we know of: the human brain.

The field of neuroscience research is a very busy and productive one today. A large number of scientists are trying to understand the physiology of behavior, using more and more advanced methods, yielding more and more interesting results. Their findings provide me with much to write about. I admire their dedication and hard work, and I thank them for giving me something to say. Without their efforts I could not have written this book.

I wrote the first edition of this book at the request of my colleagues who teach the course, and who wanted a briefer version of my *Physiology of Behavior* with more emphasis on research related to humans. The first part of this book is concerned with foundations: the history of the field, the structure and functions of neurons, neuroanatomy, psychopharmacology, and methods of research. The second part is concerned with inputs: the sensory systems. The third part deals with what might be called "motivated" behavior: sleep, reproduction, emotion, and ingestion. The fourth part deals with learning and with verbal communication. The final part deals with neurological and mental disorders.

CONTENT CHANGES FOR THE FIFTH EDITION

Of course, all chapters in this book have been revised. My colleagues keep me busy by providing me with interesting research results to describe in my book. The problem is always to include the interesting new material without letting the length of the book get out of hand. Like the previous editions, this edition contains a chapter on neurological disorders that is not found in *Physiology of Behavior.*

The following list covers some of the information that is new to this edition:

- An expanded discussion of the evolution of our species
- A new section on evolution of the human brain
- A discussion of new reseach on neural circuits involved in facial recognition
- Discovery of mirror neurons in primate cortex and their possible role in the evolution of language
- Discovery of new nociceptors
- Discovery of ligands for human odor receptors
- Discussion of the potential use of transplantation of glomus cells from the carotid body to treat Parkinson's disease
- Discovery of the role of histamine in sleep and arousal
- Discovery of the cause of narcolepsy: deficits in a system of orexin-secreting neurons
- Discovery of a new photoreceptor responsible for synchronization of circadian rhythms

- Discussion of the role of the prefrontal cortex in emotion and decision making
- Role of the basal ganglia in disgust
- New research on alcohol, serotonin, and aggression
- Discovery that peptides are critically involved in hunger and satiety: α-MSH, orexin, CART, and MCH
- Role of uncoupling proteins in obesity
- New research on biochemical and structural changes during long-term potentiation
- Expanded discussion of the role of the prefrontal cortex in working memory
- Recent functional imaging studies on the anatomy of memory
- More functional imaging studies on the anatomy of language
- The PCP hypothesis of schizophrenia
- Recent research on schizophrenia as a degenerative disorder
- Discovery of the antidepressant effect of a drug that blocks substance-P receptors
- New research on thalidomide, brain stem development, and autism

There are some important differences between this book and *Physiology of Behavior.* The text of this book is not simply a shorter and denser version of its predecessor. I kept the illustrative examples, especially those dealing with human disorders, and added explanations of phenomena to be sure that students without much background in biology could understand what I was saying. Although I have simplified some of the detailed explanations, I have retained the important principles.

STRATEGIES FOR LEARNING

This theme, which runs throughout the book, was created to apply physiological psychology to daily life. You will find a Strategies for Learning heading in Chapter 1, and a chapter entitled "Methods and Strategies of Research." This chapter does not contain a bewildering list of research methods; instead, the reader is led through a set of hypothetical investigations organized the way that a research project might proceed. Each step illustrates a particular procedure in the context in which it would be applied in an ongoing program.

In addition, each chapter is set up to reinforce learning:

- ***Learning Objectives.*** Each chapter begins with a list of learning objectives. The learning objectives also serve as the framework for the Study Guide that accompanies the text.
- ***Prologue.*** The text of each chapter begins with a prologue that describes an episode involving a neurological disorder or an issue in neuroscience.
- ***Epilogue.*** The epilogue at the end of each chapter resolves the issues raised in the prologue, discussing them in terms of what the reader has learned. The epilogue may also bring in a related topic.
- ***Interim Summaries.*** Interim summaries follow each major section within a chapter. These not only provide useful reviews, but also break the chapter into manageable segments.
- ***Thought Questions.*** Thought questions follow most interim summaries. They provide an opportunity to think about what has been learned in the previous section.
- ***Pronunciation Guides and Definitions of Key Terms.*** Definitions of key terms are placed in the margin of the page where the terms are first discussed. The definitions include pronunciation guides for more difficult terms.
- ***Suggested Readings and Suggested Web Sites.*** A list of readings and Web sites expands the topics and discussions that were presented in the chapter.

FULL-COLOR ART

The illustrations in this book were prepared by Jay Alexander of I-Hua Graphics. Jay also works in the Psychology Department at the University of Massachusetts, and he and I have been working together on my books for several years. I think the result of our collaboration is a set of clear, consistent, and attractive illustrations.

LEARNING STRATEGIES SUPPLEMENTS AVAILABLE WITH THIS TEXT

CD-ROM—*Neuroscience Animations* (Revised) and *Computerized Study Guide.* The animations demonstrate important principles of neuroscience through movement and interaction. The animations have been substantially revised and expanded in this edition. They include:

- Neurophysiology
  Neural Communication
  The Action Potential
  Synapses
  Postsynaptic Potentials
- Neuroanatomy
  The Rotatable Brain
  Brain Slices
  Meninges and CSF
- Psychopharmacology
- Audition
  Perception of Pitch
  Sound Localization
- The Menstrual Cycle
- Metabolism
- Learning and Memory
  The NMDA Receptor
  Chemistry of LTP
  Associative LTP
  Long-Lasting LTP
  Implicit Memory Tasks
- Verbal Communication
  Pure Alexia
  Voices of Aphasia

The interactive *Computerized Study Guide,* also on the CD, contains a set of self-tests that include multiple-choice questions and an online review of terms and definitions. These questions and term definitions keep track of a student's progress; missed items are presented repeatedly until they have been mastered. The *Computerized Study Guide* includes interactive figures and diagrams from the text that will also help students learn the terms and concepts. The CD-ROM is free with the purchase of the text.

STUDY GUIDE (Print). A study guide, which my wife and I wrote, provides a framework for guiding study behavior. It promotes a thorough understanding of the principles of physiological psychology through active participation in the learning process. The study guide teaches the vocabulary of physiological psychology through a set of Concept Cards. Terms are printed on one side of the card, definitions on the other.

COMPANION WEB SITE. Allyn and Bacon, the publisher, hosts a Companion Web Site for this text at: www.ablongman.com/carlsonpob. The site for *Foundations of Physiological Psychology* contains additional multiple-choice questions, organized by chapter. The site also provides hot links to other sites of interest and research. These links have been prepared by Paul Wellman, professor of psychology at Texas A&M.

Supplements for Instructors

INSTRUCTOR'S MANUAL. The *Instructor's Manual,* written by Paul Wellman of Texas A&M, contains material intended to enhance class discussions and to provide assistance and advice in using the media supplements that accompany the text. It also presents chapter-by-chapter changes in the fifth edition.

POWERPOINT PRESENTATIONS. Paul Wellman has prepared a set of PowerPoint Presentations on CD-ROM for the seventh edition of *Physiology of Behavior.* Instructors who adopt this edition of *Foundations of Physiological Psychology* may find these presentations helpful in preparing their own. They contain 15 to 20 text slides per chapter that provide a framework for lecture outlines and include selected images found in both books.

TEST BANK & COMPUTERIZED TEST BANK. Professor Wellman has also prepared a Test Bank, available in print and also in Windows and Macintosh formats, that contains a minimum of 80 multiple-choice questions per chapter.

DIGITAL IMAGE ARCHIVE, 2.0. This CD-ROM contains 256 full-color images that will allow instructors to use the best of the illustrations from the book for classroom demonstrations. In addition, adopters of this text may also request a set of 150 *new* transparency acetates from Allyn and Bacon.

VIDEO. *Biological Psychology,* a new video from Films for the Humanities and Sciences, is also available to adopters of the text. This 80-minute video covers topics such as the transmission of genetic information, neuroanatomy, the visual system, and dreaming. Please contact your local Allyn and Bacon sales representative for this and any other of the supplements for instructors.

IN CONCLUSION

Trying to keep up with the rapid progress being made in neuroscience research poses a challenge for teachers and textbook writers. If a student simply memorizes what we believe at the time to be facts, he or she is left with knowledge that quickly becomes obsolete. In this book I have tried to provide enough background material and enough knowledge of basic physiological processes so that the reader can revise what he or she has learned when research provides us with new information.

I designed this text to be interesting and informative. I have endeavored to provide a solid foundation for further study. Students who will not take subsequent courses in this or related fields should receive the satisfaction of a much better understanding of their own behavior. Also, they will have a greater appreciation for the forthcoming advances in medical practices related to disorders that affect a person's perception, mood, or behavior. I hope that people who carefully read this book will henceforth perceive human behavior in a new light.

ACKNOWLEDGMENTS

Although I must accept the blame for any shortcomings of the book, I want to thank colleagues who helped me. I thank Paul Wellman for his work on the instructor's

manual and the test bank. I want to thank colleagues who helped me with the present edition of this book and the latest edition of *Physiology of Behavior* by sending reprints of their work, suggesting topics that I should cover, sending photographs that have been reproduced in this book, and pointing out deficiencies in the previous edition. I thank:

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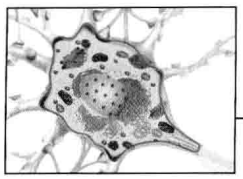
to procrastinate, but I do, and I thank her for all she has done. Bill Heckman served as copy editor. He gave me a chance to fix my errors before anyone else saw them in print.

I must also thank my wife Mary for her support. Writing is a lonely pursuit, because one must be alone with one's thoughts for many hours of the day. I thank her for giving me the time to read, reflect, and write without feeling that I was neglecting her too much.

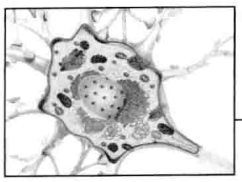
TO THE READER

I hope that in reading this book you will come not only to learn more about the brain but also to appreciate it for the marvelous organ it is. The brain is wonderfully complex, and perhaps the most remarkable thing is that we are able to use it in our attempt to understand it.

While working on this book, I imagined myself talking with students, telling them interesting stories about the findings of clinicians and research scientists. Imagining your presence made the task of writing a little less lonely. I hope that the dialogue will continue. Please write to me and tell me what you like and dislike about the book. My address is: Department of Psychology, Tobin Hall, University of Massachusetts, Amherst, Massachusetts 01003. My e-mail address is nrc@psych.umass.edu. If you write to me (or send me an e-mail), we can make the conversation a two-way exchange.

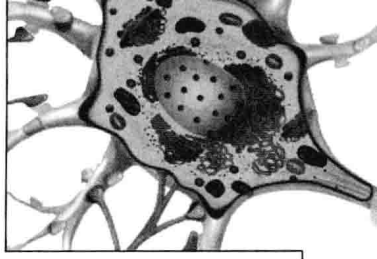


BRIEF CONTENTS



CONTENTS

CHAPTER OUTLINE



1

Origins of Physiological Psychology

LEARNING OBJECTIVES

1. Describe the behavior of people with split brains and explain what this phenomenon contributes to our understanding of self-awareness.
2. Describe the goals of scientific research.
3. Describe the biological roots of physiological psychology.
4. Describe the role of natural selection in the evolution of behavioral traits.
5. Describe the evolution of the human species.
6. Discuss the value of research with animals and ethical issues concerning their care.
7. Describe career opportunities in neuroscience.