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Linking Reading Comprehension and Executive Function: A Pathway to Improved Instruction

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Students with comorbid attention deficit hyperactivity disorder (ADHD) and specific learning disorder in reading (SLD-R) require reading comprehension instruction that is mindful of executive function deficit. Grounded in the notion that remediation is most successful when it is based on an understanding of the possible sources of failure, this literature review presents the interplay between executive function and reading comprehension and explores how reading comprehension instruction might integrate executive function support for students with ADHD and SLD-R. This proposed instructional framework integrates verbal and visual working memory, planning and goal setting, monitoring and inference making into the reading comprehension process. A lack of consensus with regards to how executive functions are identified, defined, and measured indicates avenues for future research. This literature review includes 38 peer-reviewed journal articles, five books, and one website, ranging from 1996-2019. Findings from this literature review may provide insight to teachers, administrators, curriculum developers, and those who plan and provide professional development within the field of education.

Keywords: Executive function, ADHD, specific learning disorder, reading

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Designing reading comprehension instruction that is mindful of executive function deficit is paramount for students with specific learning disorder in reading (SLD-R) and comorbid attention deficit hyperactivity disorder (ADHD). Factors associated with both these of neurological disorders require that reading instruction for students is thoughtfully considered in light of their specific learning needs. SLD-R impacts word reading accuracy, fluency, and/or reading comprehension (American Psychological Association [APA], 2010). ADHD is characterized by developmentally disproportionate levels of inattention, impulsivity and/or hyperactivity interfering with development (APA, 2010), and is associated with deficits in executive function (Barkley, 2015; Willcutt et al., 2005). Left untreated, both SLD-R and ADHD are associated with low academic achievement (Barkley, 2015; National Reading Panel [NRP], 2000), high rates of unemployment and underemployment (APA, 2010; Biederman, et al., 2010; Russell et al., 2014) and increased psychological distress (APA, 2010; Barkley, 1997). Rates of comorbidity indicate that 33% of children with ADHD are also diagnosed with SLD-R (Mayes & Calhoun, 2006). Because SLD-R and ADHD share genetic risk factors and frequently co-occur, it is important to

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identify effective treatments to address the common and unique neuropsychological deficits of both disorders (Sexton et al., 2011).

The process of comprehending written text is intertwined with complexities, even for those individuals who manage to do it effectively. Beyond phonological processing and decoding, successful readers coordinate vocabulary, background information, grammatical structures, metaphorical language, and inferential reasoning in order to comprehend written text successfully (Sesma et al., 2009). When the necessary processes do not combine as required, gaps in understanding occur, and in an educational setting this can be particularly detrimental. Attempts to remediate such gaps among those who struggle with reading comprehension are found to be most effective if they are based on a solid understanding of the possible sources of failure (Kendeou et al., 2014).

Executive function, the mechanisms which regulate the processes of human cognition (Miyake et al., 2000), includes the abilities to shift flexibly between tasks, to suppress an automatic response in favor of a subdominant response, and to manipulate information stored in memory for a short time. These mechanisms are integral to the reading process (Follmer, 2018; Georgiou & Das, 2018; Miller et al., 2013). For students with comorbid SLD-R and ADHD, deficits in these executive functions, the multi-purpose control mechanisms that regulate the process of human cognition (Miyake et al., 2000), may be at the root of this failure. Further compounding this concern and despite an understanding of the critical role of executive function in reading comprehension, models of reading comprehension have, for the most part, not explicitly incorporated executive functions (Butterfuss & Kendeou, 2018). The literature indicates a clear need to first understand the role of executive function in reading comprehension and then to develop an instructional framework that integrates executive function into reading comprehension instruction for the benefit of students with comorbid SLD-R and ADHD.

The purpose of this literature review is to use current research to explain how executive function relates to reading comprehension instruction for students with ADHD and SLD-R. This review aims to examine how decreased executive function ability in students with ADHD and SLD-R impacts reading comprehension. Additionally, it seeks to contribute to the development of a framework for reading comprehension instruction for students with executive function deficits. Three separate inquiries will be addressed in this research. The first asks how the theoretical foundations of reading comprehension and executive function integrate. The second examines what the existing research says about how executive function difficulties generally impact reading comprehension for students with comorbid SLD-R and ADHD. The third inquiry explores how reading comprehension instruction might integrate executive function support for students with SLD-R and ADHD. While these findings can provide insight to teachers of reading as well as to literacy leaders within the school setting, they may also be of value to curriculum developers, learning strategists, and those who plan and provide professional development opportunities within the field of education.

Methodology

In order to investigate the interplay between executive function and reading comprehension, as well as how reading comprehension instruction might integrate executive function support for students with ADHD and SLD-R, consideration was given to how literature was identified, analyzed, and reported within this integrated literature review inquiry. Articles were gathered from the following databases: Academic Search Complete, ERIC, Education Research Complete, and Teacher Reference Center. The key search terms initially used included: reading comprehension, learning disabilities, Attention Deficit/Hyperactivity Disorder, and executive function(s). Subsequent searches included terms specific to SLD-R: simple view of reading, reading comprehension strategies, and inference making. Owing to the significant amount of research related to ADHD and SLD-R, selection criteria mainly included articles published between 2008 and 2019. This range was determined to be large enough to include a worthwhile scope of literature while still allowing for a thorough examination of the included literature. Five foundational contributions to the literature made prior to 2008 (between 1996 and 2006) were included as well. These articles served to establish the foundations of current understanding of executive function, ADHD, and reading comprehension, and are reflective of Torraco's (2005) suggestion that both recent and older literature should be considered in a well-constructed literature review. In addition, concern for initial bias within the research process was identified prior to delving into the literature (Hendricks, 2017), in that the researcher's background in executive function was centered around the work of Barkley (2015). It became clear that in order to consider the research on a broader scale, alternatives to Barkley's (2015) work were included (Baddeley, 1996; Miyake et al., 2000; Miyake & Friedman, 2012, for example). Secondary research and non-peer reviewed journal articles were excluded from this review. This approach yielded 40 articles in total.

Literature was analyzed using a staged review process (Torraco, 2005) whereby there was an initial review of abstracts to determine suitability followed by an in-depth review of the entire article. Literature was selected based on its credibility, similarity, and relevance to this research (Hendricks, 2017). This staged review included an inspection of the references included in the literature, which provided an opportunity to uncover additional research related to the analysis. In order to provide a foundation for analysis, the literature was initially divided into categories that included reading comprehension theory and executive function theory. Subsequently, literature was categorized based on the connections the authors of these articles established between reading comprehension and executive functions. This approach allowed for a clear comparison of the literature findings, unveiled opportunities to reconceptualize the existing literature, and revealed directions for future research. In order to ensure the literature review was conducted in a responsible and accountable manner (Hendricks, 2017), ethical issues were considered through the identification of researcher bias, the creation of an audit trail, and debriefing with non-collaborating peers.

Literature Review

This literature review aims to synthesize the research related to executive function and its connection to ADHD, SLD-R, and reading comprehension. After first establishing the theoretical context within the domains of executive function, ADHD, reading comprehension, and SLD-R, this literature review presents a critical examination of how executive function impacts reading comprehension in students with comorbid ADHD and SLD-R. Finally, it examines the integration of executive function and reading comprehension.

Executive Function and ADHD

For the purposes of this literature review, executive function is defined as general-purpose control mechanisms that regulate the processes of human cognition (Miyake et al., 2000). It is a hierarchical construct encompassing several distinct but interrelated components including the ability to sustain attention, shift attention, think flexibly, inhibit responses, and hold and update goal-directed information in working memory (White et al., 2017). Early reference to executive function can be found in the work of Vygotsky (1896-1934). While Vygotsky did not label it as executive function, he suggested that self-directed speech permits the organization and personal planning of children's behaviour (Vygotsky et al., 1994). This reference to self-directed speech was revisited by Barkley (1997) in his work on executive function, decades later. A subsequent model of executive function was suggested by Baddeley (1996), who theorized that the central executive drives working memory and allocates data to the visuospatial sketchpad, or the inner eye, and to the phonological loop, the part of working memory that manages language. This model suggests that the components of executive function operate relatively independently of each other. In 1997, Russell Barkley began to make strong associations between executive function and ADHD. He eloquently labeled executive function as being "essential for the contemplation of the future juxtaposed against the here and now" (Barkley, 2015, p. 429). At its foundation, Barkley (1997) considered self-awareness to be the hub of the central executive, while inhibition was seen as the next most critical executive function, followed by nonverbal and verbal working memory.

While our collective understanding of executive function may indicate an association to ADHD, the literature reflects a variety of approaches in terms of how that association is made. Barkley's (1997) model, for example, began to establish ADHD as a disorder of executive function. In contrast to Barkley's model, Brown (2006) established that some, but not all, of those who meet the criteria for ADHD diagnosis are impacted by an executive function deficit. Willcutt et al., (2005) and Pennington and Ozonoff (1996) agreed that there is a strong association between executive function and ADHD however they concluded that the lack of universality of executive function deficits among individuals with ADHD suggests that difficulty with executive function is likely one component of ADHD neuropsychology but not sufficient enough to be the basis of the diagnosis. While the literature has not conclusively determined that executive function deficit is invariably interconnected with ADHD, there is a clear indication that a strong association between the two is often present.

Approaches to Reading Comprehension

An examination of reading comprehension presents opportunities to combine aspects of the reading process with executive function and reveals how executive function deficit impacts one's ability to understand written text. In general, reading comprehension refers to the construction of a mental representation of written text (Butterfuss & Kendeou, 2018). In much the

same way that the understanding of executive function has matured, perspectives related to reading comprehension have also progressed over time. However, since most reading comprehension models were proposed in the 1980s, before the link between executive function and reading had been established, and despite advances in comprehension literature, reading comprehension models have not been further developed (Butterfuss & Kendeou, 2018). This presents an opportunity for the refinement of our understanding of reading comprehension, especially given the critical importance of executive function.

A suitable entry point into understanding the process of reading comprehension is through the simple view of reading (Gough & Tumner, 1986). The simple view consists of two components: decoding and linguistic comprehension. It establishes that skill in reading can simply be characterized as the product of skill in these two domains. Several relevant implications surface with this model. One implication is that reading difficulties encountered by individuals who adequately comprehend language must stem from a deficiency in decoding skill. Similarly, for an individual with adequate decoding skills, the limit on reading is a deficiency with linguistic comprehension (Gough & Tumner, 1986). The simple view of reading establishes that the overall education of individuals must be considered while working to enhance reading ability among students because as understanding develops, linguistic comprehension also likely expands, regardless of whether one is involved in reading or listening.

While the simple view of reading has had significant impact on the pedagogy of reading comprehension, it is not without its controversy. Concannon-Gibney and Murphy (2010) identified the need for a less simple view of reading in order to recognize the importance of cognitive flexibility, metacognition, and explicit comprehension strategy instruction. Catts (2018) noted that although it was not the intent of its original authors, the simple view can easily be seen as a one-dimensional construct, while in reality it is a complex, multidimensional cognitive activity. Despite the simplicity of its name, the simple view of reading presents an opportunity to synthesize the reading process with the complexities of executive function.

Taking further steps toward the integration of reading comprehension and executive function, Duke and Carlisle (2010) considered reading comprehension to be a process requiring the reader to analyze information in a number of different ways. They identified that as the reader constructs meaning from the text, it is not the memory of the specific clauses or sentences within the text that holds value, but rather the overall meaning made of the text. Duke and Carlisle's (2010) model of reading comprehension, focused on making meaning, logically involves the flexibility of thought, strategic response, and manipulation of information involved in executive function. While it is not explicitly identified, their model presents opportunities to superimpose executive function onto the reading comprehension process.

Kendeou et al. (2014) proposed the cognitive view of reading which makes direct connections to executive function. They found that the process of comprehending written text requires the reader to execute a new and correct combination of cognitive processes with each new piece of information that is encountered. Understanding where the cognitive processes may fail is integral to the work of supporting those who struggle with these comprehension processes (Kendeou et al., 2014). This understanding is critical to the problem of practice identified in this literature review because it gives educators the opportunity to be reflective about what their students are missing from the cognitive process. Higher-level processes, such as inference making and executive function, are integral in reading comprehension. Individuals who struggle with these processes have difficulty identifying semantic connections within the text, identifying the important or main ideas in text, and monitoring their comprehension (Kendeou et al., 2014).

The strong association between reading comprehension and executive function among students with SLD-R was established in research by Cutting et al. (2009). They found that students who struggle with reading comprehension deficits showed prominent weaknesses in executive function.

While the literature supports the association between a variety of reading comprehension models and executive function, the picture becomes more complex when we ask how executive function impacts reading comprehension.

The Impact of Executive Function on Reading Comprehension

Complex processes involved in successful reading comprehension demand effective use of executive function skills. This section includes a summary of how the interconnected relationship between executive function and reading comprehension is presented in extant literature.

The degree to which executive function ability is predictive of reading comprehension ability is not clearly identified in the research. While an assessment of executive function may have limited value in predicting which individual students will respond to intensive reading interventions (Miciak et al., 2019), there are clear associations to be made between both constructs. For example, relative to those with ADHD and without SLD-R, teachers report that those with ADHD and SLD-R exhibit more executive function difficulties (Martinussen & Mackenzie, 2015).

Despite the lack of clarity regarding predictability of reading comprehension difficulty based on executive function deficit, the literature indicates that there are several executive functions that impact reading comprehension. For example, shifting, which is defined as the ability to switch flexibly between tasks (Follmer, 2018), was found to directly predict reading comprehension among university students (Georgiou & Das, 2018). Further, among fourth grade students, both inhibitory control, the ability to suppress an automatic response in favor of a subdominant response (Follmer, 2018), and shifting were directly associated with reading comprehension (Kieffer et al., 2013). Alternatively, working memory, the ability to manipulate information stored in memory for a short time (Follmer, 2018), is seen to play an important role in building a coherent representation of what students with ADHD have read (Miller et al., 2013).

In addition to shifting, inhibitory control, and working memory, the literature also indicates the importance of planning, the ability to sequence multistep tasks, prioritize information, and execute an organized response (Follmer, 2018), within the reading comprehension process. Among children aged 10-14, reading comprehension difficulties were linked to poor strategic planning and organization (Locascio et al., 2010), and university students with specific deficits in reading comprehension performed significantly poorer than controls only with regards to planning (Georgiou & Das, 2016). While the literature supports the notion that reading comprehension models must consider the role of executive function, there appears to be a lack of consensus as to which functions are most impactful in the reading comprehension process.

This lack of consensus is due, in part, to the fact that research studies tend to examine different combinations of executive functions, often leading to a comparison of dissimilar concepts. For example, one meta-analytic review of executive function and reading comprehension included inhibition, shifting, working memory, planning, and sustained attention (Follmer, 2018). In contrast, Georgiou and Das (2018) assessed only inhibition, shifting, and working memory in their study, which examined if components of executive function predict reading comprehension in young adults. They determined that only shifting exerted a significant effect on reading comprehension. Research by Cartwright et al. (2017) aligned closely with that of Georgiou and Das (2018) as they also assessed inhibition, shifting, and working memory in their study, which

identified that teacher-delivered shifting intervention produced significant improvements in reading comprehension for students with difficulty in this area.

Even among studies by the same researchers, there is discrepancy about which executive functions are being investigated. In a study by Georgiou and Das (2018), planning and working memory were included in an examination of what components of executive function predict reading comprehension in young adults, while in their study two years earlier, only planning was seen to be a significant predictor of reading comprehension in students (Georgiou & Das, 2016). Other research relating executive function to reading comprehension goes as far as to simply measure executive function generally, without specifying which component of executive function is relevant. For example, Corso et al. (2016) discussed the value of general executive function as it relates to reading comprehension skills among students with low socioeconomic status.

Miyake and Friedman (2012) entered into the discussion on the interplay among executive functions, concluding that executive function involves both the correlation of a unified underlying ability, as well as the separability or individualization of executive functions. Miyake and Friedman (2012) found that inhibition correlated nearly perfectly with the common executive function. This is important because until the literature shows alignment in terms of how executive functions are identified, it will be difficult, if not impossible, for researchers to form robust conclusions on the importance of individual executive functions.

However, the findings of a study by Altemeier et al. (2008) may help to identify such conclusions about individual executive functions. These authors have suggested that just as there are lower and higher level literacy skills, there are lower and higher level executive functions. This is supported by their conclusion that inhibition, shifting, and updating ability do not predict the higher-level skill of reading comprehension. Rather they were more predictive of decoding ability, a lower-level literacy skill. Verbal and visual working memory, planning and goal setting, monitoring, and inference making were considered to be higher-level executive function processes involved in reading comprehension (Cutting et al., 2009; Martinussen & Mackenzie, 2015). Further research into the higher order executive function skills and their relationship to higher order reading comprehension processes would help to focus the literature and provide more clarity on how best to support students.

Integration of Executive Function and Reading Comprehension

Current models of reading comprehension suggest that executive function plays an important role in the reading comprehension process. While processes related to decoding and understanding syntax are necessary in order for a reader to comprehend written text, these both involve lower level cognitive processes and are not as dependent on executive function (Butterfuss & Kendeou, 2018; Potocki et al., 2017; Spencer et al., 2014). With that in mind, it becomes clear that linguistic comprehension, a component within the simple view of reading which includes background knowledge, vocabulary knowledge, language structures, verbal reasoning, and literacy knowledge (Gough & Tumner, 1986), is driven by higher order executive function skills. The literature has confirmed that higher order executive function skills including verbal and visual working memory (Kofler et al., 2018; Miller et al., 2013; Sesma et al., 2009), planning and goal setting (Georgiou & Das, 2016; Locascio et al., 2010), and monitoring (Dabarera et al., 2014) most significantly impact the higher order demands of the reading comprehension process (Altemeier et al., 2008). For example, use of strategies, such as chunking a large, cognitively demanding text into smaller, more manageable sections and underlining the key details, may allow readers to reduce the load on their working memory and facilitate self-monitoring of comprehension while

working through the text. Through instruction of strategies to facilitate reading comprehension based on differential executive function demands, students with SLD-R and ADHD may benefit.

Findings

Within the context of this literature review, these findings aim to suggest a new approach for reading comprehension instruction in light of the integration of reading comprehension and executive function.

A New Approach to Reading Comprehension Instruction

Understanding where cognitive processes may fail is integral to the work of supporting those who struggle with reading comprehension (Kendeou et al., 2014). This presents an excellent opportunity to revisit how reading comprehension is taught and how students are supported in developing their ability to comprehend written text. An extensive investigation into the most impactful executive functions provides the opportunity to elaborate on strategies and instructional approaches that could benefit students with SLD-R and ADHD and for whom executive function deficit is a concern. The following framework for reading comprehension instruction is suggested for use by teachers and those who are closely connected to literacy instruction. The framework is broken down by subheading as it relates to individual executive functions.

The literature has indicated that students with ADHD are generally inefficient strategy users and that they have difficulty identifying the correct strategies to use in specific situations (Kofman et al., 2008). Therefore, it is important to teach strategies systematically and explicitly, and support their use through scaffolding and collaborative practice (Johnson & Reid, 2011).

Another point of consideration is the purpose for reading. For example, in situations that require the reader to search for specific information in an expository text or in a web-based environment, executive functions are more heavily called upon (in particular, working memory, planning, and inhibition skills). In circumstances where students are required to read a narrative and answer questions about it, the demand on executive functions is less (Potocki et al., 2017). This should be taken into consideration by teachers as they support their students in engaging in the appropriate strategies to build reading comprehension. Further, being aware of the purpose of reading will provide students with guidance in terms of the types of strategies they might employ. Potocki et al. (2017) found that working memory, planning, and inhibition are significantly predictive of performance on inferential questions of comprehension, but that these executive functions did not predict scores on the literal tasks of comprehension.

Verbal and visual working memory

Supporting working memory may be one of the most significant strategies in developing reading comprehension skills for students with ADHD and SLD-R. Rather than taxing a weak working memory, students may annotate as they read. This annotation becomes a record of a student's thoughts, what they are reminded of, what they agree and disagree with, what they find surprising, what they are curious about, and what they do not understand. This strategy is best used when the formatting of the text is adjusted so that it includes adequate space in the margins for students to record their thinking. Recording keywords or drawing small sketches in the margins can be equally powerful. Providing students with instruction around how to properly annotate as they read may be helpful in allowing them to visualize the information they are storing in mind

and then updating with new information. The strength in this approach is that it allows students to make their thinking visible. It helps them to clearly see the progression of the text and reveals a road map of sorts, indicating where they were and where they are going within the text. Such visual and textual annotations serve as a reminder and reference for students as they reflect on what they have read and allows students to participate in planning and goal setting.

Planning and goal setting

Both Butterfuss and Kendeou (2018) and Georgiou and Das (2018) identified planning as being necessary for coordinating higher-level processes during reading. This would suggest that explicit instruction related to planning should be included in reading comprehension instruction, especially for students who are involved in understanding expository text. Engaging in strategies to support students with planning and goal setting involves reflecting on, discussing, and recording how a text fits into the bigger context. This could be framed by asking what the text adds to the conversation, the class or the larger society, how the text might impact the reader, and how we might benefit from the text. Guiding students to understand and consider the author's purpose helps students to see the progression and development of the text and leads to better comprehension.

Introducing strategies that help support planning might also involve the mapping of main ideas within an expository text. Understanding the big picture within a complicated set of details requires that the reader has a good sense of how the text is planned and organized (Georgiou & Das, 2018; Locascio et al., 2010). Graphic organizers or colour coded annotative notes could be considered as such strategies. Explicit instruction related to story mapping of narrative text may also reinforce higher-order planning functions for students.

Monitoring

Providing students with opportunities to reflect on how well they have engaged their executive function skills during the reading process allows them to identify their areas of growth and strength. This strategy assumes that students are aware of the executive functions they should be using during reading, which reflects the importance of providing explicit instruction in this regard. Engaging students in understanding what executive functions are and how they serve reading comprehension gives students agency in their learning. Providing opportunities for them to reflect on their abilities to use or support their executive function skills is critical to the development of their independence.

Opportunities for future research related to this framework include a quantitative study assessing the effectiveness of the strategies highlighted here. Additionally, it would be beneficial to differentiate this framework to better support executive function skills for students in the primary years. The strength in this framework is that it highlights the executive functions that are considered most fundamental to the reading comprehension process. It invites educators to engage in discussions with their students about what executive functions are and their role in the reading process, provides students with an opportunity to engage in reflective thinking on their personal use of executive functions during reading, and supports the use of valuable strategies to support reading comprehension across a variety of texts.

Discussion

Several conclusions can be formed based on the synthesis of literature relating to executive function and reading comprehension ability among students with ADHD and comorbid SLD-R. It was evident from this review of studies that there is a strong association between executive function ability and reading comprehension and that this association is particularly relevant for students with ADHD and comorbid SLD-R for whom executive function is impacted. This section will identify gaps in the current literature related to executive function and reading comprehension by first investigating the misalignment in terms of which executive functions are assessed within the literature. It will then consider the accuracy and lack of consistency in executive function measurement.

Reading comprehension models such as the simple view of reading (Gough & Tumner, 1986) and the cognitive view of reading (Kendeou et al., 2014) both recognize the role of executive function in skilled reading. In addition to complexities with task-impurity and the measurement of executive function, which executive functions are assessed in reading comprehension and how functions of the executive are defined can also be inconsistent. Research showing a strong correlation between ADHD and difficulties with executive function, coupled with the high rates of ADHD and SLD-R, makes it clear that reading comprehension instruction that is not rooted in executive function support fails to address the learning needs of these students. Given that students with ADHD and SLD-R are more likely to be faced with low academic achievement, low self-esteem, and are less likely to complete high-school than typical learners (APA, 2010), it is important that teachers have a strong understanding of where the disconnect lies for their students, especially in terms of helping them to understand written text. Targeting executive function development and support within reading comprehension instruction is critical to addressing that disconnect.

There exists a lack of agreement among researchers regarding the skills that are referred to when considering executive function. This may explain the variation in executive functions chosen by researchers for assessment. For example, generally speaking, there is agreement that working memory is a critical executive function, but deeper examination into whether verbal or non-verbal working memory is being evaluated may change the dynamics of the research. This could be a critical distinction to make because the cognitive demands involved in each are profoundly different (Barkley, 2015). While our understanding of executive functions and their role in the learning process is relatively well developed, consensus in this regard does not exist.

Altemeier et al.'s (2008) findings that inhibition, shifting, and updating ability do not predict reading comprehension ability, but rather were more predictive of decoding ability, was pivotal in this review. Higher level executive functions such as verbal and visual working memory, planning and goal setting, monitoring, and inference making were considered to be most influential to reading comprehension, itself a higher order process (Cutting et al., 2009; Martinussen & Mackenzie, 2015). Therefore, these executive functions formed the foundation of a proposed pedagogical framework for reading comprehension.

Additionally, it is important to consider the controversy surrounding how executive functions are best measured. Miyake et al. (2000) described the task-impurity problem associated with the measurement of executive functions. They found that in order to assess a target executive function, that function must be embedded within a specific task. This means that other non-executive function processes associated with that specific task would also be assessed and the results would not be purely reflective of the targeted executive function (Miyake et al., 2000).

Barkley (2015) shared similar concerns, stating that rating scales in executive function are superior to this type of neuropsychological testing because it is extremely difficult, if not impossible, to truly isolate executive functions. Despite this, ratings scales are seldom used in evaluating executive functions (Barkley, 2015).

Cirino et al. (2017) agreed, in part, with this lack of consensus. Their research sought to evaluate the extent to which instruction that emphasized executive function would result in increased reading comprehension ability among students. Results of this research found that the correlations between executive function centered instruction and reading comprehension ability were weak, but their conclusion echoed the thought that more sensitive measurement of executive function would allow for more in-depth examination of the topic. Thus, the literature shows that clearly understanding the importance of executive function within the context of reading comprehension will be controversial as long as executive function measurement lacks consistency.

The findings of this literature review are intended to serve teachers as they design reading comprehension instruction for students with ADHD and SLD-R. Acknowledging the critical role of executive functions in the reading comprehension process and designing instruction to highlight those functions and their purpose allows teachers to engage with their students in the most meaningful of ways. The framework provided within this literature review is proposed to achieve this outcome. Further, recognizing why this work is important is the critical first step to supporting students with comorbid ADHD and SLD-R. However, beyond that, consistently identifying and defining executive functions within the literature and resolving concern surrounding how executive functions are assessed will be important as we move forward.

When considering limitations to the literature review process, one might recognize that from a pedagogical standpoint, reading comprehension has long been a topic that garners significant attention and therefore there exists a wealth of research on the topic. While a large volume of academic resources could be viewed as an asset within a literature review, it does present a limitation to the research. The wealth of literature related to reading comprehension demanded that the methodology for this literature review include specific and fixed data bases and search terms. However, there is an acknowledgement that the literature included within this review represents a cross section of what exists in the broader context.

Conclusion

The literature indicates a clear need for executive function support to be integrated into reading comprehension instruction for students with comorbid ADHD and SLD-R. Providing educators with a framework for reading comprehension instruction which includes mindful and targeted support for higher level executive function processes like verbal and visual working memory, planning and goal setting, and monitoring addresses remediation needs for students with ADHD. This approach is reflective of Kendeou et al.'s (2014) observation that reading comprehension remediation is most effective when it is designed with a solid understanding of the possible sources of failure.

While the literature clearly indicates a strong association between executive function skill and reading comprehension (Follmer, 2018; Kieffer et al., 2013; Locascio et al., 2010), a lack of common definitions, effective measurement tools, and alignment in terms of which executive functions are most critical to the reading comprehension process, indicate clear avenues for future research. Currently, it seems that this area of study is lacking common parameters. Once those parameters are in place, it may be possible to add to the research from a neurobiological

perspective. This may be powerful as we look to build stronger foundations in the exploration of executive functions especially as they pertain to reading comprehension.

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