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The Impact of Comorbid Conditions on Reading Growth

Emily Kathryn Lewis

THE IMPACT OF COMORBID CONDITIONS ON READING GROWTH

by

Emily Kathryn Lewis

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Abstract

This study aimed to understand the impact of comorbid disorders on reading growth. Among 105 students with an SLD in reading, many had up to four additional comorbid diagnoses, and disorder frequencies were coded based on the number of cooccurring conditions present. Reading fluency and comprehension skills were measured in the fall and spring using two reading assessments and served as the dependent variables in analyses. A series of mixed factorial ANCOVAs were conducted to examine the impact of comorbidity and gender on text-level reading skills. Results indicated that the number of cooccurring conditions did not make a statistically significant difference on reading fluency or comprehension growth across the school year, with girls exhibiting less growth than boys. Further, students in earlier grades demonstrated significant improvement in fluency across the year. Given these findings, future studies should further examine the effects of having multiple cooccurring conditions on reading skill growth.

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The Impact of Comorbid Conditions on Reading Growth

Several abilities are needed to succeed in school, and reading can be considered the most necessary academic skill a child must learn before mastering other subjects. Persistent underachievement in academics despite adequate instruction is known as a specific learning disorder (SLD; Fletcher et al., 2019). Specific learning disabilities may occur in the areas of math, writing, or reading, or among more than one of these skills. However, SLDs in reading are the most commonly occurring diagnosis on our schools, representing approximately 90% of all SLD diagnoses (Fletcher et al., 2019). Another persisting issue is that individuals identified with an SLD in reading are also often diagnosed with at least one or more comorbid conditions, leaving questions about how to remediate skills. Despite the prevalence of comorbidity among those with reading disabilities, the majority of research examining students' reading growth does not address this important variable.

The aim of this study is to understand how the presence of comorbid disorders among students with SLD in reading may impact reading skill growth across the school year. First, the deficits commonly related to SLD in reading will be examined, with a focus on text-level skills such as reading fluency and reading comprehension. Next, the literature on the cooccurrence between SLD in reading and other educationally relevant disorders will be introduced, including SLDs in mathematics and written expression, communication disorders such as language disorder and speech sound disorder, and attention-deficit/hyperactivity disorder (ADHD). Shared deficits between SLD in reading and these other commonly comorbid conditions are then discussed. Finally, factors that predict reading growth are examined, followed by indications of current research gaps.

Etiology of Reading Disabilities

According to the *Diagnostic and Statistical Manual, Fifth Edition* (DSM-5; American Psychiatric Association, 2013), a SLD with impairment in reading is characterized by difficulties in one or more areas of reading including accuracy, rate or fluency, and reading comprehension. In the literature, studies of SLD in reading often do not specify which of these reading subskills were impacted when describing their samples. However, a small but growing number of researchers do differentiate between SLD in reading as either a disability in basic reading skills or in reading comprehension (Fletcher et al., 2019). For the purpose of this paper, the term reading disability will encompass all the subskills deficits represented within the SLD in reading classification as outlined by the DSM-5.

Fluent text-level reading builds upon proficient word reading skills and is characterized by reading that is accurate, automatic, and appropriately expressive (Kuhn et al., 2010). Text-level fluency is essential to student's ability to access the curriculum across academic subjects (Lee & Yoon, 2017), yet it represents a common area of difficulty for those with reading disabilities (Fletcher et al., 2019). Difficulties at the word-level often lead to concurrent difficulties in fluent reading and reading comprehension, which make sense given that the reader must be able to read and understand 90% or more of the words in order to comprehend the text (Nagy & Scott, 2000). In addition to impairments in reading comprehension, consequences of basic reading impairments may lead to reduced reading experience that can decrease growth in vocabulary skills and background knowledge (Lyon et al., 2003). Nonetheless, these reading skills are still independent, as a student with deficits in reading comprehension can still have functional word-level skills (Cutting et al., 2013).

Impairments in word reading accuracy and fluency are predominantly influenced by difficulties in underlying skills such as phonological awareness difficulties (awareness of and ability to manipulate the sounds in language), grapheme-phoneme associations, rapid naming, and letter (sound) knowledge (Hendren et al., 2018). Working memory is also considered to have a critical role in academic tasks due to the multiple steps and solutions that must be remembered for a short interval of time (Peng & Fuchs, 2017; Shah & Miyake, 1996). More specifically, rapid naming is known as the ability to name stimuli such as letters and numbers quickly and accurately, whereas verbal working memory is the capacity to temporarily store information while also undergoing other cognitive demands (Peng & Fuchs, 2017). Kudo et al.'s (2015) meta-analysis of 48 studies examining poor and average readers found that out of phonological awareness, rapid naming, and verbal working memory, phonological awareness was the strongest predictor of basic reading difficulties, implicating the overall importance of phonological awareness within reading skills. Overall, deficits in phonological awareness inhibit the accurate recognition of words, which may create a bottleneck for the development of other essential skills such as spelling, reading comprehension, and written expression (Rayner et al., 2002).

Across all the academic domains, SLDs are more common in boys than in girls, with ratios ranging from around 2:1 (American Psychiatric Association, 2013). Among the reading disability studies, there are two competing views to explain why more boys are found to have reading deficits (Quinn & Wagner, 2015). The literature suggests that these differences may be due to studies sampling from school or clinical settings subjected to referral bias, or the over-selection of participants with presenting problems (Fletcher et al., 2019). For example, one view explains that although slightly more boys demonstrate reading deficits, clinic samples exaggerate the magnitude of deficit severity (Pennington & Peterson, 2012). Unlike clinical settings,

research-identified samples with reading deficits have found that gender ratios are about 1:1 (Hawke et al., 2009). Within this realm, although more boys are referred, prior evidence reveals that girls tend to be older and display more severe reading impairments at the time of the referral in comparison to boys (Vogel, 1990). Several studies indicated that this referral bias stems from boys displaying more externalizing and hyperactive-impulsive behaviors than girls, possibly due to more boys having ADHD (Barkley, 2015; Shaywitz et al., 1990). However, Quinn & Wagner (2015) concluded that more reading deficits among boys were found even after applying reading disability criteria with a large group of students with and without diagnosed reading disabilities. Therefore, per the opposing argument, gender differences in reading deficits represent a specific reading vulnerability among boys (Liederman et al., 2005; Rutter et al., 2004).

Among other studies not specific to clinic settings, more boys have been found to display reading deficits than girls (Berninger et al., 2008). In Flannery et al. (2000), even after controlling for activity levels, attention, and race/ethnicity, boys were more likely than girls to have reading disabilities, indicating that these deficits are likely not solely due to the tendency for boys to exhibit inattentive behaviors (Flannery et al., 2000). Rutter et al. (2004) also found that significantly more boys had reading disabilities in four epidemiological studies. In contrast, Berninger et al. (2008) did not find significant reading differences between boys and girls in their sample when considering family genetics, and instead argued that boys showed more severe problems in writing. Based on a review of the literature, few studies find sex-specific phenotypic differences in the presentation of reading disabilities (Fletcher et al., 2019). However, other neurobiological evidence exists that sex differences can be traced to brain function and structure (Lambe, 1999) particularly among individuals with reading deficits (Evans et al., 2014). Arnett et al. (2017) indicated that one reason for more frequent reading deficits among boys may be the

result of boys demonstrating slower processing speed and less inhibitory control than girls. Overall, although evidence generally points to more boys exhibiting reading deficits than girls for reasons outside of referral bias, more work needs to be done to confirm and explain the severity of these gender differences.

Common Comorbidities

Due to the high comorbidity of behavioral, emotional, and learning disorders among school-age children, evaluating a single disorder without considering the effects of comorbid conditions is not possible (Mayes & Calhoun, 2006). Reading disabilities are often comorbid with other specific learning disorders in mathematics or written expression (Grigorenko et al., 2019); however, they may also be comorbid with disorders that are not learning based. Comorbid language impairments and reading disorders are common, with estimates typically falling in the range of 17% to 29% (Catts et al., 2005). Based on prior studies, prevalence estimates of ADHD in the reading disorder population range from 26% to 50% (de Jong et al., 2002). Comorbid disorders generally share common disorder-specific and genetic components, which complicates the classification of individuals in research and practice (Branum-Martin et al., 2012; Willcutt et al., 2010). Although outside of the focus of the current study, reading disabilities tend to strongly co-occur with later internalizing problems such as anxiety and depression during adolescence (Hendren et al., 2018).

Specific learning disabilities. Individuals may be identified with a SLDs in one or more of three broad adamic domains including reading, written expression, and mathematics (American Psychiatric Association, 2013). The comorbidity between reading disabilities and SLDs in math is especially prevalent, cooccurring together at a rate of between 30-70% (Willcutt et al., 2013). SLDs in math are generally conceptualized as having difficulties in accurate or

fluent calculation, math reasoning, number sense, or memorization of arithmetic facts (American Psychiatric Association, 2013). These difficulties may be conceptualized as falling under two broad domains known as calculation and word problem-solving (Grigorenko et al., 2019). As seen in reading acquisition, learning basic math skills predicts the ability to learn more complex skills (Fuchs et al., 2008). For example, calculation has been linked to phonological processing and attention, whereas problem solving skills involve reasoning and language comprehension (Grigorenko et al., 2019). Oral language and the capability to shift between spatial and verbal representations are needed for math problem solving (Fuchs et al., 2016). Difficulties in problem solving often may be traced to poor working memory and planning processes, slow execution rates, and insufficient reading skills (Fletcher et al., 2019). Specifically, working memory is needed for both reading comprehension and math knowledge, as well as more specific skills such as the retrieval of math facts (Geary, 1993).

SLDs in written expression include complications with accurate spelling, grammar and punctuation, or organization or clarity of written expression (American Psychiatric Association, 2013). Reading and writing are both language-based skills and are therefore closely related (Döhla & Heim, 2016). Among school-aged children, developmental writing deficits occur at a rate of seven to 15 percent (Katusic et al., 2009). However, prior to a meta-analysis by Graham et al. (2017), a comprehensive examination of writing skills in students with learning disabilities did not exist, signifying that this topic is understudied in the literature. SLD in written expression is characterized by having deficits within the domains of either transcription or composition of text (Berninger, 2004). Difficulties within the composition component of writing are thought to stem from executive function and oral language difficulties (Lin et al., 2007). It is widely understood in the literature that spelling is a transcription skill involving working memory, motor

planning, fine and visual-motor skills, phonological analysis, handwriting, and knowledge of orthographic conventions (Berninger, 2004). While many children have problems in these specific domains, written expression is still not widely studied with its definition, neurobiological components, and cognitive characteristics remaining unclear (Fletcher et al., 2019).

Communication disorders. In the DSM-5, communication disorders include impairments in language, speech, and communication (American Psychiatric Association, 2013). Language disorders involve delayed or impaired language skill use and acquisition independent of problems in intellectual, medical, or sensory problems (American Psychiatric Association, 2013). Language disorders are also highly related to phonological skills that have been implicated in both reading and math disabilities (Ziegler et al., 2010; Jordan et al., 2015; Catts et al., 2005). Expressive and receptive language is the foundation of writing and reading skills, such that difficulties in the oral register will likely impede the development of the written register. Among individuals with reading disorders, 55% show major language and speech impairments (Grigorenko et al., 2019; McArthur et al., 2000). Similarly, since oral language skills are required for composition such as vocabulary, comorbidity is commonly seen between written expression and oral language disorders (Bishop & Clarkson, 2003; Fletcher et al., 2019).

Speech sound disorder (SSD) is a specific communication disorder that affects about three to six percent of children between the ages of four and six (Hayiou-Thomas et al., 2017). Intelligible speech due to age-inappropriate speech production errors, such as speech sound deletions and substitutions are characteristics of SSD (McGrath et al., 2008; Shriberg, 2003). SSD and reading disabilities are highly comorbid, with estimates ranging from 25 to 40 percent (McGrath et al., 2008; Rucklidge & Tannock, 2002; Willcutt & Pennington, 2000). Children

with SSD often experience delayed development of phonological awareness and early literacy abilities (Raitano et al., 2004; Rvachew & Grawburg, 2006; Rvachew et al., 2003). SSD also includes cognitive-linguistic phonological deficits and articulatory, or sensorimotor, problems (McGrath et al., 2008). SSD is especially problematic in the early school years because of the overall impediment placed on early reading skills (Hayiou-Thomas et al., 2017).

Attention-deficit/hyperactivity disorder (ADHD). ADHD is characterized by severe difficulties with organization, hyperactivity-impulsivity, and attention, occurring in about five percent of children (American Psychiatric Association, 2013). The displayed characteristics of ADHD depend on the type, such as either the hyperactive-impulsive, inattentive, or combined presentation (i.e., hyperactive-impulsive and inattentive). A predominant symptom of ADHD is the lack of close attention to details or making careless mistakes in one's schoolwork (American Psychiatric Association, 2013). Further, the impairments with either inattention, hyperactivity/impulsivity, or both, that are associated with ADHD often interfere with social and academic functioning (Johnels et al., 2014). When considering academic outcomes, it is widely thought that the inattention symptoms of ADHD instigate issues in education (Barkley, 2015). When comparing children with combined and inattentive types, it is understood that inattentive groups are more associated with increased sluggishness in mental processing (Hartman et al., 2004). Additional support from behavioral-cognitive and behavioral-genetic research suggests that the inattentive rather than the hyperactive-impulsive type of ADHD is more associated with academic deficits (Johnels et al., 2014). A review of the literature indicates that inattention symptoms in early childhood predict school performance beyond elementary school and then into later grades, illustrating a more powerful negative influence of inattention with age (Barkley, 2015).

It is widely considered in the literature that reading disabilities and ADHD tend to cooccur at a rate of 15 to 40% (Tannock et al., 2018). Academic difficulties are more frequent in children with both ADHD and reading deficits than among individuals with just one of the diagnoses (Törő et al., 2018). Studies examining comorbid reading disability and ADHD suggest that processing speed may represent a significant deficit shared by both disorders (Arnett et al., 2017; McGrath et al., 2011; Shanahan et al., 2006).

Executive function and working memory may explain the significant overlap between ADHD and math disabilities, with studies showing an even greater overlap than between ADHD and reading disabilities (Fletcher, 2005). Based on a literature review by DuPaul et al. (2013), comorbidity between math disabilities and ADHD ranges between five and 30%. In a comorbidity study, Fletcher (2005) found similar cognitive profiles between participants with math disability only versus those with ADHD plus math disability. Profile variables included sustained attention, procedural learning, rapid naming, and visual motor skills. No main effect of ADHD was found, indicating that among profiles also associated with math disabilities, the presence of ADHD did not make a significant difference. This study provides insight into the similar deficits associated with both ADHD and difficulties presented by SMD.

Since cases of ADHD and SLD comorbidity are so frequent and impactful, many studies have examined whether these disorders share common cognitive deficits. In the literature, the comorbidity between ADHD and SLD in written expression is typically explained by common ADHD factors such as deficits in organization, monitoring, and self-regulation (Denckla et al., 2013). Deficits specific to the composition domain of writing such as motor and executive function abilities may explain the comorbidity with ADHD (Barkley, 2015). Yoshimasu et al. (2011) examined a birth cohort sample with ADHD and found that about 65% of boys and 57%

of girls had an SLD in written expression. Motor coordination and visual-motor integration represent shared impairments between writing problems and ADHD (Yoshimasu et al., 2011). In a meta-analysis comparing writing skill characteristics in children with ADHD with typically achieving peers, Graham et al. (2016) found greatest differences in spelling, writing quality, and vocabulary, with less pronounced differences in handwriting. In school-aged children with ADHD, language-related deficits in phonological and semantic abilities are also common (Johnsels et al., 2014). For example, students with ADHD often experience issues with executive function issues such as inhibition, which evidently impact spelling and punctuation skills (Semrud-Clikeman & Harder, 2011). Overall, it is apparent based on the literature that while ADHD is commonly comorbid with the various SLDs, there is also overlap between ADHD and impairments in language-related skills.

The presence of comorbidity may be explained by shared cognitive deficits across disorders and the resulting impacts on multiple academic skills. For individuals with multiple disorders, it may be effective to provide a combination of interventions versus just one (Hendren et al., 2018). In addition, when implementing reading interventions, it is suggested that the unique reading profiles of those with comorbid conditions in addition to reading difficulties need to be better considered and targeted (Hendren et al., 2018). Evidence exists that there is increased comorbidity across the forms of SLDs with age, accompanied by the impact of additional cognitive burden due to the presence of multiple deficit areas (Costa et al., 2016). Those with multiple comorbid SLDs also experience poorer school functioning and emotional adjustment in comparison to individuals with just one SLD (Martínez & Semrud-Clikeman, 2004). Hence, as the number of comorbid conditions increases, the subsequent cognitive, academic, and emotional impairments become more pronounced. Further, those with comorbid SLDs experience lower

functioning in school and emotional adjustment (Martínez & Semrud-Clikeman, 2004). Current comorbidity literature calls for a better understanding of multifaceted impairments shared across disorders such as inattention and impulsivity, internalizing issues, language, and learning issues (Barkley, 2015; Hendren et al., 2018).

Predictors of Reading Growth

Existing evidence supports the effectiveness of intervention outcomes in early grades for reading skills such as fluency, word reading, and comprehension, but outcomes for remedial interventions are less promising (Fletcher et al., 2019). It is estimated that about 20 to 25% of individuals with learning disabilities do not experience sufficient benefits from the current reading interventions in schools (Austin et al., 2017; Fuchs & Fuchs, 2015). However, it is important to recognize that skill deficits among those with reading disorders are often persistent over time. Longitudinal studies indicate that over 70% of children who have a reading disability in the third grade maintain this status through grade 12 (Shaywitz, 2004). In studies involving individuals with reading difficulties, the resulting cognitive impairments such as within the phonological processing domain persist into adulthood (Cirino et al., 2005). Dysfluent reading is another common area of difficulty and is essential to supporting more complex reading skills such as comprehension (Kuhn et al., 2010).

Those students who are provided with research-based interventions but who do not demonstrate sufficient improvement are commonly known as inadequate responders. The most common predictors for response to intervention status are phonological awareness, rapid naming, and language skills (e.g., vocabulary, oral language, listening comprehension, verbal knowledge) (Al Otaiba & Fuchs, 2006; Austin et al., 2017; Denton et el., 2013; Fletcher et al., 2011; Nelson et al., 2003; Stage et al., 2003). However, it has been argued that rapid naming and phonological

awareness were the leading predictors of response status (Al Otaiba & Fuchs, 2002; Nelson et al., 2003). Although often included in studies, weak support exists for the role of verbal IQ in predicting basic reading skills (Fletcher et al., 2011; Vellutino et al., 2003), and the evidence for demographic variables such as socioeconomic status (SES) and race/ethnicity is mixed (Al Otaiba & Fuchs, 2002; Fletcher, et al., 2011; Nelson et al., 2003). Higher initial reading skills has been implicated as a predictor of response status (Stage et al., 2003). Poor outcomes are common for first graders who fail to gain basic reading skills by the end of the year (Borman & Dowling, 2010; Cummings et al., 2015; Perry & McConney, 2010). Further, initial reading skills in reading fluency has also been identified as a significant predictor of skill growth later in the school year (Speece & Ritchey, 2005; Stage & Jacobsen, 2001). Nelson et al. (2003) reported in their meta-analysis of predictors of response status that problem behavior yielded an effect size comparable to that of rapid naming and phonological awareness. Reading fluency is commonly used to measure student progress because it is considered an indicator of general reading skill that shows sensitivity to reading growth (Fuchs et al., 2001; Scholin & Burns, 2012). As reading skills become automatic, cognitive and attentional resources are freed to use for higher level processes such as comprehension (LaBerge & Samuels, 1974). Therefore, reading fluency is often conceptualized as the bridge between decoding skills and reading comprehension abilities (Pikulski & Chard, 2005). Despite its importance, very few intervention studies in the response status literature focus on reading fluency as a relevant outcome, and much more focus is instead on word reading accuracy and reading comprehension (Speece & Ritchey, 2005).

Gains in reading fluency fluctuate across studies, and outcomes are often smaller when compared to other areas of reading skill (Fletcher et al., 2019). In a fluency growth study, Silberglitt & Hintze (2007) used fall to spring benchmarks to examine oral reading fluency

growth rates between average and low-performing second- through sixth-grade students. Rates in growth were significantly lower in comparison to the summative average student level performance for groups of students who were at the bottom and top deciles of their fall measure distributions. Additionally, oral reading fluency growth in the earlier grades was much higher compared to later grades, which is consistent with prior reading development literature (Adams, 1990; Chall, 1983). However, evidence exists that as early as first grade, at-risk and average developing children demonstrate large discrepancies in reading fluency abilities (Deno et al., 2001; Speece & Ritchey, 2005). Regardless, among struggling readers, reading fluency growth is still known to lag behind word reading and comprehension skills (Denton et al., 2013). Further, scant attention has been paid to comorbidity in the evidence-based intervention literature for students with reading disabilities, leaving practitioners with little guidance about how these conditions may impact students' reading skill development (Hendren et al. 2018).

Purpose

The presence of a comorbid condition complicates our understanding of learning disabilities. Although it is widely known that SLDs in reading tend to cooccur with other conditions, SLD research lacks studies that examine the impact of comorbidity on students' reading skill growth. Several factors are known to predict inadequate response to intervention including phonological awareness, rapid naming, vocabulary, oral language skills, initial reading skills, and problem behavior (Al Otaiba & Fuchs, 2006; Austin et al., 2017; Denton et el., 2013; Fletcher et al., 2011; Nelson et al., 2003; Stage et al., 2003). As previously discussed, phonological awareness and rapid naming have been identified as common deficit areas for those with reading disabilities. Many of the other predictors of inadequate response have been linked to other educationally relevant disorders such as SLD in math, SLD in written expression,

communication disorders, and ADHD. In sum, the variables that are frequently found to predict poor response to intervention are also related to reading disabilities and the mentioned comorbid conditions.

Comorbidity has promoted challenges in the understanding of identification, assessment, and intervention in SLD research and practice with students. Prior research has focused on the presence of two comorbid conditions at a time (e.g., ADHD + SLD in reading, SLD in reading + SLD in math, ADHD + language disorder; Korrel et al., 2017; Törő et al., 2018; Willcutt et al., 2013) while ignoring the instances where more than two conditions are present. Although this approach yields valuable information regarding a particular pairing of conditions, it is problematic due to the evidence that the presence of multiple comorbidities may pose more serious challenges for intervention efforts (Martínez & Semrud-Clikeman, 2004). Research has also demonstrated that there is an increase in comorbidity of forms of SLDs with age, with multiple SLDs creating an accumulation of cognitive burden (Costa et al., 2016). Further, although there are several approaches to studying comorbidity, this study employed the additive approach (Hankin, 2013; Landerl et al., 2009). When considering comorbidity, this framework assumes areas are independent and therefore creates cumulative effects (Hankin, 2013). Therefore, it seems likely that the cumulative effects of cognitive deficits can negatively impact reading growth.

To my knowledge, no study to date has examined the number of comorbid conditions as a predictor of text-level (i.e., reading fluency and comprehension) reading growth among students with an SLD in reading. It is widely acknowledged that oral reading fluency is essential to supporting more advanced skills such as reading comprehension (Kuhn et al., 2010), and there is an increasing awareness that dysfluent reading is a particularly challenging skill to remediate

(Denton et al., 2013; Torgesen, 2004). Therefore, the focus on reading fluency in addition to reading comprehension represents an important contribution of this study.

The goal of this study is to understand the impact of comorbidity on text-level reading skills (i.e., reading fluency and comprehension) growth in a reading remediation setting across an academic year (fall to spring). This study will utilize a clinical sample of students with a reading disability, many of whom also had cooccurring, educationally relevant conditions such as ADHD, SLD in math, SLD in written expression, and communication disorders. Since participants were drawn across grades two through five, grade was used as a covariate in analyses. Evidence exists that age is associated with having more forms of comorbid SLDs (Costa et al., 2016), and that symptoms associated with some disorders such as inattention for those with ADHD can have more negative influences with age (Barkley, 2015). Another demographic variable, gender, was important to consider because of the existing knowledge that more boys tend to be diagnosed with SLDs than girls, and generally have more severe and impactful reading deficits (Arnett et al., 2017; Quinn & Wagner, 2015; Rutter et al., 2004). Therefore, it was expected that the boys in this sample would demonstrate greater deficits in reading and less growth across the year compared to girls. Additionally, it was hypothesized that increased comorbidity as indexed by the number of diagnoses would generally be associated with lower skill levels and less reading growth across the school year due to the cumulative effects from deficits occurring with multiple diagnoses. Exploring the impact of multiple comorbid conditions on text-level reading skills will address research gaps about the role of comorbidity in a reading remediation setting. This study will therefore address the following questions:

1. After controlling for grade, does comorbidity status impact reading fluency and comprehension outcomes across the academic year?
2. After controlling for grade, does gender impact reading fluency and comprehension outcomes across the academic year?

Method

Participants

The participants in this study were recruited from a private elementary school in the mid-southern region of the United States that specialized in reading skill remediation for students with reading disabilities. In order to be admitted to the school, applicants were required to have a psychoeducational assessment conducted within the past 3 years indicating that they met the diagnostic criteria for an SLD in reading as outlined in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychiatric Association, 2013). Participants (N = 123) in grades 2 through 5 were drawn from a larger longitudinal study that spanned across four academic years (2015-2016, 2016-2017, 2017-2018, and 2018-2019). If students had more than one year of available data, the year with complete data for the relevant variables was selected. However, cases of missing data were rare overall. In instances where data were complete for multiple years, then the grade with the fewest number of participants was selected to establish a more even distribution across grade levels. Those students whose diagnostic information were missing from school records were removed from the study (n = 14). Educationally relevant comorbid diagnoses (i.e., SLD in mathematics, SLD in written expression, ADHD, language disorder, and speech sound disorder) were of primary interest. A handful of individuals with other DSM-5 diagnoses (i.e., generalized anxiety disorder, social

anxiety disorder, developmental coordination disorder, and social communication disorder) were excluded from the study (n = 4), leaving a final sample size of 105.

Participants were in the second grade (n = 27), third grade (n = 27), fourth grade (n = 27), or fifth grade (n = 24). Students were approximately 4.8 % African American, 1.0% Asian, 1.0% Hispanic, 89.5% European American, and 3.8 % Other; 61.0% were boys. On average, participants were 108.34 months old (SD = 1.4, range 72.9 – 144.8) at the date of fall testing. Participants were from predominantly middle to high socioeconomic status backgrounds based on the tuition requirement for school attendance.

Measures

Comorbidity status. School records containing student's psychoeducational reports were reviewed to obtain information about comorbid diagnoses. Based on these records, 28 students had SLD in reading only, 55 were diagnosed with ADHD (22 inattentive, 31 combined, 2 unspecified), 15 with SLDs in math, 45 with SLDs in written expression, and 26 with a communication disorder (i.e., 15 language disorder or 11 speech sound disorder). To examine the cumulative impact of comorbidity on reading skills, this information was used to create a comorbidity status variable reflecting the number of comorbid conditions for each student (0, 1, 2, or 3). Please see Table 2 in Appendix A for frequency and demographic information for this variable. Among 105 students, 26.7% only had SLD in reading (n = 28), 31.4% had one additional diagnosis (n = 33), 25.7% had two additional diagnoses (n = 27), and 16.2% had three or four cooccurring conditions (n = 17). Due to the small group size, the students who had four additional diagnoses (n = 3) were combined with 14 students who had three comorbid disorders in addition to SLD in reading. See Table 3 in Appendix A for the specific patterns of comorbid diagnoses within each group among the 77 students who had one or more comorbid disorders.

AIMSweb. To assess for oral reading fluency and comprehension, students read outload from a grade-level benchmark passages and then engaged in a one-minute retell. Each grade-level narrative ranged between 250 to 300 words (Shinn & Shinn, 2002). Passages were shortened for this study to prevent fatigue while reading. Final passages for Grade 2 were 132 words with 22 idea units and 129 words with 24 idea units. Grade 3 final passages were 137 words with 23 idea units and 141 words with 23 idea units. Grade 4 passages were 170 words with 29 idea units and 179 words with 29 idea units. Grade 5 passages were 236 and 242 words, with 33 and 40 units. Passages were counterbalanced within and across timepoints such that 50% of the students to read each passage in the fall and then read the alternate passage in the spring.

As the student read the passage aloud, the number of words read incorrectly (i.e., substitutions and omissions) and the reading time in seconds was recorded. Passages were discontinued if a student correctly read only 10 words or fewer on the first passage administered. The number of words read correctly per minute (WCPM) were calculated by subtracting the number of errors made by the total number of words in the passage, dividing that sum by the reading time, and then multiplied by 60. AIMSweb probes have yielded an alternate-form reliability of .94 (Howe & Shinn, 2002) and a test-retest reliability of .94 (Christ & Silberglitt, 2007) when used as a measure of oral reading fluency. From third to fifth grade, WCPM scores were found to correlate .70 with Illinois and North Carolina state reading tests (AIMSweb Technical Manual, 2012).

After completing the reading, the passage was taken away and students completed a passage retell. The examiners read the following instruction, “Please tell me about what you just read. Try to tell me everything you can. Begin” (Good & Kaminski, 2002, p. 34). Students were then given one minute to retell the passage. If a student paused for three seconds, the examiner

prompted with, “Try to tell me everything you can.” If students paused afterwards for more than five seconds, the retell was ended. Recordings of these retell were later transcribed and scored based on the number of recalled idea units. The idea units were identified as any information relevant to the story including the main ideas, phrases, and words using an example from the Qualitative Reading Inventory, Fifth Edition (QRI-5; Leslie & Caldwell, 2011). Any repetitive idea units or those unrelated to the passage (e.g., “I didn’t like that story” or “That’s all I remember”) did not receive any points. A half point was given to each idea unit that was only partially correct but was still insufficient in detail to be considered a full idea unit. One point was given to each idea unit of a passage that was synonymous or completely matched with the idea unit for a passage. For example, if the idea unit was about a dog that had a wedding, one point would be given if both the wedding and the dog were provided in the response. Only a half point would be given if the retell only included mention of just the wedding, but not the dog. No points would be given to a response that did not mention a wedding or a dog. The percentage correct was calculated by dividing the number of points received by the number of possible points (total number of idea units in the passage) upon the scoring of a retell transcription.

The research literature indicates that retell scores correlate moderately to highly (.52 – .82) with other reading comprehension measures (Reed & Vaughn, 2012). The magnitude of these correlations is consistent with those commonly reported among different reading comprehension assessments. For example, Keenan et al. (2008) examined variation across reading measures that used different formats (e.g., cloze task, picture selection, short answer, multiple choice, and retell) and found correlations ranging from .31 to .70. Notably, Keenan et al. (2008) examined the QRI-5 oral retell, which was used as a template for this measure, and found intercorrelations with other comprehension measures (.41–.48) to be comparable with

those of other measures. Furthermore, factor analytical results revealed that the oral retell scores loaded strongly on the comprehension factor, whereas several other of the reading comprehension measures loaded higher on the decoding factor.

The Gray Oral Reading Tests, Fifth Edition (GORT-5; Wiederholt & Bryant, 2012). The GORT-5 is a standardized, norm-referenced measure that assesses text-level reading skills including reading fluency and reading comprehension. There were two parallel forms (A and B) which contained 16 passages that increased in difficulty. Passages were administered until the ceiling criterion was met. Participants were administered form A in the Fall and form B in the Spring. For each passage the number of reading errors was recorded (i.e., omissions, mispronunciations, insertions, substitutions, repetitions, reversals, and self-corrections) for use on the Accuracy subtest, and the reading time in seconds was recorded and scored for the Rate subtest. Accuracy and Rate subtests were combined to yield the Fluency subtests. Following each passage, the examinee also answered five open-ended comprehension questions. These individual scores were calculated and then summed to find the total score for each subtest. In this study, scaled scores from the Fluency and Comprehension subtests will be used (M = 10, SD = 3). According to the GORT-5 test manual, average coefficient alphas for both forms is .93 for reading fluency and .94 for reading comprehension. Test-retest reliability coefficients for both forms are .90 for fluency and .82 for comprehension. The manual indicated alternate-form reliability of .88 for fluency and .77 for comprehension. Average correlations between the GORT-5 and other reading measures are .73 for reading fluency and .74 for reading comprehension (Wiederholt & Bryant, 2012).

Procedure

Written parental consent and student assent were required for participation in this study. Following the approval of the University of Memphis Institutional Board (IRB #3814), four waves of data were collected during the 2015-2016, 2016-2017, 2017-2018, and 2018-2019 school years. Examiners with previous training and experience in psychoeducational assessment administered all measures. Prior to data collection, examiners practiced coding assessments by using audio recordings of students' reading until a minimum of 95% agreement between examiners was met. In both the fall and spring of each school year, administration of the measures was completed over approximately two weeks. The measures given in this study consisted of a subset of the broader battery that were administered as part of a larger study. To control for possible order effects within each time point, the order of the assessments administered was counterbalanced. Measures were administered individually in a private location (i.e., an empty office or classroom) during school hours. Every testing session was audio recorded to be later scored and reviewed. Participants received a prize following each testing session such as a sticker or small toy after completing the assessments. An independent reviewer randomly selected twenty-five percent of the data for blind review using an online randomizer after the data were collected (Urbaniak & Plous, 2013) to ensure inter-rater agreement. For the data collected in waves 1, 2, 3, & 4, discrepancies rarely occurred (<1%) and were resolved via discussion.

Results

Data Processing and Screening

Prior to analyses data were screened per Tabachnick and Fidell's (2019) recommendations. Data were checked for missing values, unequal group sizes, normality (i.e.,

skewness and kurtosis < |2.0|), and univariate outliers (|*z* |> 3.29). Group sizes for gender were relatively equal with a sample size of 64 boys and 41 girls. Skewness and kurtosis values fell within acceptable limits (see Table 1 in Appendix A) and no univariate outliers were detected. Five cases were missing due to administrator error while 17 other cases were due to performance invalidations (i.e., discontinue rule employed due to low reading skill or incomprehensible oral reading) accounting for less than two percent of all values. Expectation maximization (EM) algorithm available in IBM SPSS Statistics (Version 26) were used to estimate and replace these missing data. Little's MCAR test was not significant, $\chi 2$ (57, N = 105) = 63.49, p = .259, indicating the data were missing completely at random. Gender differences were checked across the comorbidity status variable (0, 1, 2, or 3) and no significant differences were found, $\chi 2$ (3, N = 105) = 3.30, p = .348, φ = .177. Similarly, gender differences were checked across grade level (2, 3, 4, or 5) and no significant differences were found, $\chi 2$ (3, N = 105) = 1.38, p = .710, φ = .113. Next, a one-way ANOVA was used to check for differences in age in months across the comorbidity status variable, and no significant differences were found, F(3, 101) = 1.74, p = .159, $\eta 2$ = .03. Several assumptions associated with an ANCOVA approach were also checked, including the presence of linearity between the dependent variables and covariates, multicollinearity and singularity, homogeneity of variance, and homogeneity of regression slopes. Linearity of data was confirmed through the examination of scatterplots. Next, the covariates were weakly correlated with one another, r = .19, p < .05 which falls below the .5 threshold indicating concern for multicollinearity. Heterogeneity of regression occurs when there is an interaction between the covariate(s) and the independent variable; however, none were found to be significant. Lastly, Levene's test for homogeneity of variance was not significant across analyses.

Analysis of Covariance (ANCOVA)

A series of 2 (gender) X 2 (time) mixed factorial ANCOVAs were conducted to examine the impact of comorbidity and gender on text-level reading skills. Time (fall and spring) served as the within-subjects variable and gender served as the between-subjects variable. Grade level and comorbidity status (i.e., number of diagnoses beyond SLD-R) served as covariates. Specifying comorbidity status as a covariate allowed this variable to retain greater variability as a continuous variable within an ANCOVA approach. Therefore, the examination of this covariate was central to addressing the research questions posed by this study (i.e., after controlling for grade, does comorbidity status impact reading fluency and comprehension outcomes across the academic year?). Reading fluency and comprehension scores from the GORT-5 and AIMSweb assessments served as dependent variables across four sets of analyses. Specifically, the scaled scores from the GORT-5 Fluency and Comprehension subtests as well as the WCPM and percent correct retell from AIMSweb grade-level passage were used. Effect sizes in the form of η2 were also reported, with .01 indicating a small effect size, .06 indicating medium, and .14 indicating large. Finally, family-wise error was controlled for using Bonferroni correction (.05/2) with $p <$ .025.

The gender by time interaction was not statistically significant, $F(1, 101) = 1.31$, $p =$ .254, η2 = .01 on GORT-5 fluency. A significant main effect was found for gender, $F(1, 101) =$ 9.58, $p = .003$, η2 = .09, and time, $F(1, 101) = 6.21$, $p = .014$, η2 = .06. On average, boys ($M =$ 6.94) were more fluent than girls ($M = 5.98$) across timepoints on the GORT-5 passages. Students also generally demonstrated improvement in their fluency skills from the beginning (M = 5.98) to the end ($M = 6.94$) of the school year. When the covariates were examined, the time by comorbid status interaction was not significant, $F(1, 101) = 1.18$, $p = .279$, η2 = .01.

Similarly, the number of comorbid conditions was not found to impact fluency, $F(1, 101) = .064$, $p = .801$, $\eta 2 = .00$. However, grade was found to be significant, $F(1, 101) = 7.64$, $p = .007$, $\eta 2 = .07$, suggesting that students in earlier grades demonstrated higher reading fluency skills on the GORT-5.

Similar results were found when fluency was examined by using words correct per minute (WCPM) on the AIMSweb grade-level passages. Again, the gender by time interaction was not statistically significant, $F(1, 101) = .66$, $p = .420$, $\eta 2 = .01$. A significant main effect on fluency was found for both gender, $F(1, 101) = 8.32$, $p = .005$, $\eta 2 = .08$, and time, $F(1, 101) = 52.12$, $p < .001$, $\eta 2 = .34$. On average, boys ($M = 78.54$) were more fluent readers on the AIMSweb compared to girls ($M = 64.80$). Students also generally demonstrated improvement in their fluency skills from the beginning ($M = 58.82$) to the end ($M = 84.52$) of the school year. When the covariates were examined, the time by comorbid status interaction was not significant, $F(1, 101) = 1.18$, $p = .932$, $\eta 2 = .00$. The number of comorbid conditions was also not found to significantly impact the results $F(1, 101) = .17$, $p = .679$, $\eta 2 = .00$, whereas grade was found to be significant, $F(1, 101) = 55.35$, $p = .000$, $\eta 2 = .35$, suggesting again that students in earlier grades demonstrated higher reading fluency skills on the AIMSweb passages.

Next, reading comprehension performance was examined. With regard to reading comprehension as measured by the GORT-5, the gender by time interaction, $F(1, 101) = .00$, $p = .993$, $\eta 2 = .00$ was not statistically significant. There was a significant main effect was found for gender, $F(1, 101) = 5.16$, $p = .025$, $\eta 2 = .05$. On average, boys ($M = 7.35$) showed higher comprehension skills on the GORT-5 compared to girls ($M = 6.66$). However, the main effect for time, $F(1, 101) = .41$, $p = .524$, $\eta 2 = .00$ was not significant. The time by comorbid status interaction was not significant, $F(1, 101) = .003$, $p = .958$, $\eta 2 = .00$. The number of comorbid

conditions was not found to impact the results, $F(1, 101) = .46$, $p = .501$, $\eta 2 = .00$, and grade also was not impactful, $F(1, 101) = 2.21$, $p = .140$, $\eta 2 = .02$.

Lastly, the percentage of idea units recalled from AIMSweb passage retells were examined. The gender by time interaction was not statistically significant, $F(1, 101) = .065$, $p = .800$, $\eta 2 = .00$. A significant main effect on reading comprehension was again found for gender, $F(1, 101) = 5.65$, $p = .019$, $\eta 2 = .05$, and the main effect for time, $F(1, 101) = 11.20$, $p = .001$, $\eta 2 = .10$, was also significant. On average, boys ($M = 22.01$) recalled a higher percentage of idea units compared to girls ($M = 17.88$), and students showed improvement in their reading comprehension skills from the beginning ($M = 16.16$) to the end ($M = 23.83$) of the school year. When the covariates were examined, the time by number of comorbid conditions was not found to impact the results, $F(1, 101) = 1.02$, $p = .314$, $\eta 2 = .01$. Similarly, neither the number of comorbid conditions, $F(1, 101) = 3.47$, $p = .065$, $\eta 2 = .03$, nor grade, $F(1, 101) = 2.69$, $p = .104$, $\eta 2 = .03$, were found to be significant.

Discussion

The goal of this study was to examine comorbidity as a predictor of reading fluency and comprehension skill outcomes across the school year in a sample of students with an SLD in reading. It is known that reading disabilities often cooccur with SLDs in writing and math as well as other disorders (Costa et al., 2016; Grigorenko et al., 2019; Moll et al., 2015; Willcutt et al., 2013). All students in the study had a diagnosis of SLD in reading, with the vast majority (i.e., 73%) having at least one additional psychoeducational diagnosis, including other SLDs in math or written expression, communication disorders, or ADHD. Despite the prevalence of this issue, the impact of having multiple cooccurring diagnoses on reading skill growth is understudied. This study took an additive approach to conceptualizing comorbidity, consistent

with work linking increased comorbidity to an accumulation of cognitive burden and related behavioral and academic challenges (Costa et al., 2016; Landerl et al., 2009). It was hypothesized that as the number of cooccurring disorders increased, this would be associated with more severe reading difficulties and less growth across the school year. Further, given trends in the prior literature, boys were expected to demonstrate more severe reading deficits and less growth than girls. However, results from this study did not support these hypotheses.

The overarching aim of this study was to examine the impact of comorbidity on text-level reading growth across an academic year. Results indicated that even students with three or more cooccurring disorders in addition to SLD in reading did not experience significant inhibition of growth in either reading skill, which contradicts the assumption that cumulative deficits from multiple disorders would yield more impact on skills. Comorbidity within the response to intervention literature is a highly understudied factor despite evidence existing that comorbidity can complicate intervention outcomes (Martínez & Semrud-Clikeman, 2004; Mayes & Calhoun, 2006). One explanation for such complications is that comorbidity produces unique reading profiles, and these require different interventions when compared to students who have only an SLD in reading (Hendren et al., 2018). Therefore, given previous findings surrounding comorbidity and evidence of its impact, it was initially hypothesized that comorbidity frequency would be associated with lower overall skills and would inhibit reading fluency and comprehension growth across the school year. Consideration of study hypotheses is needed to further understand these findings, beginning with the conceptualization of comorbidity that guided this work.

In congruence with prior work linking the presence of multiple comorbid disorders with resulting accumulation of cognitive burden, this study explored the additive approach or

cumulative risk, of comorbidity (Hankin, 2013; Landerl et al., 2009). This approach argues that additive deficits create a cumulative risk with each additional deficit, and this is due to the overlap of multiple independent areas (Hankin, 2013). In addition to having cumulative cognitive burden, individuals with comorbid SLDs also experience poorer functioning in academic and other settings in comparison to students with only one SLD (Martínez & Semrud-Clikeman, 2004). Given this understanding that multiple cooccurring disorders often contribute to negative outcomes, the use of the additive framework led to the conceptualization of the comorbidity status variable as frequency data (SLD only, SLD + 1, etc.). However, alternative approaches to understanding comorbidity exist, and it is possible that the conceptualization of this variable may have impacted these results.

One alternative approach to conceptualizing comorbidity posits that cooccurring disorders can be underadditive (Landerl et al., 2009). Specifically, the underadditivity approach assumes that some disorders have common underlying deficit(s) shared by multiple disorders, and instead of having an accumulation of separate deficits representing the sum of each disorder, individuals experience fewer impairments from sharing few broad deficits (Landerl et al., 2009; Shanahan et al., 2006). Therefore, it could be argued that the null findings regarding the impact of comorbidity of reading outcomes from this study support this underadditivity view of comorbidity. In a prior study supporting the underadditivity view, Shanahan et al. (2006) found evidence of underadditivity for processing speed deficits among students with comorbid reading disabilities and ADHD. However, Landerl et al. (2009) found mixed results indicating the presence of both additive and underadditive features of comorbidity after assessing skill-specific deficits among children with math and reading delays. Considering the comorbidity literature and mixed evidence supporting the underadditive argument, findings from this study provoke

consideration of deficits known to be commonly shared across multiple disorders (Fletcher et al., 2019; Shaywitz et al., 2001). For example, given that executive functioning is a commonly shared deficit area among many of the disorders in this study, possible latent variability of cognitive processes should be considered (McCrory & Viding, 2015). Latent variability of executive functioning deficits could increase the likelihood that reading disability symptoms develop later on, although they are not direct symptoms of reading disabilities (McCrory & Viding, 2015). Within this realm, latent variability of broad or underadditive deficits could explain why the number of additional diagnoses did not impact reading growth. Although data regarding these common deficit areas were not available in this study, the functions and impacts of shared deficits represents an important future direction for this literature.

Although less studied in SLD literature, other researchers have considered the multiplicative approach to understanding comorbidity, or the idea that specific constellations of comorbidity cause more vulnerability than others (Hankin, 2013). The multiplicative approach is unlike the underadditive conceptualization because certain combinations of disorders are thought to be more harmful than others. Based on this view, combinations of specific comorbid disorders would result in deficits of a greater magnitude than other combinations and would then be associated with less reading growth across the academic year. However, most studies within the learning disability research have examined only two cooccurring disorders at a time (e.g., SLD in reading + ADHD, SLD in reading + SLD in math, ADHD + language disorder; Korrel et al., 2017; Törő et al., 2018; Willcutt et al., 2013), and the research questions do not aim to compare severity of pairings against others. Further, little is known about the impact of specific constellations, and this pattern in the literature does not adequately represent the complexity of real-life situations among students who have cumulative deficits associated with having three or

more disorders. Although over half of the students in this sample had two or more comorbid conditions, it is important to note that both the underadditive and multiplicative approaches would require a much larger sample size so that participants with certain constellations of three or more disorders of interest could be extracted. Due to this stipulation, neither approach was adopted in this study, and the examination of frequency of diagnoses was deemed more suitable given this sample size. Further examination of the various frameworks of comorbidity in relation to reading outcomes is needed, such as the role of underadditivity from having singularly responsible deficits as well as comparisons between the severity associated with different constellations of disorders.

Another relevant shortcoming of this study involves the use of archival comorbidity data. Again, all comorbidity data were collected by examining prior psychoeducational reports contained in students' school records. Although all reports and diagnoses came from licensed professionals, diagnoses may vary based on settings and clinical judgement. In studies where the researchers apply diagnostic criteria, quality control procedures may be used such as standardization in procedures across assessors and reliability checks. However, that level of quality control is not possible when using archival data. In addition, it was not possible to check the inner-rater reliability of the data extracted from the psychoeducational reports due to the later removal or destruction of reports by the participating school, leaving questions about the accuracy of this extracted data. This is a major limitation of this study as it indicates caution must be taken when considering accuracy of diagnostic information. Further, the nature of archival data and lack of quality control affects assignment to comorbidity groups, and this may be a possible explanation for the null results concerning the comorbidity variable. Lastly, the selected approach to understanding comorbidity in this study presents limitations. When

exploring comorbidity from an additive approach, the main concern is the quantity or frequency of cooccurring disorders, and this implies an overall summative framework. Per Defenderfer et al. (2017), one problem with this approach is that examining the sum of cooccurring disorders alone does not account for the possible variance from the specific disorders. Therefore, it is impossible to know how impactful certain disorders were compared to others in this study.

Impact of Gender

The second aim of this study was to examine whether gender impacted reading fluency and comprehension outcomes across the academic year, after controlling for grade level and number of comorbid diagnoses. Findings again presented information incongruent with the hypotheses. Across all four reading variables in this study, although both boys and girls demonstrated growth in text-level reading skills, boys yielded stronger growth in skills overall across timepoints in comparison to girls. Medium effect sizes for gender were found for reading fluency measures whereas effect size estimates were smaller for measures of reading comprehension, suggesting that there was a slightly stronger association between gender and reading fluency performance overall in comparison to reading comprehension.

Given the prior literature, boys were expected to exhibit more pronounced reading difficulties and less skill growth from fall to spring compared to girls. SLDs are generally more common among boys than in girls at a ratio of about 2:1 (Rutter et al., 2004). While it is widely known that more boys have reading disabilities than girls, arguments exist surrounding whether or not this abundance is due to referral bias stemming from behavioral differences or a truly greater presence of reading impairments among boys (Quinn & Wagner, 2015). Additional evidence highlights that the proportion of boys to girls with reading impairments varies based on the setting, with clinical environments demonstrating more referrals of boys (Hawke et al.,

2009). Finally, such reading differences have been argued to be due to biological sex discrepancies, such as boys possibly demonstrating less inhibitory control and slower processing speed (Arnett et al., 2017).

Several gender-related findings in this study warrant our attention. First, there were more boys overall in this sample (61%), which is generally consistent with prior works studying the frequency and severity of reading impairments (Berninger et al., 2008; Rutter et al., 2004; Quinn & Wagner, 2015). Although boys outnumbered girls and there were no significant gender differences across frequency data, the girls referred to this remediation setting were found to have had more significant reading difficulties overall. Prior evidence has indicated that girls are often referred during later ages when they have more severe reading impairments (Vogel, 1990). It is important to note that the proportion of girls did not differ significantly across comorbidity status or grade levels in this sample. At first glance, our findings may seem surprising; however, these results may align with the prior literature on a more global level. It is possible that the boys may have been referred with more mild reading impairments, which calls upon the argument of referral bias that has been found to be present in clinic samples (Quinn & Wagner, 2015). Beyond referral bias and diagnosis, it is also important to consider how students' gender may affect parents' decisions to enroll them in a remediation context. Specifically, the results of this study imply that although more boys were enrolled into this remediation context, the girls presented with more severe impairments, suggesting that parents may be less likely to perceive girls as needing intensive intervention. However, no data related to parents' rationale for enrolling children into this remediation setting is available, suggesting the need for further examination of this matter. Overall, questions remain surrounding not only deficit severity

differences between boys and girls, but the means in which they are referred for needed remediation services, both in this particular sample and in the current literature.

This study produced a few other noteworthy findings outside of specific research questions. Overall, it was expected that students in this reading remediation setting would generally exhibit improvement on reading comprehension and fluency measures over the school year. Since participants were drawn across several grade levels (second through fifth grade), it was important to include this variable as a covariate. Further, it is interesting that grade level, specifically younger grades, was found to impact reading fluency across both fluency measures, but reading comprehension was not impacted. Consistent with the broader literature, the earlier students are referred for intervention services, the less likely they will fall behind their peers, particularly in reading fluency (Speece & Ritchey, 2005; Stage et al., 2003; Stage & Jacobsen, 2001). These findings seem reasonable being that those students in earlier grades have not yet established this gap in skills and the resulting requirement of remedial efforts later on (Fletcher et al., 2019). Specific to older ages, neurobiological studies also emphasize structural differences that may complicate remediation progress (e.g., less brain plasticity and malleability; Fletcher et al., 2019). Further, students' fluency skills were found to increase across the school year on both the GORT-5 and AIMSweb tasks and for comprehension on the AIMSweb passages, though no change was detected by the GORT-5 comprehension subtest. Effect sizes for fluency on the GORT-5, as well as both fluency and comprehension growth on the AIMSweb passages fell in the medium to large range, respectively, whereas the improvement in terms of comprehension on the GORT-5 was less pronounced and yielded a small effect size. It is not surprising that the AIMsweb measures, particularly the fluency task, yielded more robust growth effects than the GORT-5 given the characteristics of these measures. The GORT-5 is a standardized, norm-

referenced test that takes age into account when generating scores, whereas the grade-level AIMSweb passage generated raw scores (WCPM and retell%) with more sensitivity to detecting skill growth.

Limitations & Future Directions

It is important to acknowledge several limitations of this work with regard to sample characteristics, the use of archival comorbidity data, and absence of behavioral data. First, this remediation-specific sample consisted of predominantly European American students belonging to assumingly higher-socioeconomic status families. Limited conclusions can be made about the impact of comorbidity in more diverse student populations or to those in other educational settings. When considering sample selection, it is important to note that the setting of interest involved a clinical or remediation sample, and this limited the ability to draw from a more diverse population. Next, although the a priori power analysis indicated that this study had an adequate sample size for the conducted analyses, the sample size was not sufficient for exploration of different conceptualizations of comorbidity (i.e., underadditivity and multiplicative approaches). It was also not possible to examine the specific underlying impairments shared by these disorders (i.e., SLDs, ADHD, and communication disorders) such as executive functioning, as data on those subskills or processes were not available.

Another limitation of this study was the inability to examine associations between comorbidity and social-emotional functioning, as too few students demonstrated social-emotional disorders (n = 3). In particular, behavioral data would be especially helpful when examining gender differences relative to academic deficits. In addition to the inclusion of social-emotional rating scales and assessments, future studies should also aim to examine comorbidity of relevant academic disorders in a larger and more diverse sample to better consider other

frameworks for conceptualizing comorbidity. Next, as previously discussed, due to the extraction of data from existing files and psychoeducational reports, this use of archival information and lack of reliability of the data limited the conclusions that may be drawn from this study. Future studies examining comorbidity should implement methods to maximize consistency and standardization of criteria when extracting diagnostic information from psychoeducational reports.

Conclusion

Despite the described limitations, this study sought to fill several gaps in the literature and provided several indications for future directions. This work was the first to examine the impact of reading skill growth among students who had up to three educationally relevant comorbid diagnoses in addition to SLD in reading. Historically, within the comorbidity literature, studies have generally examined instances of two cooccurring conditions (Korrel et al., 2017; Törő et al., 2018; Willcutt et al., 2013). Although meaningful, this focus in the literature on only common pairings of disorders does not capture the complexity of situations among students who have cumulative deficits associated with having three or more disorders. Further, the generalizability of current comorbidity data and our current understanding of various conceptualizations (i.e., additive, underadditive, multiplicative) is limited given this trend of studying only two cooccurring conditions at a time. To my knowledge, this is also the first study to combine both the comorbidity and responder status literatures, and therefore proposes novel associations and questions between two interrelated areas. More work needs to be done to further understand how comorbidity affects responder status in reading remediation settings, as well as other intervention settings for separate academic skills. Finally, by investigating the role of reading fluency growth among struggling readers with other comorbid diagnoses, new insights

were provided into the remediation of a foundational academic skill not well studied in the response status literature (Speece & Ritchey, 2005).

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Appendix

Table 1

Descriptive and Normality Statistics for Reading Variables (N = 105)

	Fall					Spring				
	M	*SD*	Sk	Ku	% Miss	*M*	*SD*	Sk	Ku	% Miss
GORT-F	6.10	1.80	0.13	-0.74	1.9	7.03	1.72	0.13	-0.41	1.9
GORT-RC	6.69	1.71	0.02	-0.05	1.9	7.48	1.81	0.21	-0.38	1.9
WCPM	60.18	30.17	0.68	0.23	6.7	86.16	32.51	0.40	0.78	0
Retell	16.57	9.30	0.40	-0.20	4.8	24.22	13.48	0.73	0.38	1.0

Note. Sk = Skewness, Ku = Kurtosis, % Miss = percentage of missing data.

Table 2

Comorbidity Status (N = 105)

	SLD-R (*n*=28)	SLD-R+1 (*n*=33)	SLD-R+2 (*n*=27)	SLD-R+3 (*n*=17)
Gender (% male)	50.0	69.7	61.4	52.9
Age (in months)	96.98 (1.18)	108.54 (1.37)	108.44 (1.42)	108.82 (1.28)
Fall				
GORT-F	6.25 (1.86)	5.94 (1.80)	6.41 (1.74)	5.71 (1.86)
GORT-RC	6.82 (1.49)	6.55 (1.68)	7.22 (1.76)	5.88 (1.83)
WCPM	52.56 (24.38)	65.20 (31.94)	58.75 (32.36)	65.28 (31.39)
Retell	17.00 (10.16)	20.27 (8.41)	12.89 (9.29)	14.52 (7.14)
Spring				
GORT-F	7.04 (1.75)	6.91 (1.81)	7.19 (1.86)	7.00 (1.37)
GORT-RC	7.54 (1.84)	7.55 (1.94)	7.59 (1.65)	7.06 (1.85)
WCPM	82.56 (28.86)	87.42 (33.01)	84.88 (35.46)	91.67 (34.32)
Retell	25.94 (14.46)	23.61 (12.37)	23.79 (13.17)	23.29 (15.27)

Note. Standard deviations for age are provided in parentheses. SLD-R = SLD in reading only; SLD-R+1 = SLD in Reading plus one comorbid condition; SLD-R+2 = SLD in Reading plus two comorbid conditions; SLD-R+3 = SLD in Reading plus three or more comorbid conditions.

Table 3

Patterns of Comorbidity Diagnoses (N = 77)

	SLD-Writing (*n*=45)	ADHD-Combined (*n*=31)	ADHD-Inattentive (*n*=22)	SLD-M (*n*=15)	Language (*n*=15)	SSD (*n*=11)	ADHD-Unspecified (*n*=2)
Frequency Group							
SLD-R+1 (*n* = 33)	11	14	5	1	-	1	1
SLD-R+2 (*n* = 27)	4	-	-	4	-	-	-
	8	-	8	-	-	-	-
	7	7	-	-	-	-	-
	1	-	-	-	-	-	1
	2	-	-	-	2	-	-
	-	1	-	-	1	-	-
	-	-	2	-	-	2	-
	-	-	2	-	2	-	-
SLD-R+3 (*n* = 14)	4	-	4	4	-	-	-
	3	3	-	3	-	-	-
	2	-	-	-	2	2	-
	1	1	-	-	1	-	-
	-	2	-	-	2	2	-
	-	-	1	-	1	1	-
	-	1	-	1	1	-	-
SLD-R + 4 (*n* = 3)	1	-	-	1	1	1	-
	1	1	-	-	1	1	-
	-	1	-	1	1	1	-

Note. Numbers in the table represent the count of students with each disorder.

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Approval Date:	Expiration Date:	Organization:	Active Submissions:
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Key Contacts ⓘ Attachments

Team Member	Role	Number	Email
Elizabeth Meisinger	Principal Investigator	901-678-3435	bmsinger@memphis.edu
Elizabeth Meisinger	Primary Contact	901-678-3435	bmsinger@memphis.edu
Rachel Younger	Investigator		rlyunger@memphis.edu
Hannah Manning	Investigator		hmnning1@memphis.edu
Emily Lewis	Investigator		eklewis1@memphis.edu