How the Special Needs Brain Learns

Third Edition

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EDUCATION

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Preface to the Third Edition

Welcome to the third edition! Since the publication of the first edition, there have been major developments in our understanding of how the human brain develops and functions. Brain imaging studies now number more than 3000 a year. Technologies, such as transcranial magnetic stimulation, are gathering more information about cerebral processes. Researchers in genetics have found new links to physical, psychological and learning disorders. Investigations into mirror neurons may explain why certain learning problems arise and yield clues as to how they can be treated. All the chapters in this third edition have undergone major revisions to include these developments and the findings of new studies. In addition, I have

- updated the terminology of disorders to align with the newest edition of the *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edition (DSM-5)
- updated and added nearly 400 citations and references
- updated the section on resources
- added video links that further explain certain topics
- added a section on memory systems
- included numerous forms of **assistive technology** for students with learning difficulties
- added a section on sleep difficulties
- added a section on future trends in special education
- added a section on the effects of poverty.

Researchers and clinicians have made considerable progress in recent years understanding the genetic and environmental triggers that result in learning problems in children and adolescents. Nonetheless, arriving at a specific diagnosis can be tricky. Teachers and parents often cannot tell the difference between a normally rambunctious child and one who may have a developmental disorder. My hope is that the information here will provide educators and parents with some of the strategies they need to help their students and children lead happy and successful lives.

David A. Sousa

Introduction

Teachers and students get up every school-day morning hoping to succeed. That hope is not always realised because many factors exist that affect the degree of success or failure in a teaching and learning situation. Some of these factors are well beyond the control of the teacher and the school staff. What teachers *do* control, of course, are the decisions they make about how to present the lesson so that student learning is most likely to occur. In making these decisions, teachers draw on their knowledge base and experience to design activities, ask questions and respond to the efforts of their students.

Educators are finding themselves searching for new strategies and techniques to meet the needs of an ethnically, culturally and socially diverse student population. Some tried-and-true strategies do not seem to be as successful as they were in the past and more students seem to be having difficulty acquiring just the basic skills of reading, writing and computation. The number of public school students being diagnosed with specific learning disabilities is growing. In 2012–2013, 13 per cent of the total public school population in the United States was classified as having specific learning disabilities and speech or language impairments, compared to 8.3 per cent 10 years earlier (US National Center for Education Statistics, 2014).

This situation is generating frustration in different parts of the educational community. As a result, educators are searching for new approaches, parents are seeking alternative schooling formats (charter schools and vouchers) and state legislators are demanding accountability through higher standards and standardised testing. Added to this mix are the requirements to focus on response to intervention. All these activities are in full swing, but stakeholders are debating whether these efforts are resulting in more effective services to students with special needs.

Meanwhile, more students diagnosed with learning disabilities are being included in general education classrooms and teachers continue to search for new ways to help these struggling students achieve. As more students with learning difficulties enter general education classes, their teachers are finding that they need help adjusting to the added responsibility of meeting the varied needs of these students. Consequently, special education teachers will need to collaborate more than ever with their general education colleagues on ways to differentiate instruction in the inclusive classroom.

General and special education teachers will need to collaborate more than ever on ways to differentiate instruction.

WHO ARE SPECIAL NEEDS STUDENTS?

For the purposes of this book, the term *special needs* refers to students who are:

- diagnosed and classified as having specific learning problems, including speech, reading, writing, mathematics and emotional and behavioural disorders
- enrolled in supplemental instruction programs for basic skills
- not classified for special education but still struggling with problems affecting their learning.

The term, as used here, does not refer to students with learning problems resulting primarily from hearing, visual or physical handicaps.

CAN BRAIN RESEARCH HELP?

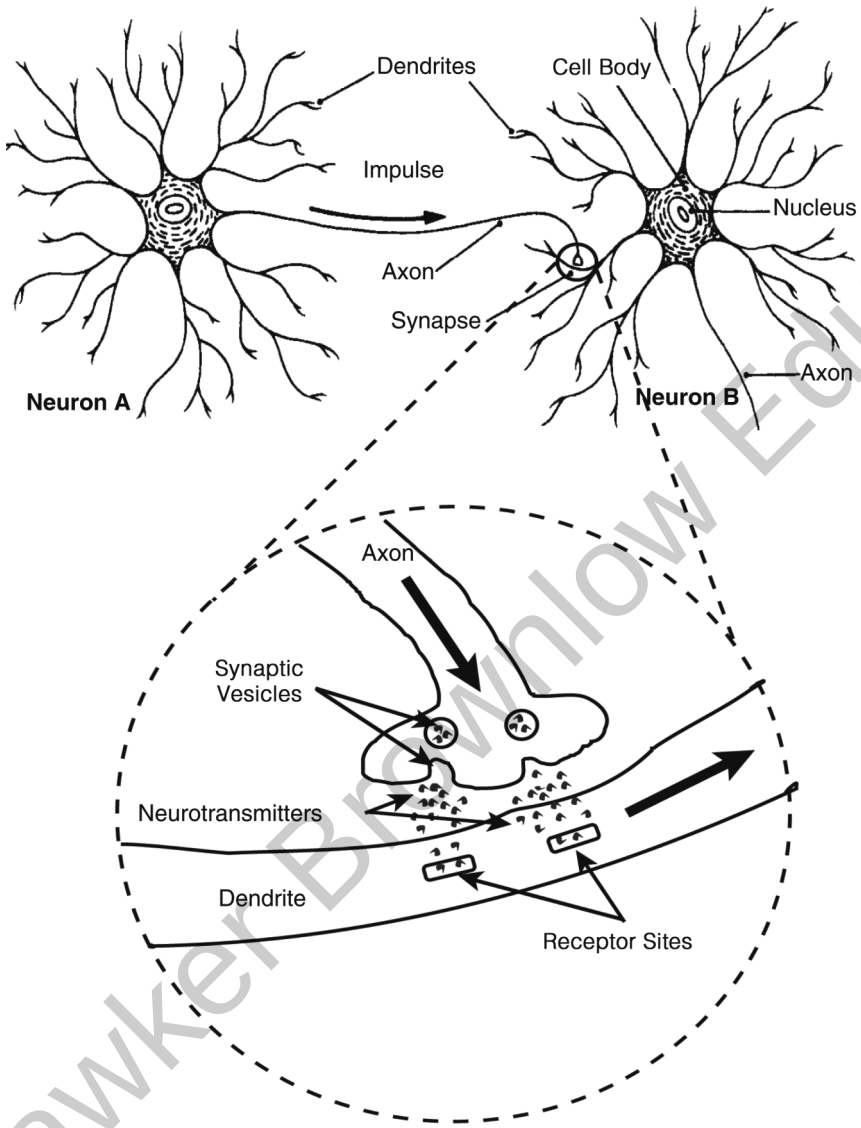
Teachers may face significant challenges when meeting the needs of children who have learning problems. Trying to figure out what is happening in the brains of these children can be frustrating and exhausting. Until recently, science could tell us little about the causes of learning disorders and even less about ways to address them successfully.

The nature of the difficulties facing students with learning problems varies from maintaining focus, acquiring language, learning to read and write and solving mathematical problems to remembering important information. Thanks to the development of imaging and other technologies, neuroscientists can now look inside the live brain and gain new knowledge about its structure and functions. Some of this research is already revealing clues to help guide the decisions and practices of educators working with students who have special needs.

Because of the efforts of scientists over the years to cure brain disorders, we know more about troubled brains than we do about healthy ones. Early ventures into the brain involved extensive risks that were justified by the potential for curing or improving the patient's condition. But now, essentially risk-free imaging technologies (such as functional magnetic resonance imaging or fMRI) are giving us greater knowledge about how the normal brain works. It all started in just one project a decade ago, when scientists compiled a database of brain scans of about 500 children without apparent health problems aged 7 days to 18 years. That information helped researchers study different stages of brain growth and expanded our understanding of what normal brain development is (Evans, 2006). Today, that database has thousands of scans.

Students with learning problems comprise such a heterogeneous group that no one strategy, technique or intervention can address all their needs. Today, more than ever, neuroscientists, psychologists, computer experts and educators are working together in a common crusade to improve our understanding of the learning process. Comparing the functions of brains without deficits to the functions of brains with deficits is revealing some remarkable new insights about learning and behavioural disorders. Some of the findings are challenging long-held beliefs about the

Figure 1.4 Neurons, or nerve cells, transmit impulses along an axon and across the synapse to the dendrites of the neighbouring cell. The impulse is carried across the synapse to receptor sites by chemicals called neurotransmitters that lie within the synaptic vesicles.



Curiously, these neurons also fired when a person saw someone else perform the movement. For example, the firing pattern of these neurons that preceded the subject grasping a cup of coffee, was identical to the pattern when the subject saw someone else do that. Thus, similar brain areas process both the *production* and *perception* of movement. Neuroscientists believe these **mirror neurons** may help an individual decode the intentions and predict the behaviour of others. If you see someone reach for a ball even though their hand is out of sight, your mirror neurons tell you that they are going to pick up the ball even before they do it (Fadiga, Craighero, & Olivier, 2005; Iacoboni et al., 2005).

Strategies to Consider

STRATEGIES FOR INVOLVEMENT AND RETENTION OF LEARNING

Students with attention difficulties need help to maximise their engagement and improve their retention of learning. The following strategies are appropriate for all students, especially those who have learning problems.

- **Get their attention.** Use humour, unexpected introductions and various other attention grabbers to stimulate student interest in the lesson.
- **Make it relevant.** Relevancy (or meaning) is one of the major factors affecting retention. Students are not likely to retain what they perceive as irrelevant. Keep in mind that it is *their* perception of relevancy that matters, not *yours*.
- **Model, model, model.** Show students how to do it. Use models, simulations and examples for simple as well as complex concepts. Ask them to develop original models. Models that cannot be shown in the classroom are often available on the internet.
- **Use teams.** Students with learning problems are particularly successful when working in teams. The opportunity to discuss what they are learning keeps them actively engaged and helps them practise interpersonal skills, rehearse new learnings and find meaning.
- **Set goals.** Success is a key factor in maintaining involvement. Set clear and realistic goals with the students (e.g. "Let's try to solve three problems this time").
- **Find out what they already know.** Take the time to assess in advance what students already know about the topic you are about to teach. Building on this prior knowledge is an effective way of helping students establish relevancy.
- **Use visuals.** We live in a visually oriented culture and students are acclimated to continuous visual stimuli from their digital devices. Graphs, pictures, diagrams and visual organisers are very effective learning and retention devices.
- **Go for the big picture.** The brain is a pattern seeker. Use your own or computer-generated graphics to put together the big picture, showing how concepts are connected. Discuss the patterns that emerge and link them to what students have already learned.
- **Think and talk aloud.** When teachers think aloud, they model the steps in cognitive processing and reveal what information or skills can be used to approach and solve a problem. Talking aloud is an excellent memory enhancer, especially when students discuss open-ended questions, such as "What might have happened if … ?" or "What would you have done instead?"
- **Suggest mnemonic devices.** All memory tricks are valuable. Teach mnemonic devices to help students remember factual information

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Speech Difficulties

We speak not only to tell other people what we think, but to tell ourselves what we think. Speech is a part of thought.

– Oliver Sacks, *Seeing Voices*

Human beings have developed an elaborate and complex means of spoken communication that many say is largely responsible for our place as the dominant species on this planet. Spoken language is truly a marvellous accomplishment for many reasons. At the very least, it gives form to our memories and words to express our thoughts. The human voice can pronounce about 200 vowel and 600 consonant sounds that allow it to speak any of the nearly 7000 languages (not counting dialects) that exist today. With practice, the voice becomes so fine-tuned that it makes only about one sound error per million sounds and one word error per million words (Pinker, 1994).

Before the advent of imaging technologies, we explained how the brain produced spoken language on the basis of evidence from injured brains. In 1861, French surgeon Paul Broca noted that damage to the left frontal lobe induced language difficulties generally known as **aphasia**, wherein patients muttered sounds or lost speech completely. **Broca's area** is located just behind the left temple (Figure 4.1). A person with damage to Broca's area, for example, could understand language but could not speak fluently. In 1871, German neurologist Carl Wernicke described a different type of aphasia – one in which patients could not make sense of words they spoke or heard. These patients had damage in the left temporal lobe. **Wernicke's area** is situated above the left ear. Those with damage to Wernicke's area could speak fluently, but what they said was quite meaningless. The inferences, then, were that Broca's area stored vocabulary, grammar and probably syntax of one's native language, while Wernicke's area was the site of native-language sense and meaning.

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Figure 6.1 In a right-handed individual, writing involves mainly the left parietal lobe. For a left-handed person, the right parietal lobe is the area of main activation. Regardless of which hand is used, the visual cortex involvement is the same.

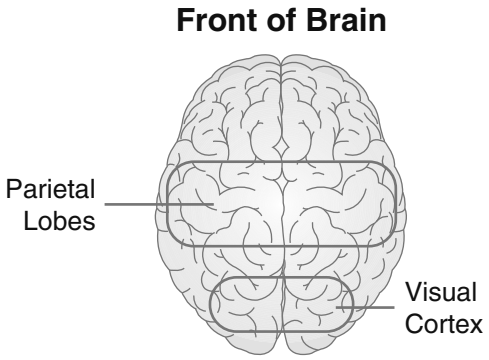
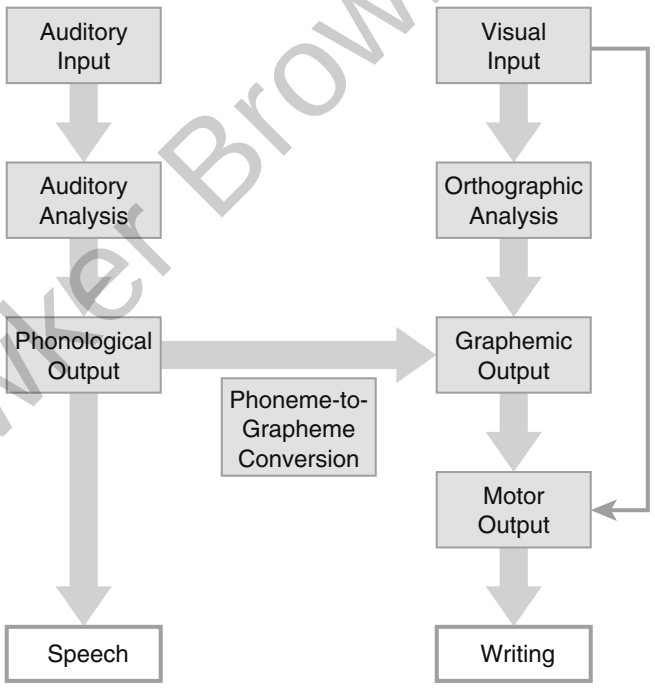


Figure 6.2 The diagram shows the relationship between speech and handwriting. The writer hears the word (phonological output) and converts the sounds to the appropriate letters (graphemes). The dotted arrow shows how motor adjustments are made as the visual system judges the legibility of the writing (adapted from Wing, 2000).



reinforces long-term memory and helps the mind sort and prioritise information. However, for some students, the process of writing becomes an arduous task that actually interferes with learning.