



PREFACE

THE SECOND EDITION of this book, although renamed and extensively revised, retains the spirit, organization, and many of the features of the first edition. Like the first edition, it provides a systematic introduction to the neural basis of mental function. Also like the first edition, it includes research from experimental work performed with humans and animals, as well as findings from clinical populations. New to this edition is the perspective on these issues that can be provided by computational models. The goal, as before, is to provide a balanced, synthesized, and integrated view of what we know both about the brain and about cognition.

The title of the book reflects not only a change in how the scientific community conceptualizes the area of study that investigates linkages between cognition and the brain, but also the fact that the book has been extensively updated to provide a state-of-the-art view of the field. Research findings from patients with neurological disorders are discussed side by side with findings from studies involving transcranial magnetic stimulation; computational perspectives are provided along with findings obtained from neuroimaging; and the results of research with animals are discussed in tandem with results from electrophysiological recordings in humans. In this regard, the material in the book clearly encompasses the field of cognitive neuroscience. Yet, at its core, the book also presents what we have learned and continue to learn from neuropsychological research, especially with clinical populations. Thus the title indicates the integration of these two perspectives on the neural bases of mental function.

TEXT ORGANIZATION AND FEATURES

Users of the first edition will find that, despite the title change, the book's soul remains very much the same as the following main features have been retained.

■ **The book provides a systematic survey of the neural bases of a wide variety of mental functions.**

The overall organization of the book is changed little from the first edition. The first section of the book, comprising the first four chapters, provides students with a basic foundation for the exploration of cognitive neuroscience and neuropsychology. The first chapter provides information about the basic parts and

divisions of the central nervous system, while the second chapter, which is new, discusses the fundamentals of neural transmission. These two chapters are probably unnecessary for students who have already completed a course in physiological psychology, but will be of use to students who have not.

The third chapter acquaints students with the myriad of burgeoning techniques, both standard and novel, that are available to scientists and clinicians in their quest to understand the neural bases of mental function. The fourth chapter provides an overview of lateralization of function. The second part of the book, Chapters 5 through 12, provides a survey of the neural bases of mental function, with each chapter devoted to a distinct mental function. The chapter topics discussed are, in order, motor processes, object recognition, spatial processing, attention, language, memory, executive function, and emotion.

The last part of the book, comprising the last two chapters, looks at broad-based issues in cognitive neuroscience and neuropsychology. Chapter 13 examines neural plasticity from a life-span perspective, including not only developmental changes during childhood but also those that occur with aging. In addition, it discusses recovery of function in children and in adults, and the neural bases of developmental disabilities. Chapter 14 examines syndromes that are characterized by generalized cognitive disorders (rather than the specific disorders discussed in Chapters 5 through 12), including closed head injury, dementia, demyelinating diseases, disorders due to substance abuse or exposure to toxins, and epilepsy.

■ **Both the sequence of the chapters and the information within them is designed for progressive learning.**

The chapters have been carefully sequenced so that information in later chapters builds upon information in earlier chapters. Namely, the processes most linked to motoric and sensory functions are presented earlier, and those that depend on more integrative aspects of brain function, such as executive function and emotion, are presented later. For example, the chapter on object recognition directly precedes that on spatial processing, so that the student is introduced to the ventral and dorsal visual-processing streams in consecutive chapters. The chapter on memory is preceded by the language and object-recognition chapters so that the distinction between generalized memory disorders and the "memory" problems that are specific to certain domains (e.g., anomia in language or agnosia with regard to objects) is clear.

In each chapter that discusses a particular mental function, the student is first introduced to the basic neural circuitry that underlies that process. Then the student is introduced to how these parts function as a system to support the mental function. Finally, relevant clinical syndromes are discussed; a presentation of their phenomenology is followed by a discussion of the syndrome's implications for understanding brain-behavior relationships.

■ **The book is designed to actively engage students in the process of learning.**

Each chapter begins with an opening case history to pique the students' interest and preview issues that are discussed later in the chapter. For example, the open-

ing case history in Chapter 5 discusses how Muhammad Ali's boxing career led him to have a Parkinsonian disorder, and the opening case history in Chapter 14 discusses the mental decline of my maternal grandmother due to dementia. The text is written in a conversational tone rather than in a technical style, to grab the students' interest and retain it. So that difficult conceptual issues can be presented in a tractable manner, analogies are used extensively. Each chapter includes information in a special-interest box focused on a particular issue in research in cognitive neuroscience or on the implications of neuropsychology for everyday life.

To keep students oriented to terminology, key terms are introduced in bold-face and defined in a glossary at the back of the book. Chapter summaries allow students to review the material learned or preview what is to be discussed, and outlines at the beginning of each chapter provide a clear conceptual structure of the contents. All these features are designed to make this book as user-friendly as possible.

■ State-of-the-art knowledge in the field is presented without sacrificing accuracy or oversimplifying the material.

As a researcher who maintains a highly active and visible research program, the author is in a position to ensure that the book contains not only a discussion of the agreed upon and "classic" findings in the field, but also the cutting-edge portion of our knowledge. Never, however, are students overwhelmed with a laundry list of findings or with overly technical arcane issues. Rather, representative studies are used to highlight the nature of current debates, so that students can understand the conceptual issues under consideration. The author's extensive work in the field, as well as her experience teaching this course, allows her to present issues in a manner that is precise and sophisticated, yet also accessible and integrative.

WHAT'S NEW IN THIS EDITION

While the approach of the first edition has been retained, this second edition has nevertheless been extensively revamped. The main new additions are as follows.

■ The introduction of color.

In this edition, color has been introduced to enhance students' understanding of the material. Figures now highlight the regions of the brain that are being discussed so the reader can quickly see "where" and "what" in the brain are important. Data from patient populations under discussion are highlighted in graphs and figures by use of color. In addition, a full-color insert in the center of the book provide examples of the way in which data from new brain imaging techniques are providing insights into the bases of neural function. Color is also used to set off the glossary terms as well as the chapter summary, which is now provided in a concise bulleted format rather than paragraph format.

■ Ancillary materials to aid in learning.

This new edition of the book is accompanied by a website that offers chapter quizzes written by Wouter Duyck of Ghent University. The quizzes cover the

major topics discussed in the text and provide immediate feedback for students. For instructors, the site includes PowerPoint slides of the figures in the text to aid in lecture presentations.

■ **A new chapter on the functioning of neurons and integration of new knowledge from genetics.**

In response to many requests, the book now includes a chapter (Chapter 2) on how neurons function. This chapter provides a foundation for discussions later on in the book regarding the role of neurotransmitters in neuropsychological function. For example, in the emotion chapter, we discuss the importance of dopamine in reward systems and in schizophrenia, and in the chapter on memory and generalized cognitive disorders, we discuss the role of the cholinergic system. As an adjunct to this information, we also provide increased coverage of genetic mechanisms in neuropsychology, derived from the burgeoning knowledge supplied by the human genome project. For example, when discussing Alzheimer's disease, we discuss the genetic markers that have been linked to early versus late manifestations of the disorder, and we discuss the genetic findings that suggest a distinct etiology for nonverbal as opposed to verbal learning disabilities.

■ **Extensive updating of the material to incorporate the acceleration of knowledge in the field.**

Since the first edition, the fields of cognitive neuroscience and neuropsychology have exploded with new discoveries. As a result, most of the chapters of the book had to be extensively rewritten to incorporate this huge amount of additional knowledge, which is reflected in the over 700 new references in this edition. Much of this knowledge has been garnered from new techniques like functional magnetic resonance imaging (fMRI) and transcranial magnetic stimulation. The methods chapter has been extensively revised and enhanced to include a discussion of these techniques, as well as other promising ones on the horizon, such as optical imaging methods. The findings from studies using fMRI are discussed throughout the book and integrated with material from other methods. In addition, the insights that computational models can provide are presented.

Following is a summary of the main changes to each chapter:

CHAPTER 1

- Now focuses exclusively on the major section and subdivisions of the nervous system

CHAPTER 2—NEW

- Provides an introduction to the basics of neuronal transmission and the effect of neurotransmitters on cognitive and emotional function

CHAPTER 3

- Expanded coverage of functional MRI (fMRI) as a method

- New discussion of transcranial magnetic stimulation (TMS), optical imaging, and computational modeling

CHAPTER 4

- New coverage on the evolution of lateralization and handedness

CHAPTER 5

- Expanded coverage of the roles of distinct regions of premotor cortex in motor control
- New discussion of computational models of movement control

CHAPTER 6

- Expanded coverage of the distinct roles played by specific regions of the ventral visual-processing stream, emphasizing recent information gleaned from fMRI
- Updated discussion of computational models of object recognition
- Updated discussion of categorization of agnosias
- Expanded coverage of the degree to which faces are or are not processed differently than other objects

CHAPTER 7

- Updated with recent fMRI and ERP studies pertinent to spatial processing

CHAPTER 8

- Reorganized to emphasize both the component parts and the interrelationships in the network of brain structures that control attention
- Expanded coverage of the role of the anterior cingulate in attentional control
- Expanded coverage of neurobiological and computational models of the attentional network
- Expanded coverage of methods to ameliorate hemineglect and of the implications of hemineglect for our understanding of the neural bases of attentional control
- Expanded discussion of the neural bases of unconscious processing of information

CHAPTER 9

- Updated discussion of recent findings from fMRI and ERP studies pertinent to language processing, especially those related to the role of inferior frontal regions in language processing
- Added coverage of the neural basis of bilingualism and other language systems, such as American Sign Language

CHAPTER 10

- New section on mechanisms that support encoding, consolidation, and retrieval in memory
- New sections on working memory and skill learning
- New section on the interface between memory and emotion

- New discussion of transcranial magnetic stimulation (TMS), optical imaging, and computational modeling

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- New section on mechanisms that support encoding, consolidation, and retrieval in memory
- New sections on working memory and skill learning
- New section on the interface between memory and emotion

CHAPTER 11

- New coverage of conflict and error-monitoring and their neural substrates
- Enhanced discussion of how frontal regions may act as an interface between working memory, goal-setting and executive processes

CHAPTER 12

- Reorganized to emphasize the myriad of brain regions involved in emotional processing, rather than highlighting the lateralization of emotional processes
- Expanded coverage of the role of the amygdala, prefrontal regions, and retrosplenial cortex in emotional processing
- New section on individual differences in affective processing

CHAPTER 13

- New coverage of genetic mechanisms that influence the neuropsychological profile of development disorders
- Expanded discussion of techniques that induce recovery of function after brain insult and of possible mechanisms for their effects
- New discussion of neurogenesis in adults and the factors that affect it
- Expanded coverage of changes in patterns of brain activity that accompany aging
- New section on how the changes in the brain that accompany aging may be reduced or slowed
- New discussion of neurochemical changes associated with development and of neurotransmitter mechanisms that are involved in developmental disorders

CHAPTER 14

- Expanded coverage of closed head injury related to sports
- New discussion of genetic influences in Alzheimer's disease
- Updated section on potential mechanisms involved in Alzheimer's disease and other neurodegenerative disorders
- Expanded coverage of Creutzfeldt-Jacob (i.e., "mad-cow") disease
- New coverage of the association of neurotransmitter systems with specific dementing disorders, substances of abuse, and toxins

ACKNOWLEDGMENTS

This book has benefited greatly from the generous help of a number of colleagues who reviewed it. I was genuinely touched by the amount of time and effort that these individuals took to improve the book. Their enthusiasm for the project bolstered me when the process seemed to be dragging on forever. They kept me on my toes, and although I may not have taken all of their advice, I thought about each and every one of their suggestions. I am most appreciative of their input.

Mark H. Ashcraft, Cleveland State University; Ruth Ann Atchley, University of Kansas; Mark Beeman, Northwestern University; Robert Bohlander, Wilkes University; Robert Bornstein, Ohio State University; Joan C. Borod, Queen's College of CUNY; Marie-Christine

Buhot, Centre National de la Recherche Scientifique, France; Brian Butterworth, University College London; Michael P. Caligiuri, University of California, San Diego; James V. Corwin, Northern Illinois University; Verne C. Cox, University of Texas, Arlington; Suzanne Craft, University of Washington; Tim Curran, University of Colorado; Martha J. Farah, University of Pennsylvania; Deborah Fein, University of Connecticut; Wim Fias, Ghent University; Susan M. Garnsey, University of Illinois; Siegfried Gauggel, University of Technology Chemnitz; Jordan Grafman, National Institute of Neurological Disorders and Stroke; Kenneth F. Green, California State University, Long Beach; Gary Greenberg, Wichita State University; Dai Jones, Cheltenham & Gloucester CHE; Daniel Kimble, University of Oregon; Karen E. Luh; James V. Lupo, Creighton University; Jennifer A. Mangels, Columbia University; Yuko Munakata, University of Colorado; Loraine K. Obler, CUNY Graduate School; Shelley Parlow, Carleton University; Michael Peters, University of Guelph; Graham Ratcliff, Healthsouth Harmarville Rehabilitation Center; Patricia Reuter-Lorenz, University of Michigan; John D. Salamone, University of Connecticut; Martin Sarter, Ohio State University; Carol A. Saslow, Oregon State University, Emeritus; Sid Segalowitz, Brock University; Matthew L. Shapiro, Mount Sinai School of Medicine; Myra O. Smith, Colgate University; Chantal Stern, Boston University; Christopher Sullivan, Butler University; James Tanaka, University of Victoria; Eli Vakil, Bar-Ilan University; Janet M. Vargo; X. T. Wang, University of South Dakota; David A. Westwood, Dalhousie University; and Daniel B. Willingham, University of Virginia.

I thank Doug Bernstein for his insights and wisdom regarding the textbook publishing process, which spared me many headaches with this and the prior edition, and to Jane Knetzger for helping me formulate a vision for this book during her work on the first edition. I also thank my editor on the second edition, Danielle Richardson, who always seemed to be available the instant I needed her, and who obviously took great care and thought regarding all decisions of the book, prodding me tactfully when I needed it. I have appreciated as well the support of Kerry Baruth, my sponsoring editor, who was an enthusiastic backer of the very extensive revisions that went into this edition. Furthermore, I am grateful to both Neal J. Cohen and Wendy Heller for their willingness to contribute yet again to the book, even though their schedules would have made it much more convenient for them to refuse.

I was most fortunate to have two very able assistants, Felicia Tomasko and Vanessa Currie, aid me in researching material for this book. I am even more pleased that I can now consider them among my friends. Felicia's dedication and doggedness in tracking down even the most arcane issues, in organizing the chaos of my papers and PDFs, in discussing the best ways to present a concept to make it accessible to students, and in catching those places where my fingers got ahead of my mind, were invaluable. Vanessa's ability and enthusiasm at filling in after Felicia left enabled me to keep the momentum going as I was coming down the home stretch.

In the end, however, the people most important to this revision are the three who made it possible, and to whom it is dedicated—my father, my mother, and my partner. One of my father's favorite sayings was, "You live, you learn." By that he meant that we all make mistakes. For him there was no shame in slipping up here and there as long as you harvested the seeds of your future success from today's mistakes. In doing a revision of this book, I took my father's words

from today's mistakes. In doing a revision of this book, I took my father's words to heart—vowing to let any shortcomings of the first edition teach me how to improve the second.

Although she never explicitly stated it this way, my mother's mantra is undoubtedly, "You learn, you live." To her, the essence of life is to continually learn. During my childhood she fashioned everything as an opportunity to learn, from trips to the grocery store, which became mini-lessons in nutrition, to family vacations, which were venues for improving map-reading skills. Those lessons taught me that learning makes the world come alive. As she goes off in her eighth decade of life to tackle the Internet, learn more about opera, or attend her first stockholders' meeting, she is showing me that learning keeps you young. And so it is with that spirit that I undertook this revision.

Finally, Laura Edwards, my soulmate and spouse, took fingers to keyboard and crafted words, sent with deliberate casualness via the Ethernet, that reinitiated a connection made during the days of my dissertation research and visited only intermittently over the intervening years. That small, single brave act has, to my exquisite good fortune, blossomed into the most enthralling experience of my life. She reminds me daily that words can open doors and vistas to worlds barely conceived of in the imagination. Even though my writing lacks the elegance and panache of hers, she inspired me to write yet again in the hope that I might be able to convey to some of my readers the wonders of the human brain and mind that have captivated me for over 20 years.

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