CHAPTER 1

Executive Skills

What Are They, and Why Are They Important for Developing Thinking Readers?

> And so, to completely understand what we do when we read would almost be the acme of a psychologist's achievements, for it would be to describe very many of the most intricate workings of the human mind, as well as to unravel the tangled story of the most remarkable specific performance that civilization has learned in all its history.
>
> —Edmund Burke Huey (1908, p. 6)

Huey was on to something back in 1908. Skilled reading is remarkably complex and requires readers to juggle actively multiple sources of information in text, integrate that information with what they already know, and consciously monitor their own understanding to produce nuanced interpretations of text content. In short, reading is thinking, very active and incredibly complex thinking. Yet we often find that our students seem to lack the thinking skills, such as memory, the ability to plan ahead, and the ability to shift focus when necessary, that seem natural to us as skilled comprehenders.

Consider your own reading of a text: You must quickly recall letter–sound connections, relatively effortlessly translate the letters on the page into speech sounds (phonemes) that you hold in mind and blend into words, link those words to their appropriate meanings, and weave those meanings together to make sense of sentences, paragraphs, and the text as a whole. When reading fiction, you make inferences about characters' emotions from information about their behavior, and you also anticipate characters' future actions based on inferences about their thoughts, feelings, and intentions. When reading fictional and expository texts, you use your knowledge about different kinds of text structures to construct your interpretations of texts, and you make connections between your own knowledge and the information you encounter as you read. Not only that, you somehow manage to hold all of this information in mind while continuing to work your way

through the text, and you shift your focus when necessary to ensure that you understand what you read.

These processes are just the tip of the iceberg in skilled reading. These cognitive feats are indeed impressive, and they are also difficult to teach. The trouble for teachers (who are also skilled readers) is that the thinking processes we use when we read are so well practiced that they often occur below the level of conscious awareness (Duffy, 2014). That is, they occur automatically, which makes it difficult for us to reflect on them in ways that help us explain them to our students. Much like riding a bicycle, we know we can do it, but explaining how it happens is another story entirely.

Contemporary cognitive and educational neuroscience perspectives have much to say about the kinds of higher order thinking skills necessary for academic success (Blair et al., 2007; Guare, 2014; Katzir & Paré-Blagoev, 2006; Liew, 2012; Meltzoff, Kuhl, Movellan, & Sejnowski, 2009; Spiegel, Goodrich, Morris, Osborne, & Lonigan, 2021) and for the development of skilled reading in particular (Butterfuss & Kendeou, 2018; Cartwright, 2012; Cartwright & Guajardo, 2015; Follmer, 2018; Fuhs, Nesbitt, Farran, & Dong, 2014; Sesma, Mahone, Levine, Eason, & Cutting, 2009). These higher order skills, called *executive skills* (or executive functions), help us process, coordinate, and integrate text information at the word, sentence, and passage levels (Nguyen, Pickren, Saha, & Cutting, 2020), and they have important implications for instruction.

If you've opened any professional education book catalogues recently, you've probably seen a host of texts on executive skills and learning problems, executive skills and ADHD, "smart but scattered" students, or some other such topic (e.g., Dawson & Guare, 2009, 2012, 2016, 2018; Faith, Bush, & Dawson, 2022; Guare, Dawson, & Guare, 2013; Kaufman, 2010; McCloskey, Perkins, & Van Divner, 2009; Meltzer, 2010, 2018; Solanto, 2013). The burgeoning market for texts with these popular themes may lead us to believe that knowledge of executive skills is particularly important for special education teachers, but that executive skills are not necessarily relevant for teachers in regular education classrooms or for literacy coaches and reading specialists who support implementation of the reading curriculum for all students.

As it turns out, executive skills are important not only for understanding learning *problems*, but also for understanding learning *successes* across the curriculum (Guare, 2014; Meltzer, 2010, 2018). What's more, new research is revealing that executive skills play important roles in literacy learning, with particularly critical roles in successful reading comprehension (see Butterfuss & Kendeou, 2018; Cartwright, 2012, 2015; Follmer, 2018; Kieffer, Vukovic, & Berry, 2013; Sesma et al., 2009). Furthermore, as you might expect, children who have word reading difficulties have significant problems with key executive skills (Abo-elhija, Farah, & Horowitz-Kraus, 2022; Kudo, Lussier, & Swanson, 2015). Likewise, children who have age-appropriate word reading skills but nevertheless have difficulties with reading comprehension have significantly lower levels of key executive skills than

their peers with better reading comprehension (Borella et al., 2010; Cain, 2006; Cartwright, Coppage, et al., 2017; Locascio et al., 2010). In fact, problems with executive skills emerge consistently for struggling readers, regardless of type of reading difficulty (Booth, Boyle, & Kelly, 2010). These discoveries are important for all educators because reading is the foundation for all other learning in school. Students cannot understand, enjoy, or respond to literature without effective reading comprehension. Likewise, students cannot gather new information from science, math, or social studies texts when they don't understand what they read. Fortunately for reading educators and for our students, executive skills that support reading can be taught, providing us additional ways to convey the complex thinking processes involved in skilled reading to our students and yielding improvements in executive skills and reading (e.g., Cartwright, 2002; Cartwright, Bock, et al., 2020; Cartwright, Coppage, et al., 2017; Cartwright, Marshall, Huemer, & Payne, 2019; Follmer & Tise, 2022; García-Madruga et al., 2013; Horowitz-Kraus, 2016; Johann & Karbach, 2020; Karbach, Strobach, & Schubert, 2015; Peng & Fuchs, 2017) to support our students' current—and future—academic success.

Perhaps the term *executive skills* is new to you; without any background knowledge, this term may sound a bit like the kinds of managerial skills required of a chief executive officer (CEO). And you're absolutely right! Our executive skills enable us to be effective managers of our own brains and thinking processes. As educators, in addition to teaching reading, writing, and arithmetic, we must equip our students to become CEOs of their own brains so that they become active independent, self-regulated readers who know how to manage their thinking to decode and understand texts. You may be like one of my reading specialist colleagues who recently lamented that one of her students did not seem to have the memory skills necessary to comprehend a text. As our conversation continued and I mentioned executive skills, she said that she had never heard of them and wondered what they were. Like my colleague, you may be asking: What exactly are these skills, how do they support reading comprehension, and how can we incorporate them into classroom instruction in ways that promote better reading in students who struggle? This book is designed to answer those questions. Just as I did in writing the first edition of this book, I have two main goals in writing this second edition:

1. To provide practitioners and scholars with new information about executive skills and why they are essential to successful reading comprehension and reading instruction.
2. To provide executive skill-based (and research-based) intervention strategies that can be used to improve students' executive skills and reading comprehension and thus their future academic success.

Because this research area is so new, most studies to date have focused on the various contributions of different kinds of executive skills to reading comprehension, with promising results. I review these findings in the chapters that follow.

Many interesting questions remain to be investigated, and comparatively fewer studies have been done to explore ways to improve students' executive skills for better reading comprehension. The results that are emerging in this area are exciting and have the potential to revolutionize the ways we teach reading comprehension, especially for students who struggle in this area.

In addition, some research on reading interventions, though not originally focused on executive skills per se, has used methods that target children's executive functioning to improve reading comprehension. I share information about these promising interventions to support your reading instructional practices, especially for students who struggle with reading comprehension. All of the interventions I present can be integrated into a differentiated literacy instruction framework, such as the response-to-intervention (RTI) framework (Fuchs & Fuchs, 2009; Fuchs, Fuchs, & Vaughn, 2008; Fuchs & Vaughn, 2012) or other multi-tiered system of support (MTSS; Utley & Obiakor, 2015) to assist readers at all levels of instructional need.

Overview of This Chapter

In this introductory chapter I start by defining reading comprehension, drawing on contemporary theories of reading to explain why executive skills are related to skilled reading. Then I provide a vignette of a student, Brittany, to provide a tangible example of the ways underlying problems with executive skills can affect reading. Next, I describe how executive skills develop and relate to underlying brain structures and to the brain's reading network. This sets the stage for understanding how executive skills relate to reading difficulties experienced by students like Brittany (about 10–30% of struggling readers; Aaron, Joshi, & Williams, 1999; Applegate, Applegate, & Modla, 2009; Buly & Valencia, 2002; Catts, Hogan, & Fey, 2003; Shankweiler et al., 1999; Torppa et al., 2007; see Cartwright, 2010, for a review) who struggle with reading comprehension despite having adequate word reading skills. These students, who teachers commonly call "word callers" because they read aloud fluently without any apparent understanding of what they are reading (Cartwright, 2010; Dolch, 1960), have specific reading comprehension difficulties (RCD); they emerge in most classrooms, do not respond to typical evidence-based comprehension instruction, and puzzle their teachers and parents because they *sound* like good readers (Applegate et al., 2009). Because of their difficulties with executive skills, students with RCD are particularly likely to benefit from reading comprehension interventions that also target and support their executive skills. Finally, I provide a history "mini-lesson" to describe the recent surge in attention to the connection between reading comprehension and executive skills. After briefly addressing executive skills assessment (and providing useful resources), I close the chapter with an overview of the remainder of the book.

What Is Reading Comprehension?

Before embarking on a discussion of formal definitions of executive skills, I begin with a definition of reading comprehension to frame our discussion for the remainder of the book. In this section, I also explain how executive skills fit into broader theories of reading comprehension, informed by scientific research on reading (i.e., the science of reading), to help you place these skills in your understanding of reading more broadly. Such integrative views are important because executive functions and reading mutually influence one another across development (Ferrer et al., 2007; Follmer, 2018). Instruction that is aligned with our knowledge of both reading and executive skills can better capitalize on the synergistic relation between these processes (Peng & Goodrich, 2020; Slipp, 2021).

The RAND Model of Reading

The oft-cited RAND Reading Study Group report (RRSG; 2002, p. xiii) defines reading comprehension "as the process of simultaneously extracting and constructing meaning through interaction and involvement with written language" and describes three elements that influence the comprehension process: "the reader, the text, and the activity or purpose for reading." See Figure 1.1 for a visual representation of these three types of factors that interact to produce successful reading comprehension. The operation of executive skills in reading comprehension cuts across all three of these areas. Executive skills are reader factors that influence the comprehension process, and the ways we deploy our executive skills depend on the types and structures of texts that we are reading, as well as our purposes in reading. However, the RAND group's definition doesn't unpack *how* readers "simultaneously extract and construct meaning through interaction and involvement with written language"; that is, it doesn't help us understand *how* reader factors work together and interact to produce skilled reading. In their book, *Beyond Decoding:*

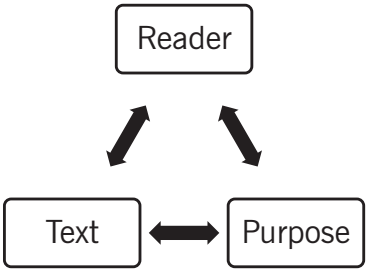


FIGURE 1.1. The three factors that interact to produce successful reading comprehension, according to the RAND Reading Study Group (2002).

The Behavioral and Biological Foundations of Reading Comprehension, Wagner, Schatschneider, and Phythian-Sence (2009, p. xi) point to a key reason why this might be the case. They state simply that "the only purpose for reading is to comprehend the author's message . . . but most of what we understand about reading concerns the mechanics of decoding individual words." Historically, we have known much more about the ins and outs of word reading processes than we have about comprehension processes. But we have made great strides since the RAND report (2002) was published in understanding how reading comprehension works and the roles that executive skills play in that process.

Two-Factor Views of Reading

Another model of reading that may be familiar to you is the popular simple view of reading (Gough & Tunmer, 1986). The simple view holds that reading comprehension is the product of word reading and linguistic comprehension (also called language comprehension), and educators often use this theory to guide intervention practices with students at risk for reading difficulty (Grimm, Solari, McIntyre, & Denton, 2018; Melby-Lervåg & Lervåg, 2014). You may also be familiar with Scarborough's (2001) rope, which illustrates these same two broad processes (word reading and language comprehension), identifies component skills within them, and emphasizes that readers become increasingly able to strategically coordinate these processes across development (though the mechanism for that coordination isn't described). Finally, Hoover and Tunmer (2020) recently offered an update to the simple view, which they call the cognitive foundations framework, that is similar to Scarborough's rope in that it retains the two divisions of word reading and language comprehension while unpacking some of the processes within them. Such two-factor models help us to understand some extremely important aspects of reading that are both necessary for effective reading comprehension. However, they miss (or at least underemphasize) key understandings from recent scientific research (i.e,, the science of reading) that may provide a more nuanced view of reading comprehension.

First, none of these models illustrates *how* readers actively deploy, manage, and coordinate their word reading and language comprehension processes. That is, they don't clearly depict how and where students' self-regulatory skills, such as executive skills, support their reading. As is shown in the chapters that follow, executive skills are critically important for helping readers to be actively engaged in comprehending—and even decoding—text. As Butterfuss and Kendeou (2018, p. 819) noted, "prominent models of reading comprehension have not explicitly incorporated EFs [executive functions]. Thus, there is a need for existing models of reading comprehension to incorporate and account for the role of EFs, as EFs can help explain the mechanisms of complex interactions between the reader, the text, and the greater discourse situation."

Second, the original simple view proposed that word reading and language comprehension occurred separately, and even sequentially, in skilled readers. As Gough and Tunmer (1986, p. 9) noted, "The simple view presumes that, once the printed matter is decoded, the reader applies to the text exactly the same mechanisms which he or she would bring to bear on its spoken equivalent." However, word reading and language comprehension processes aren't entirely separate, and they don't occur sequentially. Although they each support reading comprehension in unique ways, word reading and language comprehension also overlap substantially and influence one another in their support of reading comprehension (Cirino et al., 2019; Cutting & Scarborough, 2006; Foorman, Wu, Quinn, & Petscher, 2020; Lonigan, Burgess, & Schatschneider, 2018; Taboada Barber, Cartwright, Hancock, & Klauda, 2021). These processes occur in parallel (Seidenberg & McClelland, 1989) and are interconnected in the brain (as discussed in the later section on the reading network). Cirino and colleagues (2019, pp. 1835–1840) argue that the high degree of overlap (i.e., 70–75%) between word reading, language comprehension, and executive processes "implies that unique effects [of word reading and language comprehension], though important, need to be considered in the broader context of cognitive skills (including language) working together to influence the reading process, and these contributions are very difficult to separate from one another." Looking at this important overlap between word reading and language comprehension from a slightly different angle, Spencer, Richmond, and Cutting (2020, p. 188) suggest that "the degree of shared variance amongst skills suggests that [executive skills] could integrate with decoding and oral language processes in important ways." In fact, emerging research indicates that executive skills contribute to reading *through the overlap* between word reading and language comprehension processes (Cartwright, Lee, et al., 2020; Taboada Barber, Cartwright, et al., 2021), illustrating the important ways executive skills help us integrate these processes in service of reading comprehension.

This makes sense because young readers must *learn* to coordinate word reading and language comprehension processes and make them work together simultaneously and seamlessly as they learn to comprehend text. Consider reading fluency, for example. Fluent reading requires attention to both word reading accuracy *and* the meaning of text to produce expressive oral readings that preserve phrase boundaries and make reading sound like talking (Kuhn & Stahl, 2003). Not surprisingly, executive skills play a key role in reading fluency and the coordination of word reading and language comprehension processes (Cartwright et al., 2019; Horowitz-Kraus, 2016; Kieffer & Christodoulou, 2020).

Contemporary Models of Reading

Recently, reading scientists have begun to recognize that we need to include students' self-regulatory abilities, such as executive skills, in our understanding of the

building of these critical connections in skilled reading. For example, Perfetti and Stafura (2014) proposed the reading systems framework (an update on Perfetti's earlier lexical quality hypothesis [Perfetti, 2007; Perfetti & Hart, 2002]) that gives executive skills a central role in helping readers forge connections between print, sounds, and meanings. Likewise, new theories designed to guide research on reading comprehension (e.g., the direct and inferential mediation model [DIME]; Ahmed et al., 2016; Cromley & Azevedo, 2007; the direct and indirect effects model [DIER]; Kim, 2017, 2020a) also highlight prominent roles of executive skills in reading. However, models designed to guide research do not always translate well to practice. That's why my colleague Nell Duke and I developed the active view of reading (AVR; Duke & Cartwright, 2021). The active view is depicted in Figure 1.2, and the full article, describing the AVR, may be freely accessed in the second Science of Reading Special Issue of *Reading Research Quarterly*.[1] The AVR does a few things to highlight the complexity of reading and help practitioners support students. It:

- incorporates the extremely important word recognition and language comprehension processes in the simple view (Gough & Tunmer, 1986), Scarborough's (2001) rope, and the cognitive foundations framework (Hoover & Tunmer, 2020), identifying specific components within each that can be targeted with direct interventions that improve reading comprehension;
- recognizes and depicts the substantial overlap between word recognition and language comprehension and identifies specific skills that reflect students' coordination of word recognition and meaning-focused processes, all of which can be targeted with interventions that improve reading comprehension—this overlap is not depicted in two-factor models;
- includes attention to self-regulatory processes, such as executive skills, strategy use, and motivation, that drive word reading and language comprehension and help students coordinate these processes, but that are not directly reflected in two-factor models; importantly, all of the self-regulatory processes identified in the active view—including executive skills—can be targeted with interventions that improve reading.

In short, the active view of reading depicts how executive skills play key roles in driving and coordinating reading processes. Importantly, although many educators use the simple view as a heuristic to guide interventions with at-risk readers (Grimm et al., 2018), interventions guided by the more comprehensive array of components in the active view can do significantly more good for our students, particularly students who struggle to learn to read (Burns, Duke, & Cartwright, 2021). Thus the active view guides our understanding of reading comprehension—and the roles of executive skills in reading—for the remainder of this book.

[1] Available at *https://ila.onlinelibrary.wiley.com/doi/10.1002/rrq.411*.

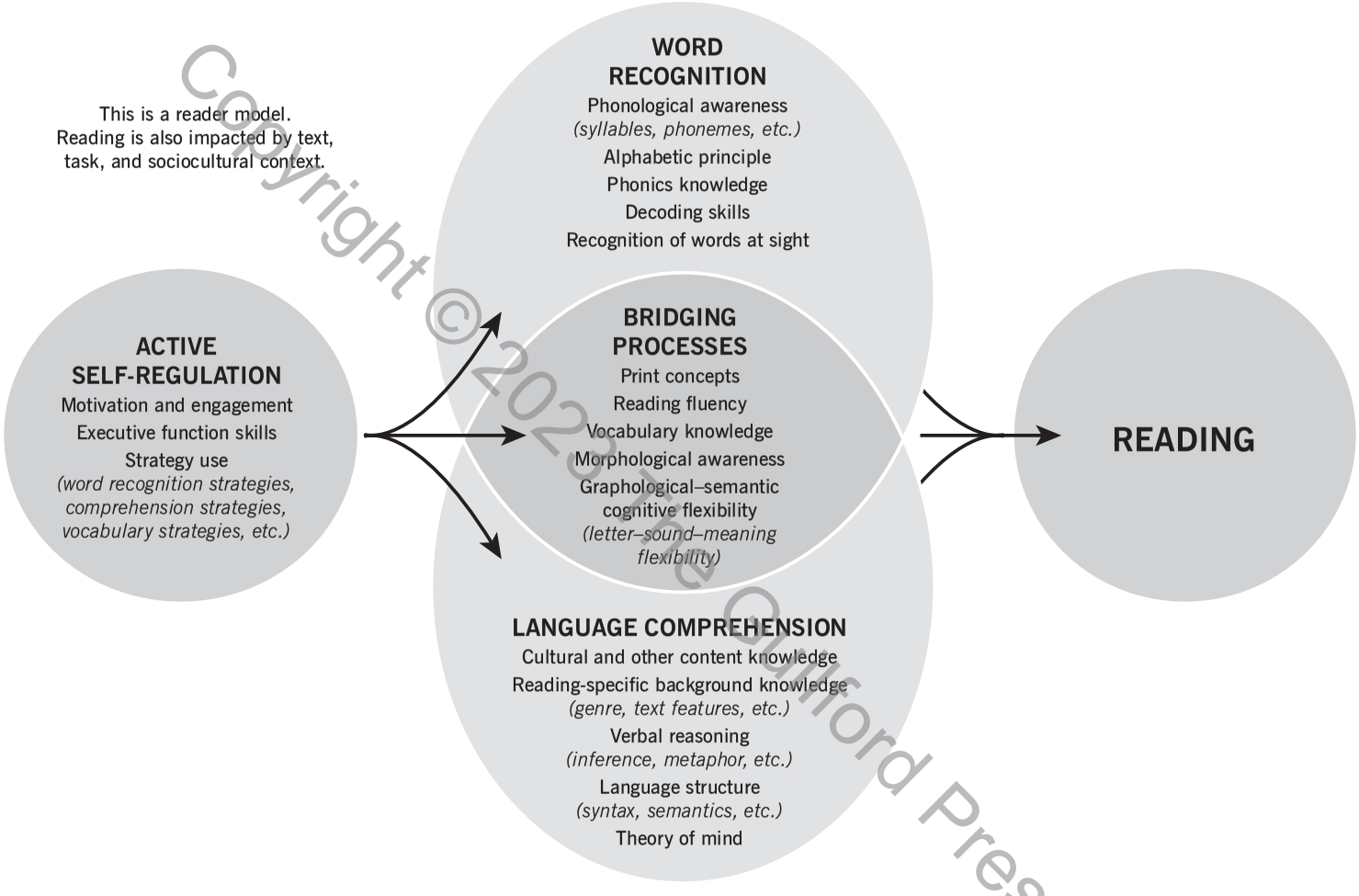


FIGURE 1.2. The active view of reading. From Duke and Cartwright (2021). Copyright © 2021 the authors. Reprinted with permission of Wiley on behalf of the International Literacy Association.

How Do Executive Skills Relate to Developing Thinking Readers?

As is shown in the forthcoming chapters, executive skills support reading comprehension in specific ways, so that research is not reviewed here. You may also be interested to know that executive skills set children up for developing strong reading skills over time. For example, preschool and kindergarten executive skills predict second-grade reading achievement (Morgan, Farkas, Hillemeier, Pun, & Maczuga, 2019; Röthlisberger, Neuenschwander, Cimeli, & Roebers, 2013), third-grade word reading (Mauer, Zhou, & Uchikoshi, 2021), and third-grade reading comprehension (Guajardo & Cartwright, 2016). Furthermore, first- and second-grade executive skills predict reading comprehension 2 years later, even after controlling for word reading, verbal reasoning, and nonverbal cognitive ability (Cartwright, Marshall, & Hatfield, 2020). A recent meta-analysis (a scientific study that incorporates findings from across multiple other scientific studies) corroborated these findings, showing that executive skills were significantly related to reading skills (comprehension, fluency, and decoding) in early elementary school (grades K–2) and late elementary school (grades 3–6; Spiegel et al., 2021).

Growth in reading and executive skills seems to be mutually supportive. First-grade executive skills predict fourth-grade reading comprehension but also modulate reading comprehension growth; children with stronger early executive skills have faster rates of growth in reading comprehension from first to fourth grades (Wu, Barquero, Pickren, Taboada Barber, & Cutting, 2020). Even in adolescent readers, executive skills predict growth in reading comprehension (Kieffer, Mancilla-Martinez, & Logan, 2021). Likewise, growth in executive skills from first to fourth grades predicts reading outcomes in fourth grade (Altemeier, Abbott, & Berninger, 2008). Thus the development of executive skills and reading comprehension seems to go hand in hand. Findings like these (see also Connor et al., 2016; Hernández et al., 2018; Meixner, Warner, Lensing, Schiefele, & Elsner, 2019), have led some scholars to suggest that the relation between executive skills and reading may be bidirectional because they support one another across development (Follmer, 2018; Peng & Kievit, 2020), which makes it all the more important for us to understand how executive skills support reading processes for our students so that our instruction can capitalize on these relations (Peng & Goodrich, 2020; Slipp, 2021).

Consider Brittany, Who Has Specific RCD

To illustrate the interplay of executive skills and key reading processes, I provide the following example of a striving comprehender, Brittany, whose reading behaviors will help you better understand the operation of executive skills in reading comprehension processes and to whom you can relate our future discussions of

particular executive skills, as she returns to illustrate points in forthcoming chapters.

Brittany is a phenomenal reader (or perhaps I should say phenomenal *decoder*) who just entered your third-grade class at a fifth-grade reading level, at least in terms of her word reading ability. (I should note that you can just as easily find students like Brittany in secondary classrooms, too.) Brittany can already read all of the high-frequency words that you would expect for third grade, and she's rarely stumped by a new word when reading aloud during small-group or whole-group instruction. During the beginning-of-year assessments, as you administer an oral reading assessment to Brittany, you find that her reading accuracy is high and that she reads with appropriate rate and expression. (No surprise there!) You are so pleased to have such a good reader in your class and expect that she'll be an "easy" student this year. And then, as you continue your assessment, you ask Brittany to retell a story she just read aloud (flawlessly, of course), and she's stumped. Her retelling misses several key story events, she confuses important story details, she seems to have misunderstood the protagonist's goals in the narrative, and she omits one of the main characters entirely. These behaviors don't align with everything else you know about Brittany, and you wonder what might be going on. She has the requisite skills to be a successful comprehender, according to the National Reading Panel (2000; good phonemic awareness and phonics knowledge, wonderful fluency [both rate and expression], and good oral and sight-word vocabularies). But clearly, something is missing.

For Brittany and students like her, "what's missing" is often executive skills. Many times, students like Brittany are unable to remember and integrate story details, or they have difficulty staying focused on relevant aspects of the text, attending to irrelevant information instead. These students may lack the ability to focus on multiple aspects of a text while reading (e.g., thinking about meaning while they are also focusing on decoding), or they may not understand that they should approach a text with the intention of making meaning. They may lack the planning ability to preview and attend to text features that support understanding or lack the monitoring ability to realize that they do not actually understand what they are reading. These students may also have trouble inferring an author's intentions or making inferences about characters' actions, based on the characters' beliefs or feelings. Finally, these students may lack comprehension strategy knowledge, or—even if they have knowledge of comprehension strategies—they may be unable to deploy those strategies to support understanding.

By now, you have probably identified several Brittanys in your class or school. And, if you are like other teachers with whom I have worked, you have probably struggled to find interventions that help these students achieve better comprehension because they just don't respond to your regular reading instruction the way that your other students do. Understanding what will work for them requires understanding the kinds of thinking processes that may be missing for these students beyond the skills we typically consider important for reading comprehension

(e.g., vocabulary, fluency, and decoding skills such as phonemic awareness and phonics). The next sections describe executive skills, the higher order thinking processes quite often missing in striving comprehenders like Brittany, so that you have a foundation on which to base your understanding of effective interventions for these students.

What Are Executive Skills?

Think of the term *executive skills* as an umbrella term that refers to a set of mental tools we use to manage tasks and achieve goals (Anderson, 2002; Dawson & Guare, 2018; Goldstein & Naglieri, 2014; Meltzer, 2010). Notice that the notion of goal-directed activity is essential to the definition of executive skills; executive skills are at the heart of goal-directed self-regulation (Hofmann, Schmeichel, & Baddeley, 2012; Roebers, Cimeli, Röthlisberger, & Neuenschwander, 2012; Taboada Barber, Cartwright, & Klauda, 2020). Just as a chief executive of a company sets goals for the company and manages that company's operations to achieve those goals, our executive skills are what we use to engage in self-regulated, goal-directed behavior in any area of life, from planning and executing a trip to the grocery store to reading and understanding a complex journal article. Other words used to describe executive skills are *executive control processes* and *executive functions*, and these terms are used interchangeably in the literature on this topic.

As you might expect, executive skills emerge early in life (Bell, 2012; Cuevas & Bell, 2014; Fuhs & Day, 2011; Morasch & Bell, 2011) and develop across childhood and beyond (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001; Cartwright, Isaac, & Dandy, 2006; Davidson, Amso, Anderson, & Diamond, 2006; Fuhs & Day, 2011; Guare, 2014; Peterson & Welsh, 2014). Even in very young students, executive skills enable the self-control that is necessary to remember classroom routines, pay attention to the teacher's directions (and not to the fidgety classmates nearby), and inhibit inappropriate behaviors such as the impulse to grab the colorful toys on the shelf when one is supposed to be sitting "criss-cross-applesauce" and listening to the teacher during circle time (Blair et al., 2007; Liew, 2012; Zelazo, 2013; Zhou, Chen, & Main, 2012).

Because research on executive skills is relatively new, there is wide variation in definitions for this set of skills. In addition, beyond three core skills (cognitive flexibility, working memory, and inhibition, described below), the numbers of thinking processes that fall under the executive skills umbrella vary depending on whose work you're reading. However, common among all of the varied definitions is the notion that executive skills involve regulating one's own thinking to achieve desired goals (Guare, 2014). For our purposes in this book, I provide information on the executive skills that have emerged as important in the reading comprehension process but that have received comparatively less attention in professional work on reading comprehension than familiar skills such as self-regulated

strategy use (Harvey & Goudvis, 2007; Keene & Zimmerman, 2007). Thus this book includes chapters on the three core skills listed earlier, as well as other, more complex executive skills that depend on the core skills and are also essential to the reading process.

The Important Relation of Language to Executive Skills

The development of executive skills is significantly related to children's oral language and vocabulary (Allan & Lonigan, 2011; Astington & Jenkins, 1999; Fuhs & Day, 2011), and thus it is no surprise that executive skills would also be related to reading comprehension. In the traditions of Vygotsky and Luria, Bodrova, Leong, and Akhutina (2011) suggested that executive skills are voluntary behaviors over which students gain increasing control by using language to guide themselves through tasks. In other words, children develop increased control over their executive skills through verbal regulation of their own thinking (Kray & Ferdinand, 2013). You've probably seen small children happily narrating their actions as they play and work their way through tasks. Talking about their own thinking helps children regulate their behavior because it causes them to reflect intentionally on their performance, become more aware of their thinking, and ignore other distracting information (Cragg & Nation, 2010; Marcovitch, Jacques, Boseovski, & Zelazo, 2008). Indeed, even in preschoolers, children's developing vocabulary is related to their executive skills (see Cartwright & Guajardo, 2015, for a review). Preschoolers' self-regulatory speech is also related to cognitive flexibility, one of the core executive skills (Alarcón-Rubio, Sánchez-Medina, & Prieto-García, 2014). Recently, Peng and colleagues (2022) conducted a meta-analysis to examine the relation of language to cognitive skills, including executive skills across the lifespan (spanning ages 3–37 years). They found that there is likely a reciprocal relation between the development of executive skills and language, such that for individuals with reading difficulties, early executive skill deficits resulted in delayed language development, which, in turn, negatively affected executive skill development, particularly in the verbal domain that directly supports reading.

Core Executive Skills

There is fairly wide agreement that the core, or most basic, executive skills are cognitive flexibility, working memory, and inhibition (Best & Miller, 2010; Diamond, 2013; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000).[2] Although I talk about these separately, it's important to remember that executive skills are not easily distinguishable from one another in practice; that is, they work together, often

[2]For a visual example of each core skill, see this video from the Harvard Center for the Developing Child: *developingchild.harvard.edu/resources/inbrief-executive-function-skills-for-life-and-learning.*

simultaneously, to help us get things done (Miyake & Friedman, 2012), and reading is no exception (Cirino et al., 2019; Nouwens, Groen, & Verhoeven, 2017).

Cognitive flexibility is the ability to shift attention from one activity to another or to actively switch back and forth between important components of a task. Students must shift attention during classroom transitions, such as when shifting from recess to math. Likewise, when reading, skilled comprehenders actively shift focus between many things, such as word and text meanings, letter–sound information, and syntactic information.

Working memory is the child's capacity for holding information in mind while working with part of that information, such as when a child remembers the steps involved in the classroom's morning routine while engaging in each of those steps (e.g., put my backpack in the cubby, sit in my assigned seat, get my journal out of my desk, find the next clean journal page, and respond to the writing prompt my teacher has put on the board). Similarly, when building a mental model of a text's meaning (what Kintsch [1994] calls a situation model), a good comprehender must keep in mind the various text ideas presented, note the causal links between them, and update the model as he or she encounters new ideas in text.

Finally, inhibition involves the ability to resist engaging in a habitual response, as well as the ability to ignore distracting information. In other words, inhibition requires one to think before acting (Diamond, 2013). You might think of this as stifling a gut reaction, such as when the preschool child at circle time (described above) resists her impulse to grab an attractive toy nearby. Similarly, good comprehenders must inhibit activation of inappropriate word meanings, such as ignoring ideas about financial institutions when reading about the *banks* of a river, or irrelevant connections to ideas encountered in texts. These three core skills underlie more complex executive skills, such as planning and organization (Diamond, 2013).

More Complex Executive Skills

Other, more complex executive skills also contribute to reading comprehension. For example, planning involves setting and working toward a goal, and organization involves ordering and sequencing information or subtasks in ways that support completion of a goal. Thus these two executive skills work hand in hand to support reading comprehension. As an example, consider what you do when you need to go shopping for various items. A shopping trip requires planning, such as choosing a route and making a shopping list, as well as organization, such as remembering the elements of your route in the correct order and arranging the items on your shopping list by the stops along your route (or even by the sections in the store, such as when you list produce items together so that you can collect them all when you visit the produce section). You cannot reach your goal without a plan, and you can do so most effectively if you are aware of the steps you need to take, in the proper order, to ensure that your goal is met.

For the purposes of this book (and for most teachers and reading researchers I know), the overarching goal in reading tasks is to understand the text. Good readers approach text with a plan to do just that. For example, even before they read, good readers do particular things intentionally to ensure that they understand a text, such as activating their prior knowledge, attending to text structure, or previewing the text (Pressley & Afflerbach, 1995; Pressley & Lundeberg, 2008; Wyatt et al., 1993). That is, they begin reading with a plan to understand. Readers may also have a specific type of comprehension goal in mind when they read that affects how they organize their approaches to reading. Students can generate goals themselves, such as when one reads an informational text to learn about the feeding and nesting patterns of an interesting bird at the classroom bird feeder. Alternatively, specific comprehension goals can be assigned by a teacher to support students' comprehension of texts, such as when we ask our students to identify the characters and problem in a story. Regardless of the comprehension goal, we know that good readers begin with goals in mind and engage in particular activities to reach those goals (Pressley & Afflerbach, 1995; Pressley & Lundeberg, 2008; Wyatt et al., 1993). Organization supports planning because it helps the reader systematically manage his or her reading activities and track the order of incoming text information, noting text structure (Armbruster, Anderson, & Ostertag, 1987; Cain, 1996; Gersten, Fuchs, Williams, & Baker, 2001; Meyer, Brandt, & Bluth, 1980; Taylor, 1982; Williams, 2005) and causal relations between text elements (Graesser, Singer, & Trabasso, 1994; van den Broek, 1989), which directly support comprehension.

The Distinction between Hot and Cool Executive Skills

In addition to varying in complexity, executive skills also vary in the degree to which they involve students' motivational or social–emotional processes. Consider the students in your class who adapt well to classroom routines and are able effectively to manage and control their own behavior. These students are able to regulate thinking and learning, and they are also able to regulate their emotional processes. In addition, they have good peer relations, and they have strong self-regulation skills. By contrast, other students are impulsive and emotionally reactive; they have difficulty controlling their own behavior, interacting with peers, and sticking to classroom routines. And these students may also have problems focusing on tasks and ignoring irrelevant information. The differences you see in these children are both cognitive and social–emotional, and both kinds of differences reflect variations in executive skills. In fact, reading difficulties, executive skill weaknesses, and behavior problems go hand in hand (Morgan, Farkas, Tufis, & Sperling, 2008; Morgan et al., 2019; Nelson et al., 2017; Pimperton & Nation, 2014). Although I know of no studies that test effects of reading and/or executive skills interventions on behavioral regulation, West and colleagues (2022) recently showed that a language intervention that focused on self-regulatory abilities

produced improvements in behavioral regulation for children with poor oral language skills in their first year of formal schooling (average age = 53 months), in comparison with a control group. Children's behavioral improvements were not due to gains in language skills, but rather were likely due to changes in self-regulation abilities (i.e., behavioral inhibition) associated with the language intervention (West et al., 2022).

Although executive skills have traditionally been viewed as purely cognitive activities involved in regulating one's own thinking and behavior, such as planning, inhibition, cognitive flexibility, and working memory (abilities known as "cool skills"), executive skills also include processes with a social, emotional, or motivational component, often called effortful control processes, such as self-regulation, impulse control, and social understanding (abilities known as "hot skills"; Blair et al., 2007; Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009; Peterson & Welsh, 2014; Zelazo & Carlson, 2012; Zelazo & Müller, 2002; Zelazo, Qu, & Müller, 2005; Zhou et al., 2012; also see Dawson & Guare, 2018, and Kaufman, 2010, for more on emotional control and self-regulation). The distinction between cool and hot executive skills is not as important to reading comprehension as the fact that *all* of these skills contribute meaningfully to readers' comprehension processes; thus I include attention to both types of executive skills in this book to expand our focus beyond just the cool, purely cognitive skills that have been traditionally viewed as important to reading comprehension processes.

Hot and cool executive skills are related in preschool (Carlson, Moses, & Claxton, 2004; Drayton, Turley-Ames, & Guajardo, 2011; Frye, Zelazo, & Palfai, 1995; Fuhs & Day, 2011; Guajardo, Parker, & Turley-Ames, 2009), elementary school (Bock, Gallaway, & Hund, 2015; Guajardo & Cartwright, 2016), and in adulthood (Saxe, Schulz, & Jiang, 2006). Additionally, although scholars have debated whether hot executive skills precede cool ones in development (or vice versa; e.g., see Perner & Lang, 1999), evidence suggests that these skills reflect the same kinds of self-regulation abilities, just expressed in different areas of development (Miller & Marcovitch, 2012; Zelazo et al., 2005; Zhou et al., 2012), existing side by side as two related skill sets in 2- to 5-year-olds, independent of age and maternal education (Montroy et al., 2019). Because both hot and cool skills reflect the same kinds of underlying thinking processes, scholars argue that we should integrate work on hot and cool skills in order to have a more complete understanding of the executive processes necessary for academic success, including success in reading comprehension (Cartwright & Guajardo, 2015; Liew, 2012; Weimer et al., 2021; Zhou et al., 2012). Thus I have included attention to both types of skills in this book.

The following findings point to the important overlap between hot and cool executive skills. These two varieties of executive skills:

- Develop in parallel (Fuhs & Day, 2011; Hongwanishkul, Happaney, Lee, & Zelazo, 2005; Miller & Marcovitch, 2012);

- Predict one another in development; that is, hot skills assessed in infancy and toddlerhood predict cool skills in childhood and adolescence (Friedman, Miyake, Robinson, & Hewitt, 2011; Ursache, Blair, Stifter, Voegtline, & the Family Life Project Investigators, 2013); and cool skills in the early preschool years predict hot skills later (Benson, Sabbagh, Carlson, & Zelazo, 2012; Blankson et al., 2013; Hughes & Ensor, 2007);
- Contribute to the same underlying complex thinking abilities (rather than emerging as separate constructs), especially in younger students (e.g., Allan & Lonigan, 2011; Fuhs & Day, 2011; Prencipe et al., 2011; see Rueda, Posner, & Rothbart, 2005, for a review);
- Are served by adjacent and overlapping brain regions: cool skills are typically associated with dorsolateral prefrontal cortex (around the top and sides of the frontal lobes), hot skills are typically associated with orbitofrontal cortex (around the bottom and front of the frontal lobes, closer to the eyes), and ventral and medial areas of the prefrontal cortex (near the bottom and sides of the frontal lobes) are associated with both hot and cool skills (Ardilla, 2013; Aron, Robbins, & Poldrack, 2004; Blakemore & Choudhury, 2006; Fletcher & Henson, 2001; Rueda et al., 2005; Saxe et al., 2006; Stone, Baron-Cohen, & Knight, 1998; Zelazo et al., 2005; Zelazo & Carlson, 2012; more about these topics later in this chapter);
- Are impaired in individuals on the autism spectrum (Ozonoff, Pennington, & Rogers, 1991; Pellicano, 2007; see Cartwright & Guajardo, 2015, for a review);
- Play important roles in academic tasks and academic success (Blair et al., 2007; Liew, 2012).

Although self-regulation is probably the most widely cited hot executive skill (Dawson & Guare, 2018; Kaufman, 2010), social understanding, also called *theory of mind*, is another hot executive skill that is significantly related to reading comprehension. Theory of mind involves a child's ability to understand her or his own and others' mental states, intentions, beliefs, perspectives, and desires (Astingtin, Harris, & Olson, 1988; Miller, 2012). Of particular importance for teachers, social understanding can be taught with positive effects on reading comprehension (e.g., Guajardo & Watson, 2002; Lysaker, Tonge, Gauson, & Miller, 2011). This makes sense because students must understand others' thoughts to comprehend an author's purpose or to make inferences about characters' motivations and intentions from their behaviors; and social understanding also facilitates readers' understanding of their own reading processes (i.e., metacognition; Lecce, Zocchi, Pagnin, Palladino, & Taumoepeau, 2010).

A related aspect of social understanding is counterfactual reasoning, which involves making inferences about alternative outcomes to one's own or others' behavior. For example, when reading *Alexander and the Terrible, Horrible, No Good, Very Bad Day* (Viorst, 1972), a reader might ask him- or herself, "How

might Alexander have had a better day?" (Guajardo & Turley-Ames, 2004; Guajardo et al., 2009; Hutto, 2007; Roese, 1997). Counterfactual reasoning in preschoolers predicts success in reading comprehension in the elementary years (Guajardo & Cartwright, 2016), and counterfactual reasoning in adults is also related to reading comprehension skill (Trabasso & Bartolone, 2003). Thus this aspect of hot executive functioning also contributes positively to the development of reading comprehension.

Because both cool and hot executive skills are related to reading comprehension and can be taught, I have included chapters in this book that focus on traditional, cool skills such as planning, organization, cognitive flexibility, and working memory. Other chapters focus on hot skills such as inhibition (which has both cool and hot components) and social understanding, and all chapters include implications of these cool and hot executive skills for improving your students' reading comprehension (see Table 1.1 for a list of executive skills and their definitions, as well as additional examples of ways these skills support comprehension processes).

The Development of Executive Skills

Executive skills change and improve from infancy into adulthood to help us manage the ever more complex tasks that we encounter throughout life. To do this, executive skills help us control our thinking and engagement with tasks and coordinate multiple elements of complex tasks (such as reading). We become better and better at coordinating that control as we age (Chevalier, 2015). As noted earlier, the development of executive skills begins very early in life (Bell, 2012; Cuevas & Bell, 2014; Fuhs & Day, 2011; Hoehl, Reid, Mooney, & Striano, 2008; Morasch & Bell, 2011) and is associated with the development of oral language skills (Allan & Lonigan, 2011; Astington & Jenkins, 1999; Fuhs & Day, 2011; Weiland, Barata, & Yoshikawa, 2014), especially the self-regulatory language that children use to talk themselves through tasks (Alarcón-Rubio et al., 2014; Bodrova et al., 2011; Cragg & Nation, 2010; Kray & Ferdinand, 2013; Marcovitch et al., 2008). In fact, one of the important ways researchers have learned about the processes necessary for skilled reading comprehension is to ask skilled comprehenders to think—and talk—aloud as they comprehend texts, voicing aloud the self-regulatory thinking that supports their comprehension (Pressley & Afflerbach, 1995; Pressley & Lundeberg, 2008; Wyatt et al., 1993).

A recurring theme in studies of executive skills is that there is both unity and diversity in these skills; that is, each executive skill has unique features and makes unique contributions to development in other areas (such as reading), but these skills are also closely related (Miyake et al., 2000). For example, children can already demonstrate working memory, cognitive flexibility, and inhibition by 3 years of age (Hughes, 1998), and these three skills overlap considerably in the preschool years and become more differentiated with age (Lee, Bull, & Ho, 2013).

TABLE 1.1. Processes Typically Included in the Umbrella of Executive Skills That Support Reading Comprehension

Process	Definition and example(s)
Cognitive flexibility	The ability to consider multiple bits of information or ideas at one time and actively switch between them when engaging in a task; this is related to *switching* or *shifting*, which involves the ability to change focus from one aspect of a task to another; also called *attentional control* (see Zhou, Chen, & Main, 2012). Note that tasks that require single shifts (such as sorting by beginning sound, and then changing the sorting rule to sort along another dimension) are less challenging than tasks that require continual shifting back and forth between multiple elements of a task (such as sorting a group of words by their beginning sound and number of syllables at the same time). *The ability to think about multiple aspects of print simultaneously, such as thinking of words as composed of sounds but also as representations of meaning, requires cognitive flexibility. Additionally, the ability to focus on a character's perspective and then change focus to consider the author's purpose in writing a story in a particular way requires the shifting (or switching) aspect of cognitive flexibility.*
Inhibition	The ability to restrain one's normal or habitual responses as well as the ability to ignore or suppress irrelevant or distracting information; sometimes called *inhibitory control* or *impulse control*. *Maintaining focus on constructing meaning from text and resisting the temptation to daydream requires inhibition. Likewise, ignoring irrelevant word meanings or text connections, while focusing on the meanings and connections that aid meaning construction, also requires inhibition.*
Monitoring	The ability to take a step back and reflect on one's own thoughts, perspectives, and mental processes and assess their effectiveness. This is an aspect of *metacognition* or thinking about one's own thinking. *Readers show monitoring skills when they actively track their own understanding while they read; such monitoring often results in the choice to engage in self-regulatory behaviors to ensure that comprehension takes place (see below).*
Organization	The ability to impose order on information and objects, create systems for managing information or objects, and recognize such orders and systems so that one can use them successfully to complete tasks *The awareness of structures for different types of texts enables readers to organize text details in ways that make sense and support meaning construction; for example, knowing typical story structure or the patterns and features found in informational text permits readers to organize incoming information in ways that support comprehension of those types of texts.*

(continued)

TABLE 1.1. *(continued)*

Process	Definition and example(s)
Planning	The ability to decide what tasks are necessary to complete a goal, including understanding which ones are most important to goal attainment and the order in which those tasks should be completed to most effectively reach the goal. *Planning necessarily involves a goal orientation, which can support comprehension in a number of ways. Readers who approach reading tasks with a plan to understand the text for a particular purpose can engage in specific goal-directed behaviors that are executed with that overarching comprehension goal in mind. For example, when reading the book* Wolf, *by Becky Bloom (1999), students who have the goal of understanding the wolf's motivation in the story, perhaps in comparison to other wolves in children's books with which they are familiar, will be better able to recognize the wolf's desire to be accepted by a group of literate barnyard animals and better able to remember the various attempts the wolf makes to become a successful reader during the course of the narrative.*
Social understanding	The ability to consider or infer one's own and others' mental and emotional states, such as thoughts, feelings, desires, motives, or intentions, and use those to make predictions and generate explanations for others' behavior; also called *theory of mind* or *social imagination*. *A reader shows good social understanding when he knows characters' emotional states and intentions play a causal role in characters' actions and can use that information to make predictions about story outcomes. Similarly, when readers can infer an author's purpose for writing a text and then use that information to better understand the text, they are benefiting from the application of social understanding.*
Switching or shifting	The ability to change one's attentional focus from an initial idea to a new one (this is related to *cognitive flexibility* and *attentional control*; see above).
Working memory	The ability to hold information in mind to support completion of tasks while working with part of that information and updating it as needed; working memory includes a storage component and a processing component. *Working memory is necessary to hold story details in mind to construct a coherent representation of a text's meaning while continuing to add new details one discovers while reading.*

Note. Italics indicate examples of how executive skills support comprehension processes. From Cartwright (2012). Copyright © 2012 Taylor & Francis. Adapted by permission.

It's important to remember that although we discuss each of the executive skills as separate processes in this book, they are recruited simultaneously as we engage in tasks like reading (Cirino et al., 2019; Miyake & Friedman, 2012).

Of the three core executive skills, inhibition improves most dramatically across the preschool period (Best & Miller, 2010; Montgomery & Koeltzow, 2010) and continues to develop more gradually across the elementary school years (Altemeier, Abbott, & Berninger, 2008). Consistent with these findings, I recall striking improvements in my son's inhibition skills when he was 4 years old (when I was writing the first edition of this book), with the emergence of inhibition-related self-regulatory language, which he even used to remind me to "Wait!" and "Be patient!"

In a study of 4- to 13-year-olds, Davidson and colleagues found that working memory and inhibition develop earlier than cognitive flexibility, which continues to develop into adolescence and beyond (Davidson et al., 2006; also see Cartwright et al., 2006, who showed that cognitive flexibility develops into adulthood). Yeniad and colleagues (2014) found that cognitive flexibility improves across the transition from kindergarten to first grade (when students were 5–6 years of age), with much room for continued improvement after first grade. Best, Miller, and Jones (2009) similarly observed that the development of working memory and cognitive flexibility occurs after age 5 (i.e., after the preschool years) and that, like cognitive flexibility, the development of working memory continues into adulthood (Huizinga, Dolan, & van der Molen, 2006). More complex cool executive skills, such as planning, improve across the elementary school years and beyond (Best et al., 2009). Hot skills, such as theory of mind, follow a similar developmental pattern, showing much improvement across the preschool years (Wellman & Liu, 2004), with continued development of more sophisticated versions of these skills into adolescence and adulthood (Im-Bolter, Agostino, & Owens-Jaffray, 2016; Lovett & Pillow, 2010; Miller, 2012; Pillow & Lovett, 1998; Weimer et al., 2021). Because reading comprehension also develops considerably across the elementary school years and into adulthood, it makes sense that the development of executive skills would affect reading comprehension development in important ways.

Factors Related to the Development of Executive Skills

You may be wondering what kinds of factors influence the development of executive skills in your students, as you undoubtedly observe differences in these skills, even among students at the same grade level. We know that the development of executive skills can vary from child to child (Yu et al., 2021) and across cultures (Legare, Dale, Kim, & Deák, 2018). Furthermore, children with more prenatal risk factors (e.g., low birth weight, prematurity, and maternal emotional and physical complications during pregnancy) have lower executive function skills at age 3 (Camerota & Willoughby, 2020). In addition, those from homes with lower socioeconomic

status or those who experience poverty and financial hardship usually have lower executive skills than their peers with more material resources (Allee-Herndon & Roberts, 2019; Raver, Blair, Willoughby, & the Family Life Project Key Investigators, 2013). In fact, executive skills (particularly working memory and to a lesser extent cognitive flexibility) mediate the relation between socioeconomic status and reading outcomes (Barnes, Boedeker, Cartwright, & Zhang, 2022). Finally, household chaos, which involves disorganization and instability in the home environment, negatively affects the development of executive function (Lecheile, Spinrad, Xu, Lopez, & Eisenberg, 2020; also see Andrews, Atkinson, Harris, & Gonzalez, 2021, for a meta-analysis).

The quality and types of family interactions children experience are related to the development of executive skills. For example, children with siblings have higher levels of social understanding than peers without siblings (Perner, Ruffman, & Leekam, 1994). But it's having older (not younger) siblings that seems to foster social understanding (Ruffman, Perner, Naito, Parkin, & Clements, 1998), probably because younger siblings must learn quickly how to infer older siblings' intentions in order to avoid unpleasant or surprising situations.

With respect to parents, secure caregiver–child attachment predicts growth in executive skills in early childhood (Matte-Gagné, Bernier, Sirois, Lalond, & Hertz, 2018). Furthermore, infants whose mothers are sensitive to their needs, express positive regard, and exhibit animation in interactions have higher levels of executive skills in preschool than infants whose mothers are more detached, who impose their own interests (rather than being sensitive to infants' needs), and show negative regard (Rhoades, Greenberg, Lanza, & Blair, 2011; also see Fay-Stammbach, Hawes, & Meredith, 2014, for a review). Moreover, when mothers of 3-year-olds exhibit positive parenting qualities, such as responsiveness and sensitivity to children's needs and positive regard (Blair, Raver, Berry, & the Family Life Project Investigators, 2014), provision of cognitive stimulation for children (Blair et al., 2014; Rosen et al., 2020), and scaffolding (Hughes & Devine, 2019), the children show more growth in executive skills from 3 to 5 years of age. On the other hand, parent–child conflict (Duran, Cottone, Ruzek, Mashburn, & Grissmer, 2020), maternal depression (Passareli-Carrazzoni, Pereira-Lima, & Loureiro, 2018), and parental control and criticism (Hughes & Devine, 2019) have a negative impact on the development of executive skills.

Parents' language use with children, such as vocabulary diversity and language complexity during a picture book reading task, mediates influences of socioeconomic status (SES) on children's executive function development (Daneri et al., 2019). Consistent with these findings, Aram, Fine, and Ziv (2013) observed that parents' references to characters' mental and emotional states during book reading fostered higher social understanding in their preschool children. The relation between parenting quality and executive skill development appears to be bidirectional in the preschool years: The levels of children's executive skills at age 3 also predict changes in parenting quality from 3 to 5 years of age, with higher child

executive skills related to (and possibly eliciting) better parenting quality (Blair et al., 2014). Finally, mothers' and fathers' own levels of executive skills (Cuevas et al., 2014; Lee, Baker, & Whitebread, 2018; Ribner, Devine, Blair, Hughes, & NewFAMS Investigators, 2022) contribute to the development of child executive skills across the preschool period. As you might expect, mothers' executive skills contributed positively to children's executive skills, whereas mothers' negative caregiving behaviors were negatively related to children's executive skills. A review summarized research on parental influences on the development of executive skills, finding that parental scaffolding of children's thinking, including elaboration, praise, redirection, and autonomy support; provision of cognitive stimulation; and parental warmth, sensitivity, and lack of hostility were all related to the development of children's executive skills (Fay-Stammbach et al., 2014).

Finally, school environments can also have an impact on students' executive skills. Teacher and classroom emotional support and classroom safety are consistently related to better executive skills in students. In contrast, teacher–student conflict, punitive environments, poor peer relations, and unsafe school environments are related to lower executive skills in students, and these negative impacts are worse for students who start with initially low levels of executive skills (Cumming, Bettini, Pham, & Park, 2020).

On the whole, although research on family and contextual influences on executive skill development is relatively new, we now know that children tend to develop better executive skills when they:

- Have access to more material resources (i.e., come from homes of higher socioeconomic status)
- Experience stable, organized home environments without chaos
- Experience better quality, more positive, supportive parenting
- Experience fewer negative, hostile parenting practices
- Experience cognitively stimulating activities such as conversations about characters' mental and emotional states during shared book reading
- Experience scaffolding in interactions with adults, such as elaboration, praise, redirection of attention, and autonomy support
- Have older siblings
- Have parents with better executive skills
- Have emotionally supportive teachers
- Experience supportive, safe, nonpunitive classroom environments

Similarly, maternal positive responsiveness, children's home literacy environments, and children's early home literacy experiences are associated with better reading comprehension in grade 3 (Sénéchal & LeFevre, 2002; Taylor, Anthony, Aghara, Smith, & Landry, 2008).

The next section reviews research on brain development to illustrate the kinds of physical changes that underlie the development of executive skills. Developmental

changes in brain structures occur at particular ages and are thought to be associated with corresponding developments in children's thinking and executive function. What we know about brain development also highlights the importance of children's experiences in developing the executive skills necessary for success in reading comprehension.

How Does Brain Development Relate to the Development of Executive Skills?

My purpose in including this section on brain development is to help you see the neurological basis for executive skills in your students. The outer layer of the brain, the cerebral cortex (typically just called the cortex), is responsible for our higher order cognitive functions, including executive skills. The cortex has two parallel halves, or hemispheres, on each side of the head, joined by a wide band of fibers called the corpus callosum. Each of the hemispheres is divided into four sections, called lobes, which are associated with different functions. The occipital lobes at the back of the head, for example, are associated with visual processing. The temporal lobes, just above the ears and near the temples, are associated with hearing. The frontal lobes, which are just behind the forehead, are associated with executive skills in children and adults (see Figure 1.3; Bunge & Wright, 2007; Dawson

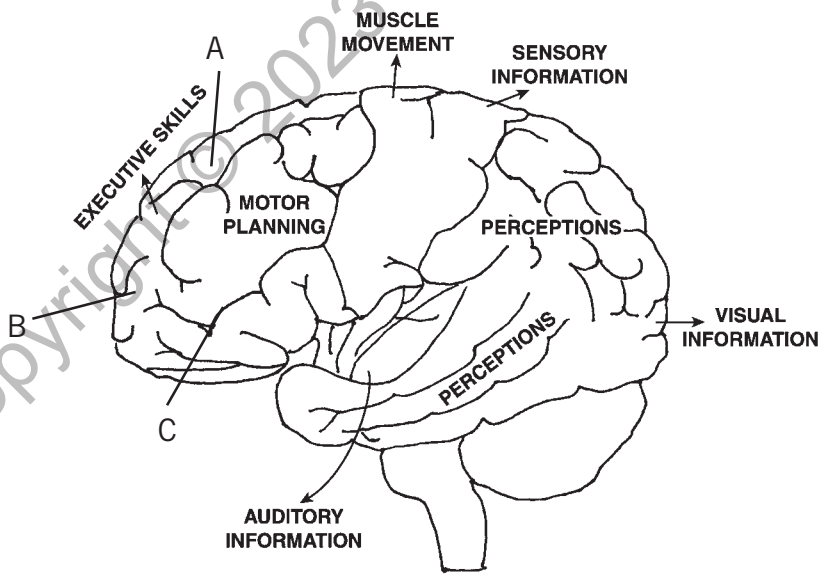


FIGURE 1.3. The human brain, with the approximate locations of major functions. *A*, dorsolateral prefrontal cortex; *B*, orbitofrontal cortex; *C*, ventrolateral, ventromedial, and medial prefrontal cortex. From Dawson and Guare (2010). Copyright © 2010 The Guilford Press. Adapted by permission.

& Guare, 2018; Eslinger, Biddle, Pennington, & Page, 1999; Kane & Engle, 2002; Montgomery & Koeltzow, 2010; Zelazo & Müller, 2002).

As noted above, different regions of the frontal lobes are related to different kinds of executive skills: The parts at the top and sides (DLPFC, labeled A in Figure 1.3) are related to cool executive skills; the parts at the front and bottom near the eyes (OFC, labeled B in Figure 1.3) are related to hot executive skills; and the parts on the bottom and sides (the ventral and medial parts, such as VLPFC, VMPFC, and MPFC, labeled C in Figure 1.3) are active in both hot and cool executive skills tasks (Ardilla, 2013; Aron et al., 2004; Blakemore & Choudhury, 2006; Otero & Barker, 2014; Rueda et al., 2005; Saxe et al., 2006; Stone et al., 1998; Vogeley et al., 2001; Zelazo et al., 2005; Zelazo & Carlson, 2012). I refer briefly to these parts throughout the book as we discuss various executive skills, so I have provided a primer here for your reference as you encounter these words in the book.

BRAIN PARTS VOCABULARY PRIMER

- *dorso:* top (like the word *dorsal*)
- *frontal:* front
- *lateral:* side
- *medial:* middle
- *orbito:* near the eyes
- *ventro:* bottom (like the word *ventral*)
- *DLPFC* (dorsolateral prefrontal cortex): near the top and sides of the frontal lobes
- *MPFC* (medial prefrontal cortex): area in the middle of the frontal lobes
- *OFC* (orbitofrontal cortex): area in the front of the frontal lobes, near the eyes
- *VLPFC* (ventrolateral prefrontal cortex): bottom and sides of the frontal lobes
- *VMPFC* (ventromedial prefrontal cortex): middle and sides of the frontal lobes

To understand how brain development is related to the development of executive skills, it will be helpful for you to know about the basic building blocks of the brain and how they change. The brain is made up of neurons (see Figure 1.4), or nerve cells, and the majority of our neurons are produced before birth, which means we are born with almost all of the neurons we will have throughout our lives

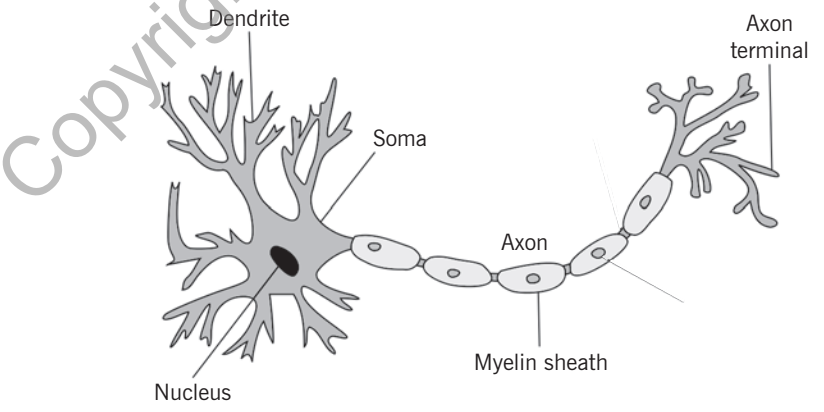


FIGURE 1.4. A neuron or nerve cell. Image by Quasar Jarosz (public domain).

(Bjorklund, 2012; Bjorklund & Causey, 2018; Johnson, 2011). Nevertheless, the brain grows rapidly through the preschool years, and brain weight nearly triples by age 5 (Bjorklund, 2012; Bjorklund & Causey, 2018; Dawson & Guare, 2018). These changes in brain weight reflect important physical brain developments that occur throughout the cortex; the changes in the frontal lobes in particular are related to the development of executive skills (Anderson & Spencer-Smith, 2013).

Because we generally do not add new neurons in development, the tremendous increases in brain weight across the preschool period reflect changes in our existing neurons that facilitate processing of information. For example, dendrites, or the branching parts of neurons that receive incoming information from other neurons (see Figure 1.4), increase in number and size. And axons, the long parts of neurons that send outgoing messages, get longer and thicker, and they grow more terminal branches. Each of these changes produces more places for neurons to connect and communicate with one another, providing junctions called *synapses*. You should note, however, that neurons do not actually touch one another—they lie very close together and pass chemical signals through the microscopic spaces around them. You might have heard people refer to the building of "connections" in the brain; these connections are synapses (sometimes called synaptic connections), which increase rapidly in the preschool years to produce the raw connections necessary to support learning (for reviews of brain development, see Bjorklund, 2012; Bjorklund & Causey, 2018; Cartwright, 2012; Dawson & Guare, 2018; Johnson, 2011). After the brain overproduces synapses in this way, it begins pruning away the ones that are not used. When children have experiences that require the use of particular synapses, those synapses (connections) are strengthened. But if children do not experience activities that activate connections between their neurons, those connections will be lost and not replaced.

A good example to illustrate this use-it-or-lose-it concept comes from language acquisition. In the course of prenatal brain development, we all develop synapses that support the learning of all languages around the world, and babies are thus able to distinguish all sounds (or phonemes) in all spoken languages in early infancy (Werker & Tees, 1984). However, the set of phoneme-related synapses we keep depends on the language(s) that we hear and experience. If we grow up hearing English, for example, we do not need to understand or produce the sounds that are uniquely characteristic of other languages, such as the rolled *R* in spoken Spanish. Thus we lose the synapses associated with the ability to hear and produce that sound. As a result, many late learners of Spanish find it quite difficult to produce rolled *R*'s in high school Spanish class. In contrast, just hearing a language spoken around you during childhood (even if you didn't speak the language yourself) will help you retain the ability to learn and pronounce the sounds in that language later in life (Knightly, Jun, Oh, & Au, 2003).

One other brain development that produces increases in brain weight and that is important to the acquisition of executive skills is the addition of a fatty sheath—the myelin sheath—around the axons of some neurons (see Figure 1.4).

The myelin sheath is much like the insulating rubber coating on electrical wires, and it improves the speed and efficiency of communication for those neurons that it covers (Bjorklund, 2012; Bjorklund & Causey, 2018; Cartwright, 2012; Dawson & Guare, 2018; Johnson, 2011). Myelin is added to different areas of the brain at different times in development in ways that support children's developmental needs (Bjorklund, 2012; Bjorklund & Causey, 2018; Sowell et al., 2004). For example, the parts of the cortex that control our sensory systems acquire myelin before birth, as infants need efficient sensory systems to gather information about their world once they are born. Areas that control movement, on the other hand, generally receive myelin across the first year after birth, supporting infants' developing locomotor abilities. The frontal lobes do not acquire myelin until later in development, when executive skills become more important to developmental success (Anderson & Spencer-Smith, 2013; Gotgay et al., 2004; Sowell et al., 2004).

You may have heard the terms *gray matter* and *white matter* in reference to the brain. These terms reflect the fact that the bodies of neurons appear gray, whereas myelinated axons appear white. Thus the actual color of these different types of brain tissues has led to the labels *gray matter* and *white matter*, respectively. As you might expect, the volume and proportion of white matter increases across development as more myelin is added, whereas the proportion and volume of gray matter decreases due to the addition of myelin and the pruning of unused neurons and synapses. So babies have more gray matter than white, and teenagers and adults show the opposite pattern (Amso & Casey, 2006; Gotgay et al., 2004; Sowell et al., 2006).

In the frontal lobes, these processes work together to support the development of executive skills (Anderson & Spencer-Smith, 2013; Gotgay et al., 2004; Sowell et al., 2006; Zelazo & Müller, 2002). In the first 3 years of life, the number of synapses in the frontal lobes increases dramatically to produce the raw connections necessary for successful development, and preschoolers actually have more synapses than adults (Bjorklund & Causey, 2018; Dawson & Guare, 2018; Johnson, 2011). Then, at about age 4 or 5, synaptic pruning begins, which refines the connections and makes processing more efficient. These changes are related to the rapid increase in executive skills we see across the preschool period. From ages 7 to 9, there is a surge in the addition of myelin in children's frontal lobes with a second surge in myelination from 10 to 12 years of age. It is interesting—but perhaps not surprising—that these age ranges correspond roughly to the points in development at which Piaget and his colleagues (Piaget & Inhelder, 1969) observed important advancements in children's thinking (i.e., the onset of concrete logical thinking around age 7 and the onset of abstract logical thinking at the beginning of adolescence). Perhaps increases in myelination provide the improvements in processing efficiency necessary for these important advances in children's thinking. Finally, in adolescence and early adulthood we see shifts in the proportions of gray to white matter due to the parallel processes of continued pruning and myelination, with increases in amounts of white matter and decreases in amounts of gray matter

(Anderson & Spencer-Smith, 2013). These changes serve to support advancements and improved efficiency in the development of executive skills across the lifespan, permitting the increased use of executive skills in support of the development of reading comprehension.

Executive Skills and the Reading Network in the Brain

Researchers have made tremendous advances in recent years in understanding what goes on in the brain for skilled (and less skilled) readers (Dehaene, 2009; Seidenberg, 2017; Wolf, 2007). As you will see, executive skills play a key role in connecting the important elements of reading tasks, particularly for skilled readers (Horowitz-Kraus & Hutton, 2015). Before getting into the nitty-gritty details of the reading network, I want to emphasize what the brain needs to *do* to enable skilled reading. Our brains aren't designed to read. Rather, our brains are wired for oral language: to help us talk, to hear and say the sounds that constitute words, connect those words' pronunciations to meanings, and weave words' meanings together to understand spoken discourse. In contrast, processing print (orthography) and linking it to our other language skills and knowledge—such as meaning (semantics) and sounds (phonology)—is a relatively new development in human history (Wolf, 2007). So our brains must commandeer regions originally intended for visual and language processing and repurpose them for reading (Dehaene, 2009; Seidenberg, 2017; Wolf, 2007).

Because connecting various kinds of information is essential for successful reading (Ehri, 2014; Perfetti, 2007; Perfetti & Stafura, 2014; Seidenberg & McClelland, 1989), the reading network is just what it sounds like: a web of connections that helps us to link different kinds of information important for skilled reading. Skilled reading requires that readers learn to connect print, sounds, and meanings. The strength and efficiency of those connections relates to the strength and efficiency of our reading skills (Phan et al., 2021; Pugh et al., 2001; Seidenberg, 2017). To help you understand the job of the reading network in the brain, consider a key process in learning to read with which you may be familiar—*orthographic mapping*: "Orthographic mapping (OM) involves the formation of letter–sound connections to bond the *spellings, pronunciations, and meanings* of specific words in memory" (Ehri, 2014, p. 5, emphasis added). See Figure 1.5 for a visual depiction of these important links. Learning to read is more than just learning to match sounds to letters and groups of letters to words' pronunciations; it requires that we bond those combinations to words' meanings, too. If these types of information (or processes) are all linked in this way, then a word's meaning calls to mind its spelling and sounds/pronunciation; the word's sounds/pronunciation call to mind its spelling and meaning; and the word's spelling calls to mind the word's sounds/pronunciation and meaning. These parts are linked in memory by the brain connections between them. Importantly, teaching mappings between individual letter–sound

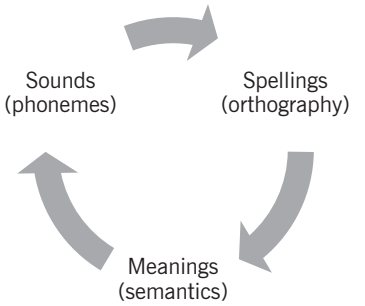


FIGURE 1.5. A visual depiction of orthographic mapping.

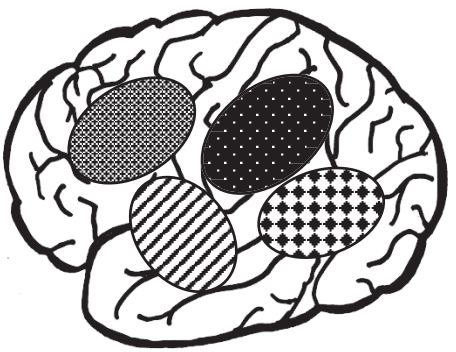
combinations (individual grapheme–phoneme connections) is more effective than teaching bigger chunks of letters and sounds (Sargiani, Ehri, & Maluf, 2021; Yoncheva, Wise, & McCandliss, 2015). Likewise, teaching letters, sounds, *and* meanings is more effective than teaching just letters and sounds alone (Austin, Vaughn, Clemens, Pustejovsky, & Boucher, 2022). Effective teaching attends to all features of words to link them in memory through orthographic mapping.

Similarly, the reading network is all about links between processing areas. However, as I noted, we aren't born with a reading network. Rather, from infancy we have specific brain areas that process important aspects of oral language, which help us to detect and connect the sounds and pronunciations of words, sentences, and narratives with their meanings (Yu et al., 2018). Brain connections between semantic and phonological processing areas strengthen across development from ages 5 to 18 and are associated with narrative comprehension (Karunanayaka et al., 2007). It is not until we begin to learn letters and to make letter–sound connections (grapheme–phoneme connections) in reading that our brains rewire a specific part of our visual cortex to process print and graft that area into our already existing oral language network (Monzalvo & Dehaene-Lambertz, 2013). In other words, attention to letter–sound connections is necessary for the development of the reading network in the brain (Monzalvo & Dehaene-Lambertz, 2013; Pugh et al., 2001; Yoncheva et al., 2015).

The reading network involves hubs of activity, which anchor key pathways that help us to make the important connections we need to be good readers, and these correspond roughly to areas that process letters, sounds, and meanings. In skilled readers, a dorsal (upper brain) pathway links letters to sounds, and a ventral (lower brain) pathway links letters and letter strings to meanings (Seidenberg, 2017). The main hub of the reading network is the visual word form area (VWFA), which is also known as the "letterbox" (Dehaene, 2009; Seidenberg, 2017), and this is the part that develops through exposure to print (Dehaene et al., 2010; Monzalvo & Dehaene-Lambertz, 2013; Pugh et al., 2001). The letterbox sits at the junction of the occipital (visual) and temporal (auditory) areas of the cortex and is associated with processing print, or orthography. Processing of speech sounds (phonology)

is associated with areas at the junction of the temporal (auditory) and parietal (sensory perception) areas. Meaning, or semantic, representations are associated with inferior frontal and anterior temporal regions (Dehaene, 2009; Seidenberg, 2017). Figure 1.6 illustrates approximate locations of these brain regions. When we effortfully decode words by linking letters and sounds, we recruit the dorsal (upper) pathway that connects the letterbox to the areas that process sound. Children usually show stronger connections between these areas after about a year of instruction that focuses on grapheme–phoneme connections (Monzalvo & Dehaene-Lambertz, 2013; Nation & Cocksey, 2009; Pugh et al., 2001). When decoding becomes automatic after repeated effort in decoding words, we begin to quickly recognize words and link them rather automatically (fluently) to their meanings, which is associated with the ventral pathway in the reading network that connects print to meanings (Ehri, 2014; Seidenberg, 2017).

This shift in development from effortful decoding to automatic word recognition has led some educators to assume that bypassing letter–sound connections and teaching children to memorize "sight words" will help them develop automatic word recognition more quickly. This is not the case. Effortful decoding using grapheme–phoneme correspondences is the way that we build connections between print and the sounds that exist in our language network. In other words, without those letter–sound connections, an important driver of reading network development is missing. Even skilled readers activate phonological information in the process of automatic word recognition (Perfetti & Bell, 1991). However, without such experience, such as in illiterate adult readers, the VWFA—the letterbox, or main



orthographic: occipitotemporal cortex (letterbox; spellings, letters)
phonological: temporoparietal cortex (sounds, phonemes)
semantic: medial and inferior temporal cortex; inferior frontal gyrus (meaning)
executive functions: prefrontal cortex and neighboring areas

FIGURE 1.6. Some major components of the reading network (brain regions are approximate).

hub of the reading network—does not develop (Dehaene et al., 2010). Similarly, readers with dyslexia show significantly underdeveloped VWFAs in comparison with their typically developing counterparts (Monzalvo, Fluss, Billard, Dehaene, & Dehaene-Lambertz, 2012), showing disconnection between hubs (Paulesu et al., 1996) and delays in construction of the reading network (Nicolson & Fawcett, 2019). These findings have important implications for instruction. Memorizing "sight words" does not activate or strengthen the reading network in the same way that learning individual letter–sound connections does (Yoncheva et al., 2015), just as teaching chunks of words is not as effective as teaching individual letter–sound connections (Sargiani et al., 2021). After continued instruction in grapheme–phoneme connections, children begin to show stronger connections in the ventral (automatic word recognition) pathway, similar to adults (Monzalvo & Dehaene-Lambertz, 2013; Pugh et al., 2001). Finally, as you might expect, students with RCD have abnormal brain activity patterns in areas related to meaning processing, suggesting they have problems accessing the meaning-focused aspects of the words that they are reading, whereas students with dyslexia have abnormal activation patterns related to the phonological, or sound-related, aspects of words (Cutting et al., 2013).

You may be wondering how executive skills figure into these processes. Strategic reading comprehension and learning from text are associated with activity in the frontal lobes in regions typically associated with executive skills (Moss et al., 2011, 2013; see Baker et al., 2014, for a review). In addition, skilled reading is associated with greater activity in executive skill areas in the brain (Horowitz-Kraus, Vannest, Gozdas, & Holland, 2014). Using new kinds of analyses that detect connectivity between brain regions, scientists have discovered that, for skilled readers, both word level and comprehension processes in the reading network are functionally connected to the frontal lobe regions associated with executive skills (Aboud, Bailey, Petrill, & Cutting, 2016; Twait & Horowitz-Kraus, 2019).

Furthermore, although relatively few studies have examined the neurological changes associated with reading interventions, a recent review of this work provided evidence that reading interventions literally change the brain by producing increases in activation in the frontal lobes (i.e., areas associated with executive skills), as well as other brain areas, to levels of activity that more closely match those seen in typical readers (Barquero, Davis, & Cutting, 2014). This kind of connectivity matters for intervention. Recent work showed that struggling readers who are more responsive to interventions show greater connectivity between executive function and reading network regions in the brain, whereas comparable students who don't respond to treatment show abnormally low connectivity between executive skill regions and the reading network (Aboud, Barquero, & Cutting, 2018; Nugiel et al., 2019). Reading intervention can improve connectivity between executive skill and reading network regions for 8- to 12-year-old children with reading difficulties (Horowitz-Kraus, DiFrancesco, Kay, Wang, & Holland, 2015; Horowitz-Kraus, Toro-Serey, & DiFrancesco, 2015) and typically

developing readers (Horowitz-Kraus, Vannest, Kadis, et al., 2014). Taken together, these findings suggest that executive skills perform important functions in subserving interconnections in the reading network. However, students with underdeveloped executive skills, such as those I describe in the next section, have significant difficulties with reading comprehension.

Children with Specific RCD

As I noted earlier in the chapter, there is a particular group of students you may encounter in your classroom who have difficulties with reading comprehension despite having intact (and quite skilled) word decoding abilities (Duke et al., 2014). These students exhibit wonderfully fluent oral reading of texts and thus sound like good readers (Applegate et al., 2009; see Cartwright, 2010, for a review), yet they are at risk for lower educational attainment in comparison with their peers with better reading comprehension (Ricketts, Sperring, & Nation, 2014). Many times, we do not detect these students' comprehension difficulties in early elementary grades because our assessments in those grades often focus on decoding processes rather than on comprehension. However, when we ask these students to remember information from texts they've just read or to retell a story, we discover their primary reading problem: They are just not getting the meaning of the texts that they are reading. These students have specific RCD, which is distinct from word-recognition difficulties (WRD), and have distinctly different underlying problems (Cutting et al., 2013; Locascio et al., 2010).

As you might expect, these students also have problems with oral language comprehension (Nation, Cocksey, Taylor, & Bishop, 2010; Nation & Snowling, 2004; Stothard & Hulme, 1992; see Spencer & Wagner, 2018, for a meta-analysis) and processes that support oral language comprehension, such as determining semantic relations among words (Nation & Snowling, 1999), making inferences (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999), understanding appropriate syntax (Nation & Snowling, 2000), morphology (Adlof & Catts, 2015), and grammar (Nation et al., 2010), resolving ambiguity in language (Oakhill & Yuill, 1986; Yuill & Oakhill, 1988), understanding idioms (Oakhill, Cain, & Nesi, 2016), and understanding and awareness of narrative structure (Cain, 2003; Cain & Oakhill, 1996). Narrative comprehension development is also supported by executive skills (see Cartwright & Guajardo, 2015, for a review), and students with RCD have significantly lower executive skills than their peers with better comprehension, which may contribute to their global (oral and print) comprehension problems. Indeed, a recent meta-analysis showed that traditional predictors of reading comprehension (word reading and language comprehension skills described by the simple view; Gough & Tunmer, 1986) only explain about *half* of the difficulties experienced by students with RCD (Wagner, Beal, Zirps, & Spencer, 2021). In other words, these findings show that half of the troubles we see in

students with RCD are *not* explained by word reading and language comprehension, leaving much room for other skills—such as executive skills—to affect reading comprehension. Thus it is no surprise that elementary and secondary students with RCD typically have weak executive skills in comparison with their counterparts with better reading comprehension (e.g., Borella et al., 2010; Cain, 2006; Cartwright, Coppage, et al., 2017; Locascio et al., 2010) that can continue into adulthood (Cartwright, Bock, Coppage, Hodgkiss, & Nelson, 2017; Georgiou & Das, 2015, 2016). For example, students with RCD have significantly lower working memory (Carretti, Borella, Cornoldi, & De Beni, 2009; Carretti, Cornoldi, De Beni, & Romanó, 2005; Oakhill, Hartt, & Samols, 2005; Potocki, Sanchez, Ecalle, & Magnan, 2017), inhibition (Borella et al., 2010; Cain, 2006; Kieffer et al., 2013; Potocki et al., 2017), planning (Cutting, Materek, Cole, Levine, & Mahone, 2009; Locascio et al., 2010; Potocki et al., 2017), and cognitive flexibility (Cartwright, Bock, et al., 2017; Cartwright, Coppage, et al., 2017) than typically developing readers. In other words, what the research is showing is that when students have age-appropriate, fluent word reading abilities that should support comprehension, the differences between good and poor comprehenders can quite often be attributed to problems with executive skills. These differences suggest important targets for intervention, discussed in subsequent chapters in this book.

A Brief History of Executive Skills and Reading Comprehension

Now that you know what executive skills do for thinkers and a bit about how they develop, you understand how these skills would support successful reading comprehension and many other academic and everyday tasks. At this point you may be asking yourself why you haven't seen information on executive skills before now, given their potential for transforming the ways your students approach texts, as well as your reading instruction. As is the case in many academic areas, practice often lags behind research. This section traces the emergence of attention to executive skills in research on reading comprehension so that you know where the field stands with respect to these important discoveries.

Across the last decade, research on the role of executive skills in education has flourished. Although executive skills have traditionally been studied from a neuropsychological perspective to better understand processing deficits associated with illness or brain injury, recent decades have seen a remarkable increase in research on broader applications of executive skills, especially in education and development (see Zelazo & Müller, 2002, for a review; also see Zelazo & Carlson, 2012). Much of this research has focused on the ways that executive skill deficits contribute to learning disabilities such as ADHD (Barkley, 1997; Berlin, Bohlin, & Rydell, 2003) or mathematics learning difficulties (Mazzocco & Kover, 2007; McLean & Hitch, 1999; Toll, Van der Ven, Kroesbergen, & Van Luit, 2011). At

the time of this writing, the Guilford Press catalogue alone includes 25 titles published since 2005 that focus on executive skills, and, consistent with trends in the field, most of these are based on the assumptions that (1) deficits in executive skills underlie a host of learning problems and (2) executive skills interventions will improve academic performance.

I wrote this book because, although recent research indicates that executive skills underlie successful reading comprehension and that executive skill deficits underlie reading comprehension problems in children and adults (e.g., Borella et al., 2010; Cartwright, Bock, et al., 2017; Cartwright, Coppage, et al., 2017; Cutting et al., 2009; Locascio et al., 2010; Sesma et al., 2009), there are no published texts available that focus on the relation between executive skills and reading comprehension. Furthermore, much new research on the relation between executive skills and reading comprehension has occurred quite recently and has not been included in existing professional books on executive skills in the classroom (e.g., Dawson & Guare, 2018; Kaufman, 2010; Meltzer, 2010). Thus the primary purposes of this book are to provide an updated research base for individuals and schools interested in the role of executive skills in reading comprehension and to provide practical guidance on executive skills interventions for reading comprehension difficulties.

As I noted earlier, there are no practitioner-oriented texts on the market that focus exclusively on the role of executive skills in reading comprehension; in fact, there are not even scholarly texts on this topic! Existing practitioner texts focus on executive skills more generally, with limited attention paid to specific applications of executive skills for improving performance in particular academic subjects such as math or reading. Although the role of working memory—probably the most well-known executive skill—has been the focus of reading comprehension research for decades, scholarly texts are just recently beginning to include attention to a full range of executive skills (planning, organization, inhibition, cognitive flexibility, and self-regulation, to name a few), consistent with trends in the field. A brief summary of significant milestones in the development of resources on executive functions and reading comprehension follows.

One of the earliest texts to focus on the relation between executive skills and reading processes was Britton and Glynn's (1987) edited collection, *Executive Control Processes in Reading*, of which only Wagner and Sternberg's chapter focused exclusively on reading comprehension. At that point in history, the study of executive skills was in its infancy. As Wagner and Sternberg noted (1987, p. 2), there was "as yet little, if any, consensus about what executive control [was], or even what it [was] not." They reported findings of a study that focused on a particular aspect of the reading comprehension process: how readers manage their time and effort in reading tasks, depending on the difficulty and purpose of a text. However, given the state of the field at that time, the chapter provided scholars and practitioners with little guidance regarding the breadth of influence of various executive skills on reading comprehension and even less guidance on how these might affect reading comprehension instruction.

Six years later, Dawson and Guare (2003) published the first edition of their practitioner-oriented text on executive skills in children and adolescents. The updated third (2018) edition provides a thorough overview of executive skill assessment techniques, makes recommendations for identifying executive skill deficits in students, and provides guidance for designing individual executive skill intervention plans. The bulk of Dawson and Guare's book provides recommendations for teaching executive skills in classroom routines throughout the school day. Thus Dawson and Guare's (2018) widely used book is applicable to education more generally but not to reading comprehension specifically, as evidenced by the fact that the terms *reading comprehension*, *reading*, and *comprehension* do not even appear in the index of that book. Similarly, another popular book on executive skills, *Executive Functions: What They Are, How They Work, and Why They Evolved* (Barkley, 2012), includes no table of contents or index references to *reading comprehension, reading*, or *comprehension*.

After Dawson and Guare published the first edition of their book (2003), which offered classroom applications of executive skills research, texts with applications to specific academic subjects began to emerge. For example, Lynn Meltzer published two books: *Executive Function in Education* (Meltzer, 2007, newly revised in 2018), an edited collection of chapters by leading scholars in the field, including one on reading comprehension (Gaskins, Satlow, & Pressley, 2007), with recommendations for classroom practice; and *Promoting Executive Function in the Classroom* (Meltzer, 2010), which is organized into chapters that each focus on a particular executive skill. Although reading comprehension is mentioned briefly in several chapters in Meltzer's 2010 text, her focus is on teaching executive skills to support struggling learners more generally, across academic subjects. (See also Kaufman's [2010] practitioner-focused text, *Executive Function in the Classroom*, which has a similar focus.)

My 2008 book, *Literacy Processes: Cognitive Flexibility in Learning and Teaching*, presented an edited collection of chapters from leading scholars in the field that focused on the role of one executive skill, cognitive flexibility, in literacy processes; however, that text was not practitioner-oriented, and its focus was on various aspects of literacy teaching and learning, not reading comprehension specifically. Additionally, the only practitioner-oriented text on the market that focuses solely on reading comprehension with attention to executive skills is my 2010 practitioner-oriented book *Word Callers: Small-Group and One-to-One Interventions for Children Who "Read" but Don't Comprehend*. This text's primary focus is on interventions that improve comprehension for children with RCD and includes only a brief review of work in executive skills. In fact, many contemporary studies of the role of executive skills in reading comprehension had not yet been completed or published when I wrote that book.

It is not surprising that practitioner-oriented books have not yet emerged that focus exclusively on the role of executive skills in reading comprehension because, as noted above, no scholarly texts even exist at this intersection. When I wrote the

first edition of this book, contemporary neuropsychological research on the role of various executive skills in reading comprehension was just beginning to appear in scholarly books (e.g., Cutting, Eason, Young, & Alberstadt, 2009; Eason & Cutting, 2009). Even scholarly handbooks have lagged in this area. For example, although executive skills have been studied from the perspective of learning disabilities for quite some time, the *Handbook of Reading Disability Research* (McGill-Franzen & Allington, 2011) includes no mention of executive skills in chapter titles, in headings, or in the index; furthermore, even the chapter on neuropsychological perspectives on reading disabilities does not include attention to executive skills. I should note, however, that the *Handbook of Language and Literacy: Development and Disorders* (Stone, Silliman, Ehren, & Wallach, 2014) includes a chapter on reading comprehension difficulties that attends to the role of executive skills in reading comprehension (Duke et al., 2014), and the most recent version of *Theoretical Models and Processes of Literacy* (Alvermann, Unrau, Sailors, & Ruddell, 2019) includes attention to executive skills in reading. Finally, the forthcoming fifth edition of the *Handbook of Research on Teaching the English Language Arts* (Fisher & Lapp, 2023) includes a chapter on self-regulation and executive skills. So the field is moving in the right direction.

In summary, although we have known about the important role of executive skills in reading comprehension processes for some time, this is the first book that examines this relation. Work in executive skills has important implications for understanding skilled reading comprehension processes, as well as reading comprehension difficulties. Furthermore, incorporating instructional approaches that enhance students' executive skills in service of their comprehension can enrich classroom reading comprehension instruction. Thus I wrote this book to meet those needs in the field.

Can We Assess Executive Skills?

In short, yes! Dawson and Guare (2018, Chap. 2) provide a thorough overview of existing assessments for the majority of the executive skills that are discussed in this volume. Additionally, they provide rubrics to guide your observations of students' behaviors in the classroom so that you can note various levels of executive skills among your students. They also provide guides that help you determine how executive skill difficulties may appear in testing, classroom, and home contexts, with suggested assessments for each type of executive skill. Finally, they also include teacher and student forms of an executive skills assessment that you can use to determine your students' strengths and weaknesses. The remainder of their book is focused on classroom routines and other interventions to promote students' executive skills across the school day.

When students have problems with executive skills, those problems affect behavioral and academic functioning across a wide range of activities, not just

reading comprehension. Thus Dawson and Guare's (2018) book provides a broader view to help you identify executive skills difficulties in your students across multiple contexts. In the current volume, I provide specific information on the impact of executive skills on reading comprehension with recommendations for instruction and intervention. In the course of doing these things, I refer you to assessments when appropriate. However, assessment is not a primary focus of this book. I highly recommend the Dawson and Guare book if you want to learn more about executive skills assessment and about how to link the results of those assessments to instruction across the curriculum. In addition, to assist you in determining whether your students might be exhibiting weaknesses in executive skills in the context of reading comprehension tasks, I have developed a rubric that you can use to informally assess executive skills in observations of your students' reading behavior (see Appendix A).

Structure of the Book

The majority of the remaining chapters in this book focus on a particular executive skill or set of related skills (e.g., shifting and cognitive flexibility are related executive skills) and how each skill contributes to reading comprehension. Chapters are organized chronologically with respect to their operation in the reading comprehension process as much as possible. For example, planning occurs before inference and integration in working memory when one comprehends a text, so planning is described in Chapter 2. Chapters share a common structure to facilitate your comprehension and use of the text, including the following sections.

- *What Is the Skill and How Is It Typically Assessed?* This section provides a definition of the skill that is the focus of the chapter, and I describe how the skill is typically assessed in research on executive skills so that you may better understand the kinds of behaviors that are associated with the skill. Additionally, I link each executive skill to your knowledge of board games and children's games because such games typically require the kinds of reasoning involved in executive skills (Hessels-Schlatter, 2010; Kulman et al., 2010; Larner, 2009). Although research in this area is relatively new, there is emerging evidence that executive skills are actually improved by game play (Gashaj, Dapp, Trninic, & Roebers, 2021; Hessels-Schlatter, 2010; Kim et al., 2014), and children's games best teach cognitive skills when game demands are aligned with the skills to be learned (Laski & Siegler, 2014). Because most of us have knowledge of common children's games, these serve as good examples to illustrate the behaviors associated with particular executive skills by building on our shared background knowledge about familiar activities. Therefore, in addition to providing a formal definition for each executive skill in this book and describing the typical ways each skill is assessed, I also provide examples from common children's and board games to connect these skills

to your prior knowledge. (See Appendix B for a list of games that require behaviors related to the executive skills described in this book.)

- *Why Is the Skill Important to Reading Comprehension?* This section provides an explanation to illustrate how the skill(s) would be important for reading comprehension.

- *What Does the Skill Look Like in Real Readers?* This section provides practical examples to illustrate how that chapter's executive skill would look in successful and unsuccessful reading comprehension.

- *What Does the Research Say?* This section provides a brief treatment of the research base on the relation of the skill(s) to reading comprehension with attention to comprehension of various types of texts (e.g., fictional vs. informational) when supported by the research base.

- *How Can I Apply This Knowledge to Classroom Practice?* This section provides recommendations and applications for classroom practice, including descriptions of specific, research-based interventions (when available) that target that particular skill to improve reading comprehension.

- *What Do We Still Need to Know about This Skill?* In many cases, because this text covers a relatively new area in research and practice, there will be issues and topics that deserve future research, and this section highlights those needs and directions for future work.

In summary, after reading this book, I intend for you to have (1) new information about executive skills, what they are, and what they look like in young readers; (2) an understanding of why executive skills are essential to successful reading comprehension and comprehension instruction; (3) knowledge of instructional techniques and intervention strategies you can use to improve your students' executive skills and reading comprehension; and (4) a sense of what we know about particular executive skills and reading comprehension now and what we need to know in the future in order to take full advantage of what the neurosciences have to offer to support the teaching and learning of reading comprehension.

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