

An anatomical illustration of a brain section, showing the cerebral cortex and underlying white matter. The illustration features a dense network of black lines representing fiber tracts, which fan out from the center towards the periphery. The brain tissue is rendered in a realistic, reddish-pink color. The overall shape is roughly circular, with some irregularities at the edges.

# **Brain Structure and Its Origins**

in Development and in Evolution of Behavior and the Mind

**Gerald E. Schneider**

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Gerald E. Schneider



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## Brain Structure and Its Origins

This book is dedicated to the memory of my mother and father and my youngest sister, Linda Jean. Their enthusiastic support is always with me.

## Preface

The first draft of this book was based on classes I have taught in the MIT Brain and Cognitive Sciences Department for many years, including classes for undergraduates. The book is also based on an introduction to neuroanatomy I teach to beginning graduate students. Finding no available textbook that fitted what I wanted for these classes led me to start writing the book. In the writing, I have assumed that readers have had some exposure to biology or to anatomy and physiology. This book can be useful to advanced undergraduates, to graduate students studying psychology, biology, zoology, or neuroscience, and to interested readers in other fields. More generally, the book is for any persons who wants to gain greater familiarity with the nervous system and how it works. It will be useful also for scientists, bioengineers, and medical personnel who have plunged into work on details of a particular portion of the brain and want to fill out their picture of how that part fits into the whole system.

The book is not primarily about evolution. It is about the structure and functional significance of the central nervous system (CNS), especially the major structures and their interconnections in the brains of vertebrates with a special focus on mammals. CNS structure and its variations among vertebrates can be learned and understood more easily if one knows something about *why* it is so. The “why” can be answered in terms of functions, in terms of evolution, or in terms of development. In this book, I consider each of these three aspects of why the brain is put together as it is, because they make the structure more comprehensible as well as more interesting and memorable.

Brain evolution is presented in broad outline, based primarily on comparative neuroanatomical findings. The great importance of functional adaptations in evolution as described by Charles Darwin is assumed. Darwinian theory as updated in modern times, together with comparative neuroanatomical findings, are used to guide the formulation of suggested explanations of some key steps in early chordate CNS evolution.

The major goal is to help the student of brain anatomy and function gain an outline that she or he can use in further explorations of this field. It is a field that can seem formidably intimidating at first but fascinating and rewarding to the explorers who persist in going through the territory and learning the rudiments of the language.

I am indebted to many teachers, especially to Hans-Lukas Teuber, Norman Geschwind, and Walle J. H. Nauta when I was a graduate and postdoctoral student at MIT. I also owe much to teachers and advisors who preceded them in my education, especially to Joseph Spradley and Arthur Holmes at Wheaton College (Illinois), from whom I learned that studies of physics and philosophy prepared me for intellectual adventures outside those specialties. The book would not have been completed without the unfailing assistance and encouragement of my wife, Aiping Liang Schneider. I also acknowledge the help of Jeffrey Meldman of the MIT Sloan School, who read an early draft of the manuscript and helped me to clarify the ideas and to improve the English and the logic. The MIT students who have been reading drafts of the chapters as they prepared for my classes have also given me encouragement, as have the teaching assistants who assure me that the book is worthwhile for them as well as for the students. Two teaching assistants have given special help during final stages of editing: Andrew Bolton and Beverly Cope. I also thank my faculty colleagues and colleagues at other institutions, and other friends for their help and support. George Adelman at MIT has promoted this project and given help from its onset. Finally, I am grateful to the various members of my family for their encouragement and humor during the whole process.

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