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Original Paper

Findings of Letter/Sound Knowledge in Children with Mild, Moderate and Severe Dyslexia: A Case for Structured Literacy Intervention

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Abstract

Dyslexia is a prevalent language-based reading disorder that is often undiagnosed and untreated in children and adults, and current literature in the Science of Reading (SoR) argues that explicit, systematic, structured, multi-sensory instruction has the potential to help students with dyslexia learn to better map letter-sound correspondences. This mapping of letters and their corresponding sounds lays the foundation in phonological awareness needed for reading proficiency. In this study, a quasi-experimental single group pre-post interventional design was utilized with a small sample of students (n=24), which examined pre-intervention and post-intervention letter-sound knowledge of school-age children. Students were enrolled in a university reading clinic specializing in reading differences. Results indicated that after 25 hours of one-on-one structured literacy instruction, those children diagnosed with mild, moderate and severe dyslexia made statistically significant improvements in their letter-sound knowledge. Moreover, the severity of dyslexia did not appear to meaningfully impact the readers' abilities to make adequate progress. These findings strongly support the implementation of evidence-based literacy instruction that incorporates systematic, explicit and multi-sensory phonics interventions one-on-one and may have implications for whole class instruction and small group intervention.

Keywords: dyslexia, multi-sensory instruction, structured literacy, phonics, Science of Reading (SoR)

Introduction

Learning to read is the most pertinent life skill schools must teach young children. When children are taught the basics of reading, they experience a variety of positive outcomes including higher rates of college attendance, which leads to increased earning potential (Miller et al., 2010; McLaughlin, et al., 2014) and positive mental health outcomes (Hilhorst et al., 2018). On the contrary, those children who struggle to read often experience poor self-esteem, negative school behavior (McGee, et al., 2002), risk for depression (Maughan et al., 2003), school dropout (Hernandez, 2012; Stillwell et al., 2011), and low income and poor health (Miller, McCurdle & Hernandez, 2010). According to Blachman (2000), once a child begins to struggle with learning to read, these difficulties remain throughout their lifetime and are often categorized as having a reading disability such as dyslexia, but effective early reading instruction can reduce the number of children with persistent reading problems (Torgesen et al., 1999).

Dyslexia is a prevalent learning disability often unrecognized and untreated in public schools. Those individuals diagnosed with dyslexia may struggle with language comprehension, reading, spelling and self-image (The International Dyslexia Association, 2018; Shaywitz et al., 2003). The prevalence and treatment of dyslexia in school-aged children has been at the forefront of national debate and school agendas in recent years and has entered discourse surrounding many states' legislatures. According to the International Dyslexia Association (2016), 13-14% of the school population qualifies for special education services (Dyslexia Basics, 2020) under the Individuals with Disabilities Education Act (IDEA), and 6 to 7% of those students are diagnosed with a learning disability such as dyslexia. Dyslexia, a developmental disorder affecting approximately 5-11% of individuals (Jones et al., 2016), affects a reader's ability to read accurately and fluently despite intellectual ability (Lyon et al., 2003). At the core of dyslexia, readers often lack the ability to make letter-sound associations, a prerequisite for

reading and later literacy skills (Rosenthal & Ehri, 2008; Caravolas et al., 2012), and often struggle with phonological processing inefficiency (Lyon, 1995). The automatic recognition of letters and their corresponding phonemes hinders reading for those who suffer from dyslexia (Blomert, 2011; Froyen et al., 2011; Bishop, 2007), and rapid automatic naming (RAN) often impedes their ability to read fluently thus impairing comprehension. Because individuals diagnosed with dyslexia commonly face challenges in spelling, fluent reading, and working memory, the enduring retention of letter-sound associations becomes particularly intriguing. This is noteworthy as people with dyslexia often encounter difficulties in establishing and swiftly recalling these letter-sound connections.

Since dyslexia is so widespread in our schools, it is imperative students are provided sound pedagogical strategies and interventions that will best meet their literacy and language needs. Moreover, teachers must be prepared to teach children with significant reading challenges—whether or not they have a diagnosis. Combating reading failure can be accomplished by employing knowledgeable teachers of reading who can implement effective, evidence-based literacy instruction (Moats, 1994; Snow et al., 1998). According to Snow et al. (1998, 2005), impactful reading teachers are able to implement instruction that is situated in current research, have the ability to identify struggling readers and differentiate instruction based on an individual student's needs. A number of studies have shown that, with appropriate interventions, students with reading difficulties can indeed develop and maintain grade-level reading skills (Kilpatrick, 2015; Torgesen et al., 2010). Moreover, teachers armed with knowledge in the science of reading (SoR) and reading disabilities have the potential to close the reading gap so prevalent in our nation's schools.

Letter-sound Correspondence

Letter-sound correspondence, or the ability to orthographically map graphemes and phonemes, is a critical element of the alphabetic principle and learning to read. In the pivotal work by the National Reading Panel (2000) and supported by the Reading First Initiative, the cornerstone of the No Child Left Behind Act (NCLB) (U.S. Department of Education, 2002), and more recently Every Student Succeeds Act (2015), recommendations for a strong, systematic and explicit approach to teaching both phonemic awareness and letter–sound correspondence was an important finding. For example, Wagner et al. (1993) determined that reading programs that combined phonemic awareness, letter–sound correspondence, and spelling had a significant effect on reading achievement. Likewise, work by Torgesen et al. (1994), Juel (1988), and Joseph (2002) also found that young children, who are able to accurately apply phonemic awareness skills, were better-equipped readers and spellers. While these findings were compelling, it's worth noting that evidence-based practices in phonics were seldom implemented in classrooms until recently.

For readers who have learning differences, such as dyslexia, the skill of making letter and sound connections is imperative for one's capability to decode unfamiliar words, which leads to proficient comprehension- the goal of reading. Readers who can decode the words have improved fluency, accuracy and efficient and expressive reading (Kuhn & Stahl, 2003; Benson, 2008; Reutzel & Hollingworth, 1993; Wood, 2006; Rasinski, 1990). Furthermore, a significant relationship exists between decoding and fluency. LaBerge and Samuels (1974), Perfetti (1985), and Stanovich (1980) posit that the ability to automatically recognize and understand words allows readers to devote their limited attentional resources to understanding and comprehending at the highest level (Ari, 2015). Because of this, it is critical that struggling readers learn the basics, which will essentially provide them with the skills needed to become proficient, fluent readers who read with purpose and for meaning.

Structured and Multisensory Literacy Instruction

Teaching letter-sound associations in a systematic, cumulative and explicit manner is the hallmark of phonics instruction for students with dyslexia (Plante, 2020). Coined by the International Dyslexia Association (2016/2018), the term Structured Literacy (SL) refers to evidence-based pedagogy that incorporates reading, spelling, and writing (Fallon & Katz, 2020; Moats, 2019). Structured literacy focuses on language skills such as phonological and phonemic awareness, orthography, syntax, semantics, and morphology (IDA, 2016; Moats, 2019; Birsch & Carreker, 2019). Unique to SL (as used in this study) is the integration of multisensory phonics instruction and multisensory strategies, which include at least two of the sensory modalities such as visual, auditory and/or kinesthetic (Moats &

Farrell, 2002; Birsh, 2006; McIntyre & Pickering, 2001). Situated in dual coding theory, "teaching that engages a child's sensory modalities (e.g., visual, auditory, and tactile), as well as their linguistic system, may enhance learning" (Schlesinger & Gray, 2017, p. 220). Torgesen et al. (2001) and Campbell et al. (2008) establish that instruction, which integrates multisensory components, is indeed more effective for gains in word decoding and phonological processing both real and nonsense words. Furthermore, Foorman et al.'s (1997) study found gains in second and third graders' abilities to decode utilizing multisensory strategies. The implementation of structured, multi-sensory phonics instruction has the potential to aid students diagnosed with dyslexia in the pursuit of automatic, fluent reading.

Teacher Training

Because the emphasis of the primary years is on teaching younger readers, teacher quality and training sit at the forefront of educational reform (Moats, 1994; Darling-Hammond, 2000; Cunningham et al., 2004). Children diagnosed with dyslexia or other reading differences benefit from systematic, explicit and cumulative instruction situated in phonemic awareness (Moats, 1994), phonics (Moats, 2009), as well as morphology and orthography (Snow et. al., 2005). In response, the International Dyslexia Association developed the Knowledge and Practice Standards (2018) to guide "the knowledge and skills that all teachers of reading should possess to teach all students to read proficiently" (www.dyslexia.org). More recently, accreditation for teacher preparation programs have forced universities and schools of teacher education to reevaluate how preservice teachers understand how to teach reading and how they are prepared to do so.

Methods

A times series quasi-experimental design was utilized in this study. An intervention was implemented that consisted of one-on-one literacy tutoring for two hours per week by a qualified clinician who received training in structured literacy pedagogy. Both in-person and virtual tutoring were employed for 25 and 50 hours. Data were collected pre-intervention, after 25 hours of intervention, and after 50 hours of intervention. The Word Identification and Spelling Test (WIST) was administered to participants before tutoring, after 25 hours, and after 50 hours. The WIST is a norm-referenced assessment instrument that helps clinicians identify students who are struggling in foundational literacy skills. The WIST can also be used in conjunction with a structured literacy program for progress monitoring. Tutoring sessions were conducted at a small, private university reading clinic in the U.S. All tutoring sessions followed a structured literacy lesson plan template provided by the university.

Participants

Clinicians. Five clinicians were included in this study who are dual-certified teachers in at least two subject areas (i.e. early childhood and special education), and reading specialist. Additionally, all clinicians hold the credential of Structured Literacy Teacher/Dyslexia Interventionist through the Center for Effective Reading Instruction (CERI) and the International Dyslexia Association (IDA). All tutors hold a master's degree in literacy from an IDA accredited university program.

Subjects. Data from 24 subjects were collected. Subjects enrolled in the tutoring clinic were referred by a teacher, administrator, psychologist and/or parent. Upon enrollment, subjects were categorized as having mild, moderate or severe dyslexia utilizing criteria established by the clinic. A child was classified as having *mild* dyslexia if they struggled in sight word identification or other orthographic identification and/or automatic word fluency. A child was identified as *moderate* if they showed weakness in one area of reading as identified by an IEP or clinician screening. Finally, a child was classified as *severe* if they suffered a double deficit (Wolf & Bowers, 1999) in reading and/or another disability (comorbidity). While the clinic ascribed these labels to the students, the clinic and clinicians were not responsible for officially diagnosing dyslexia in any of the children. A dyslexia diagnosis for any of the children in the study was determined by a qualified psychologist.

Intervention

All tutoring session were conducted one-on-one for one hour, twice a week, for 25 and 50 hours. Clinicians used a structured literacy framework for lessons that included a review of previous sounds (visual drill), blending drill, auditory drill, oral reading (words and sentences), multisensory phonemic

awareness activity, Simultaneous Oral Spelling (SOS), dictation of sentences for writing, and a controlled reading. Immediate corrective feedback was provided to subjects.

While specific intervention strategies differed among clinicians, the three drills dedicated to strengthening letter-sound knowledge (visual drill, blending drill, and auditory drill) were standardized procedures. During the visual drill, clinicians reviewed previously known sounds with the participant by showing them a card with a letter on it; the participant then identified all known sounds associated with that letter. In the blending drill, clinicians arranged the cards from the visual drill into three piles (initial sound, medial sound, and final sound). The participant pointed to each card and identified the sounds, sweeping their fingers to blend the sounds into either a real word or a nonsense word. In the auditory drill, the clinicians voiced a sound to the participant, who repeated the sound and then identified all the letters that are associated with that phoneme. The participant wrote the graphemes down and read them back to the clinician at the end of the drill.

Results

Table 1 summarizes participants' raw scores on the WIST Letter Sounds subtest, presenting the means (*M*), standard deviations (*SD*), and medians (Mdn) for all variables. An initial analysis of the descriptive statistics for the three groups of participants (mild, moderate, and severe) revealed that the mean post-assessment scores and median post-assessment scores on the WIST increased for all three groups. A Wilcoxen signed-rank test showed that 25 sessions of structured literacy sessions did elicit a statistically significant change in students' Letter Sound scores ($Z = -4.073$, $p < .001$, $\alpha = .05$). Of the 24 participants, all but one participant had a higher Letter Sound score after 25 sessions of structured literacy intervention.

Table 1. Descriptive Statistics for Severity Level (Mild, Moderate, and Severe) Across Two Time Points

Variables	*N*	*M*	*SD*	*Mdn*
Mild	5			
Before Intervention		50.20	10.13	49.00
After 25 Sessions		63.00	12.51	61.00
Moderate	8			
Before Intervention		51.50	15.58	48.00
After 25 Sessions		62.88	9.55	62.00
Severe	11			
Before Intervention		45.45	10.53	44.00
After 25 Sessions		57.00	10.05	59.00
Totals	24			
Before Intervention		48.46	12.17	46.50
After 25 Sessions		60.21	10.39	60.50

Figure 1 depicts students' Letter Sounds scores before intervention and after 25 sessions of structured literacy intervention. Aforementioned, all students had higher Letter Sounds scores after 25 sessions, except Student 1.

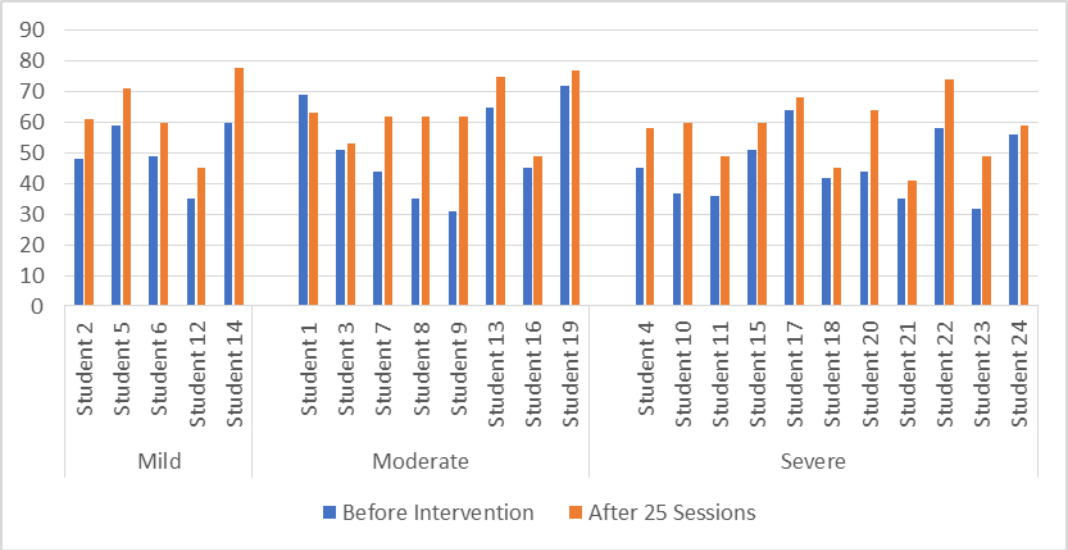

Figure 1. Students' Letter Sound Scores

A one-way ANOVA was performed to evaluate the relationship between Letter Sound scores before structured literacy intervention and the severity of a student's reading disability. The means and standard deviations are presented in Table 1. The ANOVA was not significant at the .05 level ($F(2, 21) = 0.62$, $p = .55$).

A repeated-measures ANOVA was then performed to evaluate the effect of the severity of a student's reading disability on their Letter Sound scores across three time points (before intervention, after 25 sessions of intervention, and after 50 sessions of intervention). From the initial 24 participants, 12 participants were measured across three time periods. The means and standard deviations for the Letter Sound scores across three time points are presented in Table 2.

Table 2. Descriptive Statistics for Severity Level (Mild, Moderate, and Severe) Across Three Time Points

Variables	*N*	*M*	*SD*
Mild	4		
Before Intervention		47.75	9.84
After 25 Sessions		59.25	10.72
After 50 Sessions		64.50	9.88
Moderate	5		
Before Intervention		51.60	12.68
After 25 Sessions		64.20	8.29
After 50 Sessions		69.20	8.96
Severe	3		
Before Intervention		49.00	16.09
After 25 Sessions		59.00	9.54
After 50 Sessions		67.33	7.77

Totals	12		
Before Intervention		49.67	11.63
After 25 Sessions		61.25	8.93
After 50 Sessions		67.17	8.44

Mauchly's test indicated that the assumption of sphericity had not been violated ($\chi^2(2) = 3.422$, p = .188). The repeated-measures ANOVA determined that mean Letter Sound scores differed significantly over time ($F(2, 18) = 27.13$, $p < .001$). Post-hoc pairwise comparisons with a Bonferroni adjustment showed a significant difference between mean Letter Sound scores from before intervention compared to after 25 intervention sessions ($p = .002$), a significant difference between mean WIST scores from 25 intervention sessions to 50 intervention sessions ($p = .029$), and a significant difference between mean WIST scores from before intervention compared to after 50 intervention sessions ($p < .001$).

However, the repeated-measures ANOVA determined that there was no significant difference in mean Letter Sound scores between the three groups of participants, grouped by severity level ($F(4, 18) = .101$, $p = .981$).

Figure 2 depicts the Letter Sound Scores of the 12 students who completed 50 sessions of structured literacy intervention. All of the mild students, except Student 14, made gains from 25 sessions to 50 sessions. Only one moderate student, Student 16, made gains from 25 sessions to 50 sessions. All severe students made gains from 25 sessions to 50 sessions.

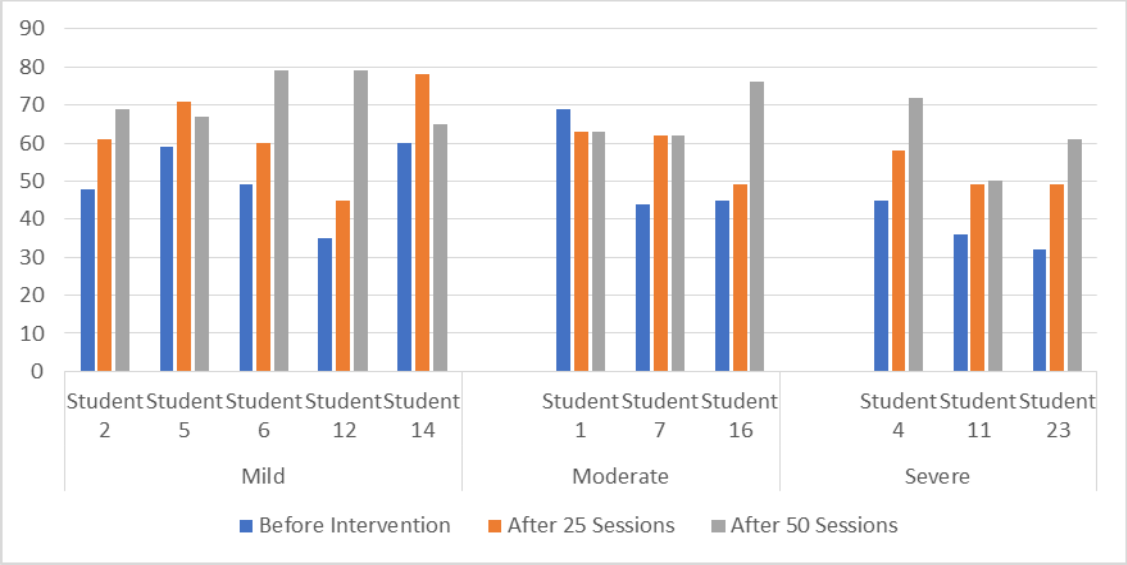

Figure 2. Students' Letter Sound Scores across 50 Sessions

Discussion

Results from the Wilcoxen signed-rank test revealed that students (n=24) made statistically significant gains in their letter-sound knowledge after 25 sessions of structured literacy intervention. Therefore, systematic, explicit, multi-sensory reading intervention grounded in principles of structured literacy leads to improved phonics outcomes in students. Phonics is a necessary requisite skill for decoding and encoding and ultimately proficient reading (Silverman, 2019). Without the ability to recognize letters and corresponding sounds, students will struggle to become fluent, proficient readers. "Isolated

skill-based activities have their place in learning to decode, but they should not be the only focus of a quality reading program" (Shallow, 2016, p. 27). These findings suggest that without accurate letter-sound identification, little fluency can occur thus impeding comprehension. In the NAEP 2018 Oral Reading Fluency Study, findings suggest that 36 % of fourth-grade public school students performed below the NAEP Basic level. This lead educators to search for innovative ways to support students in fluency and comprehension while also ensuring they have the foundational skills necessary to read the words on the page. One way to help struggling readers become more fluent is to improve their ability to decode utilizing a multi-sensory, structured, explicit approach to teaching letter-sound knowledge and increased rapid automatic naming (RAN). These findings support the implementation of intensive, intentional phonics instruction for students with mild, moderate and severe dyslexia.

The one-way ANOVA and repeated-measures ANOVA tests showed that the severity of students' reading disability did not impact their scores, indicating that structured literacy intervention is effective for all students regardless of ability. However, students categorized as severe, made more consistent gains when receiving more than 25 sessions of structured literacy intervention than students categorized as mild or moderate. An additional finding of this study is the examination of intervention hours necessary to make gains in letter-sound knowledge. Poor readers must increase their decoding ability to become proficient readers who comprehend (Perfetti, 1992), and in order to do that, repeated practice is essential. In this study, decoding data were examined at two points (25 and 50 hours). Since the letter-sound portion of the lesson is approximately ten minutes with variation among clinicians and subjects, it would be remiss to determine the amount of time it takes to show gains. The data revealed that subjects did increase their letter-sound knowledge after 25 hours of one-on-one intervention and continued to increase when 50 hours were implemented. Other variables such as working memory, clinicians' level of intervention proficiency, and exposure to text could also contribute to the documented gains. Other variables, not mentioned, may lead to reading gains for mild, moderate and severe dyslexia.

This study contributes to the growing body of evidence in the science of reading (SoR) and reading instruction grounded in principles of structured literacy and provides supporting evidence for current legislative efforts to incorporate structured literacy instruction within the general education classroom as all participants in the study benefited from the intervention. Because the severity of a student's reading disability did not impact their scores, this study has implications for student grouping within classrooms. If grouping students homogeneously based on reading ability, teachers may expect all student groups to make gains in their knowledge of phonics when utilizing effective structured literacy instruction.

This study also has implications for the pacing of phonics instruction and creation of literacy goals appropriate to a student's level. The mean score for mild students was 50.20 before intervention and 63.00 after intervention; students with a mild reading disability learned approximately 13 new letter sounds within 25 sessions of structured literacy intervention, which is equivalent to 25 hours of instruction. The mean score for students with a moderate reading disability was 51.50 before intervention and 62.88 after intervention, an increase of 11.38, indicating that 11 new letter sounds is an appropriate goal after 25 hours of instruction. The mean score for students with a severe reading disability was 45.45 before intervention and 57.00 after intervention, an increase of 11.55, indicating that 11 or 12 new letter sounds is an appropriate goal after 25 hours of instruction.

Another practical implication of this study involves the letter-sound knowledge drills that the clinicians utilized with participants. Even though this was not a true experimental study and a definitive cause-effect relationship cannot be established, the participants made significant gains in their letter-sound knowledge and all participants were subject to the same standardized letter-sound knowledge drills. These drills can be effectively utilized in both small group and whole class instruction. The recursive, repetitive, and multisensory nature of the drills are all facets of structured literacy intervention—of which successful implementation is supported by the SoR.

Since structured literacy is a pedagogical approach and not a curriculum, teacher differences do exist. One difference is in the type and frequency of corrective feedback. Struggling readers and those identified as having a reading disability often display dysfluent decoding abilities. The examination of

clinicians' corrective feedback was not examined in this study but may play a role in a child's ability to self-monitor while reading connected text and lead to better comprehension. In Pany and McCoy's (1988) study, third graders with a learning disability scored higher on measures of decoding and comprehension when immediate feedback was provided. The importance of corrective feedback in phonics instruction has proven to have positive effects on reading gains (Heubusch & Lloyd, 1998).

Ultimately, these findings have significance in two very important ways. First, one-on-one reading intervention with children who are diagnosed with dyslexia make significant gains when teachers and clinicians follow an explicit and systematic instructional methodology that is implemented with intentionality and fidelity. Ensuring previous phonetic concepts are reviewed within the lessons is essential for repetition and eventually retention and application. Feedback is an important part of the intervention, but this study determined neither the type nor frequency of that feedback. Finally, the findings of this study illustrate how intentional invention can indeed improve phonetic knowledge of children with reading differences. Early identification and intervention for children diagnosed with dyslexia can be successful in reading if provided with deliberate instruction in areas of weakness typically in phonological processing.

Limitations

Limitations of the study include lack of random assignment, sample size, and singular subtest measure used for data collection and reporting. The classification of mild, moderate and severe is based on criterion of the university reading clinic and variations among subjects' abilities within each categorization was not examined. Therefore, the generalizability of results is unknown.

Conclusion

Ultimately, decoding is essential for readers to become fluent and proficient readers. For many readers with developmental dyslexia, this can be a daily struggle. Research indicates that those diagnosed with dyslexia benefit from an effective intervention curriculum, which explicitly teaches phonological awareness and is multi-modal in nature that includes training in strategy, orthography, morphology, and fluency (Lovett et al., 2017; Suggate, 2010). Structured literacy tutoring that includes an explicit and systematic letter-sound component with corrective feedback and consistent practice has the potential to help students increase their ability to identify letters and corresponding sounds. Translation of those skills to connected text is essential for proficient reading.

Future research on the literacy gains of students with dyslexia in a SL approach can build upon this study with either more participants or longer intervention hours. Future research should also examine the ways in which letter sound knowledge gains translate to gains in decoding and encoding abilities, which was not examined in this study.

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