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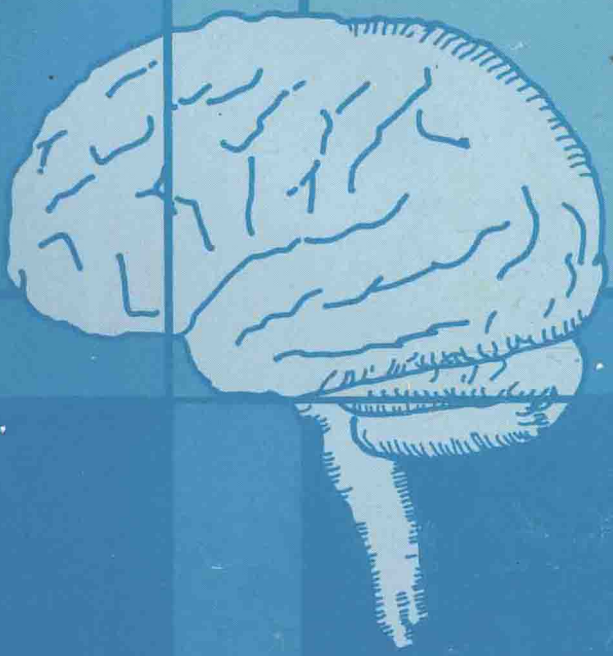

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Preface

The study of the brain and research on human psychological behavior existed in two different worlds until relatively recently. The problems of understanding human behavior seemed to be too complex to be informed by the study of the central nervous system. For years many psychologists thought it best to study relations between environmental stimuli and human behavior, omitting from their research and theories the little-understood and difficult-to-study cognitive psychological processes and the complex neural structures and systems of the brain. If one could show that environmental stimuli control human behavior, then for reasons of parsimony there was little need to study complex cognitive processes, such as attention, learning, and memory and their neural substrates.

But recent research in cognition and in individual differences has indicated that behavior is influenced by environmental stimuli and by the learner's previous experiences, memories, attributions, motives, organized knowledge, intentions, and physiological processes. Research in memory, attention, encoding, imagery, verbal processes, cognitive styles, and information-processing strategies began to flourish and to contribute to the emerging field of cognitive science.

At a different level of study, neuropsychologists and other neuroscientists developed new research methods and techniques that led to important, sometimes dramatic, findings about the cognitive functions,

neural structures, and physiological processes of the brain. Attentional mechanisms and arousal systems were identified. Cortical information-processing systems, which function in perception, learning, and memory, were discovered. The neural substrates of some of the psychological processes underlying human behavior, such as the synaptic transmission of neural impulses, became better understood.

The levels of study were different in neuroscience and in cognitive psychology, but the phenomena under study, such as attention, perception, memory, learning disabilities, and individual differences, were often closely related to each other. Precisely because different levels of related phenomena are under study in these two fields, the recent findings of the research on the human brain have become of interest to many psychologists, educational psychologists, and educational researchers who study cognition, human learning, memory, development, individual differences, attention, motivation, perception, cognitive style, and learning disorders. People in these areas can no longer afford to ignore some of the findings of the recent research on the brain.

This volume reports an important part of the recent findings of the research on the brain. The book begins with a section on the organization of the brain, including its structural and its functional organizations. The first chapter, by Richard Thompson, Theodore Berger, and Stephen Berry, introduces the anatomy, physiology, and chemistry of the brain. The authors describe and illustrate the interesting structures and fundamental processes and systems of the brain. The fascinating sequence of chemical and electrical changes in the synaptic transmission of neural impulses is presented, along with the basic anatomical structures of the different regions of the brain. This chapter provides a useful base for the chapters which follow.

Colwyn Trevarthen describes the functional organization of the brain in the second chapter of the book. He elaborates the psychological and behavioral functions of structures in the spinal cord, brainstem, cerebellum, and forebrain, especially the cerebral cortex.

The information-processing systems of the brain are described in the second section of the book, which consists of four chapters. In Chapter III, Diane McGuinness and Karl Pribram write about attention and its motivational and emotional controls. They present a sophisticated model of attention, analyzing it into three major components: arousal, activation, and effort. Their model leads to a new understanding of the brain's complicated functioning in attention, and to new ways to measure concept learning or categorization and reasoning and problem solving. Their chapter summarizes a lengthy and fruitful research program in the neuropsychology of attention.

Richard Madden and Robert Nebes report next on visual perception and memory. In the context of the recent history of research on cortical hemispheric processes, they discuss, at length, recent findings about perception that have grown from information-processing approaches to the study of vision. They introduce fundamental ideas about encoding as well. The chapter brings together related research from the two worlds of cognitive psychology and neuroscience. As a result, one can get a better understanding of each of these two worlds and of the directions in which they are proceeding.

Daniel Bub and Harry Whitaker delve into language and the brain in Chapter V. They discuss a model of language structures of the brain that has been refined over the years since Karl Wernicke introduced it in 1874. They summarize data from a variety of research approaches used in linguistics, psychology, and neurology that contribute to an understanding of some of the relations between language and the structures of the brain.

Part II concludes with a comprehensive chapter by Jerre Levy on cerebral asymmetry in cognitive processes and individual differences in brain function (Chapter VI). She organizes an enormous number of research findings about the different functions of the cortical hemispheres of the brain, a widely popular, often oversimplified, but highly complicated topic to discuss. She presents the research-based state of the art of hemispherisity, with emphasis on the research in individual differences in hemispheric brain functions, especially among right-handed and left-handed men and women.

The third and final section of the book consists of three chapters on relationships between recent research on the brain and cognitive processes of interest to psychologists. Marcel Kinsbourne, a neuroscientist, writes about cognition and the brain, about relations between the organization of the brain and the problems of psychologists, educational psychologists, and educators interested in the acquisition of behavior. From relatively stimulus-bound trial-and-error behavior, learners develop abilities to represent experience mentally, to abstract it, and to adapt fluently to new and different environments by use of their mental representations and the output mechanisms of their brains.

In Chapter VIII, Wendell Jeffrey, a developmental psychologist, discusses development and the brain. He relates recent research on the brain to some of the problems and processes of child development. He shows that attempts to influence the environments of children should be built upon knowledge about the development of the brain's cognitive mediating structures, their neural substrates, and their differences among individuals.

In the final chapter of the book, I discuss, from an educational psychological perspective, learning and the recent research on the brain. The theme of the chapter is that research in neuroscience and research in cognitive psychology lead to a new emphasis upon the generative processes of the brain and their important role in influencing learning. The theme recurs in research on encoding and memory. Implications of this theme are discussed, including a paradigm for research on teaching and instruction that includes the cognitive processes of the brain, the transformations they perform, and their effects upon learning.

In brief, Part I (Chapters I and II) introduces the basic structural and functional organization of the brain. Part II (Chapters III–VI) discusses research on the basic information-processing systems of the brain: attention, perception, encoding, and memory, including imagery and verbal processes, as well as some of the research on individual differences in information processing strategies. Finally, Part III (Chapters VII–IX) relates the research on the brain to several problems in psychology as these relationships are perceived by a brain researcher, a developmental psychologist, and an educational psychologist.

Acknowledgments

I want to thank the people who participated in the preparation of the book, including the authors of the chapters; the typists Joan Morley and Barbara Trelease; the graduate students who read and commented on my chapter, Helen Schultze, Theresa Roberts, Janet Sutton, and Elizabeth Weinberger; and Professor Allen J. Edwards, the editor of this monograph series, who was active throughout the development of the volume. A special thank you goes to my wife Nancy, to whom the book is dedicated.

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PART I

THE ORGANIZATION OF THE BRAIN

In this first of three parts of the volume, the chapters on the structural organization and the functional organization of the brain introduce two different levels of study of the major systems of the brain and its complex cognitive functions. Chapter One introduces the anatomy, chemistry, and physiology of the brain, and Chapter Two introduces the functional organization of the brain. These two chapters provide holistic perspectives of the organization of the brain and introduce the often complementary findings that emerge from these two different levels of study of the brain.