LATERALITY

Functional Asymmetry in the Intact Brain

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To my three P’s
PAT, PENNY, AND PAM
who keep me going, each in her own way.
Preface

This book grew from a concern with the sweeping generalizations about brain function and laterality that have become popular in recent years. When I first became interested in the possibility that behavioral techniques could be used to study the functional specialization of the brain in normal individuals, there were only a few relevant papers. Now, dozens of new articles appear each month, and an understanding of the differences between the two hemispheres is seen by some researchers as leading to the solution of almost all problems—from psychopathology and dyslexia, to stuttering and management effectiveness.

As I reviewed the literature, however, I found it important to adopt a more conservative stance. Cerebral laterization is one factor affecting performance on a wide variety of behavioral tasks, but it is only one of many factors. Unless we understand the demands of the specific tasks chosen and the strategies subjects use to meet these demands, we risk the danger of overinterpreting the results of experiments on laterality. Thus, the central message of this book is that not all behavioral asymmetries are necessarily related to the differing functions of the two hemispheres.

A major goal of the book is to provide a single source that will introduce the reader to the various methods used to assess behavioral asymmetries. The initial chapters review the literature on perceptual-cognitive laterality effects in different sensory modalities, for it is research of this type that has generated much of the enthusiasm for laterality studies. These chapters indicate some of the problems with the existing research and offer suggestions about the direction of future research. Chapters 7–9 deal with the areas in which laterality research has become popular: lateralization of emotion and of motor behavior, and the electrophysiological evidence.

For many people, handedness is one of the most salient asymmetries.
General statements about brain organization and cerebral laterality are often prefaced by the statement that they do not apply to left-handers. Chapters 10 and 11 deal with the measurement and origins of handedness and indicate the extent to which handedness must be considered to be an important variable in laterality research.

In a broad sense, Chapters 12–16 are all concerned with problems of individual differences in laterality. First, I examine the question of whether laterality changes with age in young children. Second, I consider the data on laterality effects in special groups, especially those studies dealing with sex differences and with language-impaired subjects. Third, I consider the evidence for hemisphericity as a cognitive style. The concluding chapter summarizes the major points of the book and presents a general framework for laterality research in the normal subject.

This book is addressed primarily to neuropsychologists, experimental psychologists, neurologists, and educators. I am convinced that experimental psychology has a major contribution to make to the understanding of human brain function. Experimental psychologists can typically afford to test various hypotheses, develop precise methods, and rule out alternative explanations by careful experimentation. The practicing neuropsychologist can seldom afford such luxury: A patient with a particular type of brain damage may appear only rarely, and one cannot try a dozen alternatives before settling on an appropriate experimental procedure. In the domain of laterality research, this volume can direct the neuropsychologist toward those hypotheses that may be most fruitful and away from those that are less viable.

The book should also provide a similar function for the educator interested in special groups. Researchers in education often do not have access to the immense literature of experimental psychology, and yet a grasp of this literature is essential in planning good studies of dyslexia, language impairment, and related phenomena. By providing a general overview of laterality research, the book will give those researchers who wish to investigate particular types of laterality effects a view of how other researchers with different viewpoints have approached similar problems.

The book does not, however, provide a unified theory of lateralization of function. The more I read and wrote, the more convinced I became that there was as yet scant evidence to support any one general theory. There remain too many unanswered questions and too many unsolved problems to do any more than point in the direction of an integration of the laterality data. That will have to wait for more experimentation. In the meantime, this book may suggest fruitful lines of research.
Acknowledgments

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I must also acknowledge the support of Harry Whitaker, the series editor. Whit encouraged the project from the beginning, reassured me when I was most pessimistic, tolerated the lengthy time it took to complete even the first draft, and made wise suggestions about all parts of the manuscript. I looked forward with some trepidation to the pages of single-space commentary he sent me on each chapter. Derek Besner, Ernie MacKinnon, Janice Murray, and Sid Segalowitz also read and commented on my penultimate draft, and their advice has colored the final project. Many thanks are also due to Bonnie Lee Bender, Laurie Westlake Bruin, Bev Dakins, Diane Hagan, Paula Kovacs, and Lyn Spaetzel who did an outstanding job of typing page upon page of manuscript. Finally, my own contribution was aided by a grant from the Natural Sciences and Engineering Research Council of Canada and by the willingness of the Department of Psychology at the University of Waterloo to assist with both typing services and computer facilities.
Introduction

The notion that the two cerebral hemispheres have different functions and that this is important in our daily lives has become very popular in the past few years. Such ideas have a long history (Wigan, 1844) but were given new impetus by the exciting work of Sperry and his colleagues on the behavior of patients following section of the corpus callosum and anterior commissure (e.g., Gazzaniga, Bogen, & Sperry, 1962, 1963, 1965). This work revealed that the isolated left hemisphere perceived, remembered, and responded in a fashion quite different from the isolated right hemisphere (see Bogen, 1969a, 1969b; Gazzaniga, 1970 for reviews). At about the same time, work by Doreen Kimura (1961a, 1961b, 1967) in auditory perception provided some suggestion that the different functions of the two hemispheres could be measured in the normal, intact brain.

The popular appeal of this work has been such that it has led to a vast number of speculations. Cerebral asymmetries are now taken as givens, and ideas derived from the study of cerebral asymmetry are used to explain almost every imaginable kind of behavior, from reading disability to schizophrenia, from stuttering to the gender-related difference in spatial ability, from infantile autism to the generation gap.

The objective of the present book is to review the evidence pertaining to cerebral asymmetries in the intact human brain. We shall be concerned primarily with two issues. First, can one reliably assess the different function of the two cerebral hemispheres with noninvasive techniques? Second, do the patterns of cerebral asymmetry relate in any consistent way to meaningful behavior? One of the viewpoints developed in this book is that many of the studies supposedly dealing with cerebral asymmetries do not in fact do so. Nevertheless, sufficient consistencies do exist for one to believe that functional cerebral asymmetries
can be measured and that they do have some meaningful consequences for normal behavior. The aim of the succeeding pages is to provide a realistic assessment of the current state of the art.

**A Simplistic View of Cerebral Asymmetry**

Ever since the work of Dax (1865) and Broca (1861) in the mid-nineteenth century, it has been known that damage to certain portions of the left hemisphere results in disturbances of language (aphasias) that do not occur following damage to the right hemisphere. Thus, in some fashion the left hemisphere is functionally specialized for at least some language processes. In the late nineteenth and early twentieth century, there were a number of reports of aphasias following right-hemispheric damage, often in individuals who were left-handed or had some familial history of left-handedness. It was an easy step from these observations to the notion that left-handers were the reverse of right-handers, using the right hemisphere rather than the left for speech and language processes. While current evidence indicates that this is an oversimplification, it is generally agreed that the incidence of right-hemispheric speech is higher in left-handers than in right-handers (Herron, 1980).

Perhaps because disturbances of speech and language are relatively obvious and important in one’s daily life, much of the early clinical neuropsychological work concentrated on the aphasias and on the functions of the left hemisphere. Only in the past 30 years has much attention been paid to the right hemisphere and to nonverbal skills. Although the deficits may not be as striking or as clear-cut, recent evidence has suggested that the right hemisphere plays an important role in a variety of nonverbal activities, including music (Gates & Bradshaw, 1977b), spatial abilities (Benton, 1979), face recognition (Geffen, Bradshaw, & Wallace, 1971), and emotional expression (Ley & Bryden, 1981). At a simple level, then, the left hemisphere can be viewed as concerned with speech and language, whereas the right hemisphere is concerned with nonverbal skills. In the search for a better distinction, the left hemisphere is often described as analytic or concerned with sequential processing, whereas the right is considered to be concerned with the integration of information over space and time, a holistic or gestalt processor (cf. Bradshaw & Nettleton, 1981).

It is only a small step from this elementary description of functional asymmetry to the view that those people who excel in verbal skills are using their left hemispheres in preference to their right and, conversely,