NEUROANATOMY

FOR SPEECH-LANGUAGE PATHOLOGY AND AUDIOLOGY

SECOND EDITION

MATTHEW H. ROUSE

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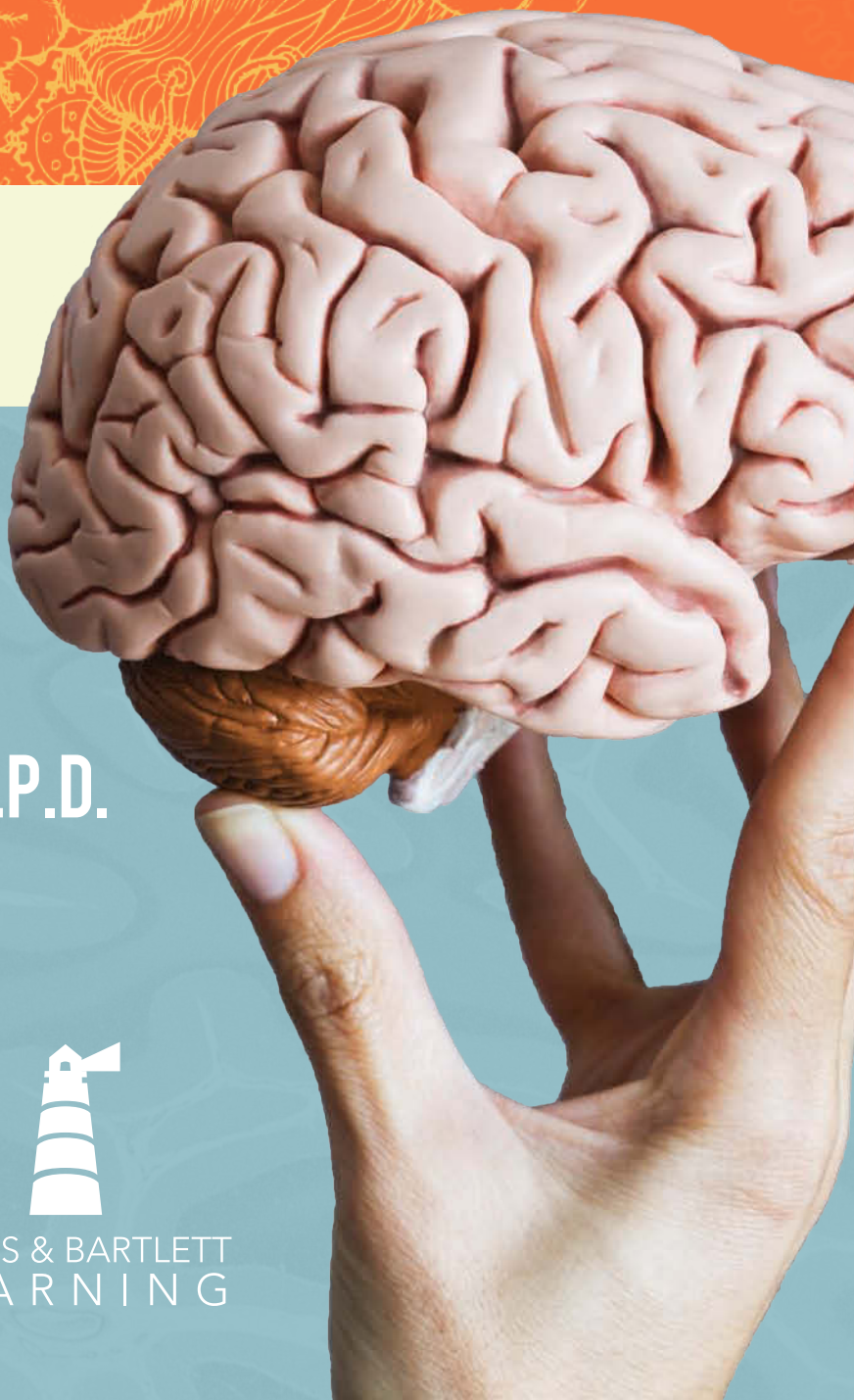

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This book is dedicated to three sets of people:

To my wife, Chrissie, and my daughters, Torie and Lexie… thank you for your gracious gift of time to complete this work.

To my parents… thank you for your years of love, commitment, and encouragement.

To my neuroanatomy students… thank you for your feedback. You have all made this text better.

Brief Contents

Contents

Preface

This text is primarily intended for graduate students studying communication sciences and disorders, but it is also written in an accessible way for junior or senior undergraduates preparing for graduate school. It is more important than ever for communication science and disorders students to understand the neurological underpinnings of communication disorders. As I think back on my own education, I did not have a standalone neuroanatomy class in either my undergraduate or graduate communication sciences and disorders training. At that time, this kind of information was imbedded over the span of a couple of weeks in an undergraduate anatomy of speech and hearing course. After graduate school, I entered the profession as a medical speech-language pathologist at a regional trauma center. It was here that I was challenged to learn about a variety of neurological disorders that I had previously learned little about. It has been over a quarter century since I completed my master's studies, and a lot has changed since that time. Now, nearly all graduate training programs have a full class in neuroscience to help students better understand, assess, and treat people with neurogenic communication disorders.

This text was born after a 15-year search for a neuroscience book focused on communication and communication disorders for my class. I adopted general neuroscience texts written by neurologists and neuroscientists, but I was unhappy with the lack of discussion about communication and communication disorders. I also tried texts written by communication scientists and others in communication disorders, but I found these to resemble the general neuroscience texts with some discussion of communication disorders sprinkled in here and there. Often, robust discussions of language or swallowing were entirely missing. I mentioned this frustrating search to a salesperson from Jones & Bartlett Learning, who asked "Have you ever thought about writing one?" The seed was planted and I realized that it was time to stop complaining and produce something that would at *least* help me in my class. My hope is that this text will be helpful to those of you who also teach this subject matter as well as helpful to your students.

Organization of the Text

Neuroanatomy for Speech-Language Pathology and Audiology is organized into four main sections. The first three chapters, comprising Part I, Introductory Issues, introduce readers to the nervous system. Chapter 1 starts this process by taking the reader into the world of the nervous system. Important terms like *neurology* and *neuropathology* are explored, as well as the classification of neurological disorders and a brief introduction to the history of neuroscience. An introduction to imaging technology is included in this chapter because professionals in communication sciences and disorders are consumers of the reports generated by these studies. Chapter 2 introduces some basic orientation terms that will help in navigating around neurological structures as well as three methods for organizing the nervous system. Chapter 3 surveys the development of the neurological system through the life span, from conception to the last years of life.

Part II, General Neuroanatomy, includes Chapters 4 through 8. These chapters introduce the reader to the main neurological structures. This journey begins with the cells of the nervous system and ends with a review of the cerebral hemispheres. In Chapter 4, we take a microscopic approach and discuss the cells of the nervous system, both their structure and function. Chapter 5 zooms out to begin a macroscopic journey around the neurological structures (i.e., structures we can see and examine with the naked eye). More specifically, it looks at the spinal cord, brainstem, cranial nerves, and cerebellum. A close inspection of the 12 cranial nerves will occur in this chapter. The journey continues in Chapter 6 by examining structures above the brainstem and inside the brain—namely, the diencephalon and the surrounding thalamic structures and structures in close proximity, such as the brain's ventricles. The focus again moves in the next two chapters to the cerebral hemispheres. Chapter 7 discusses the overall structure of the cerebral hemispheres, such as their sulci, gyri, and blood supply. Chapter 8 then surveys important areas of the cerebral cortex using the Brodmann numbering system. Here we discuss the structure and function of various areas, such as Broca's

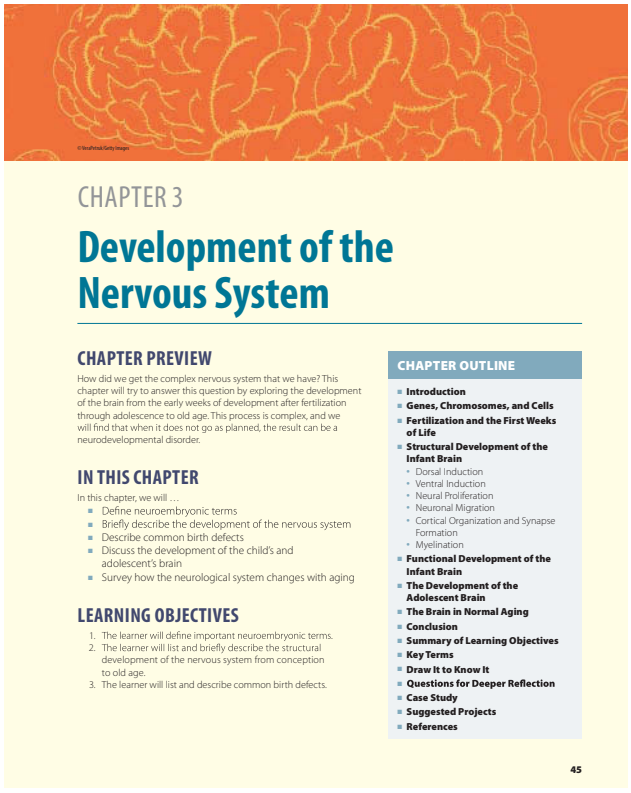
and Wernicke's, two of several areas crucial in speech production and comprehension.

Part III, Neuroanatomy Applied to Communication and Communication Disorders, includes Chapters 9 through 15. I believe these chapters are unique when compared to other neuroscience texts for speech-language pathologists and audiologists because they specifically focus on the neurology of speech, language, hearing, cognition, emotion, and swallowing. These are the communication processes important to these professionals. Chapter 9 begins this third section by exploring consciousness. We say that speech is a voluntary, conscious activity, but what do we mean by consciousness? What are the disorders of consciousness (e.g., coma) that might affect communication? Chapter 10 is of special interest to audiologists because it explores the neurology of the hearing and balance systems and includes discussion of select disorders of these systems. Chapter 11 turns to the topic of speech. Here we look at neurological structures crucial for speech production and attempt to connect problems with these structures to various speech disorders observed in clinical practice. Language is the focus of Chapter 12. The neurological structures involved in speaking, listening, reading, and writing are explored as well as communication disorders associated with each of these modalities. Chapter 13 moves away from communication to swallowing. The cortical and subcortical controls of swallowing are surveyed as well as neurogenic swallowing problems. In recent years, speech-language pathologists have taken a more active role in what are called cognitive-communicative disorders. Chapter 14 focuses on cognition by looking at three main areas of cognition: attention, memory, and executive functions. Several cognitive-communicative disorders, like right hemisphere disorder, are examined through the lens of attention, memory, and executive functions. The final chapter of this section, Chapter 15, looks at the neurology of emotion. Children with autism have become more prevalent on caseloads, so there has been increased interest in how these children process and produce emotional responses. Chapter 15 discusses what we know about the neurology of emotion and the neurological differences between typical children and those with conditions like autism.

Finally, Part IV, Practicing Neuroanatomy, helps prepare students to apply what they have learned throughout the text. Chapter 16 discusses how a neurologist examines a person with a suspected neurological condition and looks at points of overlap with what a speech-language pathologist or audiologist would do in his or her assessment. A cranial nerve examination form is included in this chapter for students to practice this important exam. Also, major signs and symptoms of neurological conditions are surveyed.

Features and Benefits

Each chapter includes a number of pedagogical features designed to enhance student learning. At the beginning of each chapter, you will find a Chapter Preview that offers a general introduction to the chapter's contents, an In This Chapter feature that lists main points discussed in the chapter, Learning Objectives that present the chapter's desired outcomes, and a Chapter Outline that lists the main headings for quick reference.



CHAPTER 3

Development of the Nervous System

CHAPTER PREVIEW

How did we get the complex nervous system that we have? This chapter will try to answer this question by exploring the development of the brain from the early weeks of development after fertilization through adolescence to old age. This process is complex, and we will find that when it does not go as planned, the result can be a neurodevelopmental disorder.

IN THIS CHAPTER

In this chapter, we will …

- Define neuroembryonic terms
- Briefly describe the development of the nervous system
- Describe common birth defects
- Discuss the development of the child's and adolescent's brain
- Survey how the neurological system changes with aging

LEARNING OBJECTIVES

1. The learner will define important neuroembryonic terms.
2. The learner will list and briefly describe the structural development of the nervous system from conception to old age.
3. The learner will list and describe common birth defects.

CHAPTER OUTLINE

- Introduction
- Genes, Chromosomes, and Cells
- Fertilization and the First Weeks of Life
- Structural Development of the Infant Brain
  - Dorsal Induction
  - Ventral Induction
  - Neural Proliferation
  - Neuronal Migration
  - Cortical Organization and Synapse Formation
  - Myelination
- Functional Development of the Infant Brain
- The Development of the Adolescent Brain
- The Brain in Normal Aging
- Conclusion
- Summary of Learning Objectives
- Key Terms
- Draw It to Know It
- Questions for Deeper Reflection
- Case Study
- Suggested Projects
- References

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At the end of each chapter, the information related to the chapter's learning objectives is described in the Summary of Learning Objectives feature. Key Terms are also listed, the definitions of which can be found in the Glossary at the end of this text. Suggestions for drawing activities—critical for visual learners—are presented in the Draw It to Know It feature, and Questions for Deeper Reflection and Suggested Projects encourage students to delve deeper into the material.