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The effect of font type on sight word reading performance of 4th and 5th grade students with reading disabilities

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The Effect of Font Type on Sight Word Reading Performance of 4th and 5th Grade Students with Reading Disabilities

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Abstract

Reading interventions are a crucial component to combat barriers associated with reading difficulties. Within the education realm, nearly 50% of students who receive special education supports have a Specific Learning Disability (Gargiulo, 2006). As a result, the development and implementation of effective and targeted interventions is critical. Christian Boer developed a font called Dyslexie to help remediate reading difficulties of individuals with Dyslexia (Boer, 2011). However, studies by de Leeuw (2010) and Pjipker (2013) provide inconsistent supportive evidence, regarding the effectiveness of Dyslexie. The current study sought to examine the effectiveness of Dyslexie as compared to Arial on sight word recognition tasks. A total of 36 fourth and fifth grade students with a Specific Learning Disability read two real word lists and one pseudoword lists in either font. Results do not suggest a significant difference between either font on sight word recognition tasks. Results, future directions, and implications for School Psychologists are discussed.

The Impact of Font Type on Sight Word Reading Performance

of 4th and 5th Grade Students with Reading Disabilities

In the United States, Specific Learning Disability impacts nearly 2.8 million students: 47.4% of children who receive special education services are classified as having a Specific Learning Disability (Gargiulo, 2006). Within this classification, different areas of weakness may be found, such as Dyslexia (difficulty learning to read), Dyscalculia (difficulty computing mathematic calculations), Dysgraphia (difficulty writing), Dyspraxia (sensory integration disorder, regarding fine motor skills), Dysphasia (difficulty with language), Auditory Processing Disorder (difficulty hearing the differences among sounds), and Visual Processing Disorder (difficulty interpreting visual information). Reading disabilities are the most common type of Specific Learning Disability.

Many factors contribute to reading problems besides Dyslexia, such as a lack of reading within the home, a lack of effort by the child, and a lack of emphasis on homework (Ehri, 2005)**.** It has been thought that by continued exposure to reading and sight words, the child's reading ability would significantly improve. Although repeated exposure is beneficial, the majority of students with reading disabilities dislike reading, which may lead to a decrease in motivation to read.

The Process of Reading

The primary goal of reading is to understand written language, by accessing and applying meaning to written words. Learning to read is not automatic; rather, it is a result of learning the code specific to a child's language, culture, and matching distinctive symbols to learned sounds (Ziegler & Goswami, 2005). Toddlers acquire speech almost automatically through imitation. Reading is a different process, however. Reading requires several neurological processes to occur at the same time, such as visual scanning, directing focal attention, identification of letters, connecting of sounds to letters, application of grammatical rules, and the retrieval of letter patterns stored from words previously encountered. Learning to read is believed to exhaust the perceptual abilities of readers, much more than learning to speak (Stein & Walsh, 1997).

The initial stage of becoming literate in English involves the establishment of connections between sounds and letters, referred to by Ziegler & Goswami (2005) as phonological recoding. Once an individual has mastered the basic sounds associated with letters, it is possible to decode and identify the majority of novel words that have been encountered through heard speech. Goswami (1986) theorized that once readers have mastered the phonological recoding process, they enter into the process of *analogizing*, which incorporates both the ability to sound out letters and to identify larger units to recognize words. This process utilizes words that are already known, such as “sought” to read the word “bought.” The unit “ought” sounds and looks identical in both words; the new word *bought* can thus be read by applying the letter sound *b* and the unit *ought*.

When an individual has practiced words sufficiently, the recognition process becomes automatic. When presented with a word, the brain can automatically recognize the shape and the units of the word, while simultaneously applying meaning. According to Ehri and Wilce (1983), this process is known as *unitization*. These authors conducted a study in which students read object words (i.e., book, man, tree), read consonant-vowel-consonant (CVC) non-words (e.g., fab, naf, lak), and single digits (3, 7, 9). Researchers measured the time it took to read each list presented and found that the skilled readers of both grade levels read the words as quickly as they read single digits. They concluded that this suggested that words are read as whole, single units, rather than individual letters, leading to an emphasis in learning sight words. Ehri (2005) proposed that novice readers learn sight words by creating connections through the knowledge of the alphabetic system, specifically between the letters and sounds of the words. Readers are able to distinguish between the relationships of phonemes and graphemes, in relation to phonemic awareness. When novice readers are introduced to a new sight word, the spelling is analyzed, a pronunciation attempt is made, and attention is directed to how the graphemes match the phonemes presented. Ehri (2005) suggests that repeating new sight words, helps establish the connection of graphemes and phonemes, as these units are embedded into memory.

Phases Theory of Reading Development. Ehri (1999) and McCormick (1998) proposed that there are four phases of sight word development. Emergent readers develop in differing ways, are more responsive to different techniques and instructional tactics than others, and may progress through the development of reading at a different pace. The initial phase consists of the *pre-alphabetic phase*. In this phase, children have little or no knowledge of the alphabetic system, and are unable to form grapheme and phoneme connections. In this phase, a child reads a word that was previously presented, makes an association between the object and the word, and embeds it into memory.

The *partial alphabetic phase* involves the identification of individual graphemes and the initial connection to corresponding phonemes. It is thought that children in this phase recognize the first and last letters of words, and project the first word that meets the first and last letters of the word. For example, a child may recognize the “p” and “k” in the word “park”. By remembering the first and last letter of the word, it is possible to substitute the word “pack” for the word “park” because both words consist of the same boundary letters. In memory, children in the partial alphabetic phase retain only partial representations of words.

The *full alphabetic phase* is acquired when children are able to form cohesive connections between letters in spellings, and phonemes in the pronunciation of the word. This results in the ability to decode novel words and acquire meaning. The *consolidated phase* is established when full alphabetic readers are able to rapidly distinguish graphemes and the associated phonemes, and utilize grapheme chunks, for example “uck” in the word “tuck or buck.” In this instance, the grapheme “uck” does not need to be phonetically decoded, as it is previously embedded in memory.

Reading Disability. The Individuals with Disabilities Education Act (IDEA) was created to ensure that children with disabilities received equal opportunity of learning. According to the U.S. Department of Education (2006) a Specific Learning Disability refers to “a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations, including such conditions as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia.” Eligibility determination suggests that a student must present with a psychological processing deficit that negatively impacts an area of achievement. It is important to note that these characteristics must not be a result of hearing or visual factors, as well as intellectual disability, emotional disability, limited English proficiency, economic disadvantage, or cultural factors.

Dyslexia Models. Dyslexia is described as a neurodevelopmental disorder that negatively impacts the accuracy and speed of word recognition and phonetic decoding. Researchers believe that phonology, processing speed, naming speed, and orthographic processing account for approximately 75% of the variance of reading performance, thus critical components of the reading process (Feifer & Nader, 2015; Pennington et al., 2012). Deficits in any of these domains may negatively impact a student's ability to read, contributing to unexpected underachievement.

According to Feifer and Nader (2015) Dyslexia can be broken down into three major types: phonemic, orthographic, and mixed. Phonemic dyslexia refers to a deficit in phonological processing, which entails difficulties decoding, blending, manipulating, and identifying letter-sound positioning within a word. Letter-sound positioning refers to a child's ability to determine a specific sound within a word, based off of a given position. For example, "What is the second sound you hear in the word cat?" The correct answer in this example is the short "a" sound. This provides additional information into how a child hears and interprets the sounds of a word, based off of phonological rules and principles. Children who have phonemic dyslexia may rely on the orthographical presentation of words that have been stored into memory: they guess at the novel word because of their similarity in word structure to a familiar word.

Orthographic dyslexia is characterized by the ability to decode words, but difficulties rapidly and automatically identifying the presented word. Children with this subtype of dyslexia demonstrate difficulty using the visual characteristics or letter sequences of words. They often have greater success decoding phonetically regular words than irregularly spelled words. These readers have difficulty developing sight word vocabulary; have slow reading speed; make spelling errors of phonetically irregular words; and lack prosody. Prosody refers to the ability to demonstrate intonation, emotionality, and rhythm while reading text (Texas Scottish Rite, 2014).

Mixed Dyslexia refers to the combination of phonetic and orthographic deficits. This subtype of dyslexia is the most severe form, as a reader has underdeveloped abilities to apply phonetic and orthographic skills to decode and visually identify previously encountered words, both regular and irregular in origin. Additionally, this is the most rare form of Dyslexia and experienced reading difficulties (Feifer & Nader, 2015).

Assessment of dyslexia subtype. When a student presents with reading difficulties, an assessment battery is used to investigate the areas of concern. An assessment battery consists of an overall cognitive evaluation that investigates the processing of crystallized knowledge, fluid reasoning, short-term memory, long-term storage and retrieval, visual processing, processing speed, and auditory processing, as described by the Cattell-Horn-Caroll Theory of Intelligence (Flanagan & Dixon, 2013).

An individual's performance on cognitive abilities, such as visual processing, processing speed, and auditory or phonological processing, provide useful information regarding the subtype of dyslexia that may be present. Research suggests that dyslexia is frequently a result of multiple deficits in neurocognitive processes with common links to weaknesses in auditory processing, particularly related to phonology (Texas Scottish Rite, 2014). For example, if a student presents with a relative weakness of 1.5 *SD* below the mean of a standard score of 100 related to phonological processing, the student may present with phonemic dyslexia, whereas if a student presents with a relative weakness in processing speed and orthographic processing as measured by the Feifer Assessment of

Reading (Feifer & Nader, 2015), the student may present with orthographic dyslexia. However, a student who presents with relative weaknesses in both phonological and orthographic processing may be identified as an individual with a mixed type of dyslexia that impacts both the ability to decode and apply letter and word structures to previously encountered words, which impacts decoding, reading fluency, prosody, and the identification of irregular words.

Pseudowords are nonsense words that follow phonetic rules and principles; for example, "nit, midcam, and aft." These words have no meaning but can be decoded by following phonetic rules. Within the education realm, pseudowords provide educators the ability to assess whether students have mastered the application of phonetic rules through their performance on pseudoword decoding. Pseudowords rely heavily on phonological decoding, as compared to automatic, orthographic processing of real word identification Groff, P. D. (N.D.).

Font

Font type can impact the overall legibility of printed words (Perea, Panadero, Moret-Tatay, & Gomez, 2012)**.** Each font contains characteristics that differ from each other (Perea et.al, 2012). For example, some fonts are referred to as serif fonts while others are referred to as "sans serif." A serif is a horizontal line at the termination of individual letters, such as in Times New Roman. A sans serif font such as Arial does not contain serifs. Figure 1 gives examples of serif and sans serif fonts.

Figure 1. Serif and Sans Serif Font Styles

Aa Bb Cc Dd (Sans Serif)

Aa Bb Cc Dd (Serif Font)

Research on the effectiveness of serifs on the reading performance of individuals is mixed. Some studies have found that serif fonts influence both greater reading speed and accuracy, as compared to sans serif fonts, such as Arial (Pjipker, 2013). In contrast, some studies have claimed that sans serif fonts produce greater accuracy and reading speed, as compared to serif fonts (Perea et.al, 2012). Perea and Gomez (2012) suggested that one possible explanation for a greater reading speed and reading accuracy using a sans serif font was that there is greater spacing between letters, which may increase the ability to recognize individual words.

Not only does the type of font have an impact on the legibility of letters and words, but the font size contributes to an individual's reading performance. Wilkens et al. (2000) suggest that children committed more errors and displayed a slower reading speed while reading text with a small font size, as compared to a large font size. Children also reported that they had a greater preference for reading in a large font size, as compared to a small font size.

Developmentally, between fourth and fifth grade, the oculomotor pathways begin to stabilize, in which the motor factors of the reading process become established. Tinker (1963) sought to determine specific aspects of typography that impacted the legibility of print. Tinker found that the reading speed of fifth and sixth grade students of 8, 10, and 12-point font were the same. It was also found that size 6 and 14-point font produced a slower reading performance, as compared to 10-point font. Tinker (1963) found that a font size of 6 is rather illegible when presented in a short text line. Tinker suggests that a slower reading speed of a 6-point and a 14-point font size could be a result of multiple variables. The 6-point font is very small, which permits less visual discrimination of the characters. The 14-point font is much larger than the typical font size used, which demands more area needed of focal fixations for each letter and word, which could lead to a slower reading speed.

The examination of the impacts of line widths for a set 12-point font of 17, 21, 25, 29, 33, 41, and 45 picas, found that in both fifth through eight grade groups, line widths ranging from 17 to 33 picas were equally legible when using a 12-point font. In contrast, when examining the legibility of line widths consisting of 37, 41, and 45 picas, the student's reading speed was significantly delayed in all groups. Typically, it is thought that pairing small font type with short pica line width and large font type with a relative large pica line width, produces optimal reading efficiency for corresponding variables. Tinker (1963) found no supporting evidence for the optimization of reading efficiency, factoring in the variation of font type and size, in relation to the width of the text line.

Crowding Effect

The crowding effect refers to the negative interaction of extraneous visual stimuli on the rapid recognition of a central target. It is thought that this is a result of inhibitory neural interactions within visual processing (Spinelli, Luca, Judica, & Zoccolotti, 2002). The extent to which the crowding effect occurs is impacted by the distance between letters, and whether or not it is within a single word presentation, or a string of words. The crowding effect increases in words as compared to letters, and sentences compared to individual words. Inter-letter spacing is a critical component in relation to the extent of a letter's position uncertainty within a word, which is theorized to directly impact lexical access (Perea et al., 2012). Research in orthographic processing, investigating the impact of inter-letter spacing suggests the possibility of a beneficial effect in inter-letter spacing, as compared to the standard typographic units. In 2002, Spinelli et al. investigated the effect of inter-letter spacing among Italian words, in normal and dyslexic readers. Researchers found that in the normal group, a non-significant difference was found in the reaction time of word identification. Spinelli et al. (2002) found that in relation to the dyslexic group of readers, increasing the inter-letter spacing among Italian words greatly reduced the recorded response time, as compared to a default typographic unit. Researchers also found that increasing the inter-letter spacing increases the amount of time it takes to read multiple words, which was expected. It was observed that the sub-lexical route in pseudo-word reading, was less impacted by the crowding effect, as compared to the lexical route of real word recognition. As a result, the crowding effect should not impact the speed of pseudoword decoding, as it impacts the visual field (Spinelli et al., 2002).

Font Dyslexie

Christian Boer created a specific font called Dyslexie that contains distinctive characteristics that claims to remediate reading difficulties for individuals with Dyslexia. It was theorized that by reducing the effort it takes to distinguish individual graphemes an individual's reading speed and accuracy should increase (Boer, 2011). Dyslexie consists of a bolded bottom portion of each grapheme which is thought to visually help graphemes from flipping upside down. Refer to Figure 2 for an example of Dyslexie font.

This train of thought relies heavily on the implications of an orthographic deficit, which pertains to visual factors of the reading process. Some graphemes contain slightly italic features, larger openings, and larger x-heights, which increases the distinctiveness and avoids possible rotation and the mirroring of letters (the letter "p" mirroring to look like the letter “q”). Additionally, the capital letters are bolded, which helps direct focal attention to the beginning of each sentence (Pjipker, 2013). Although Boer claims that Dyslexie is an effective font type intervention for children with Dyslexia, the supporting research is mixed.

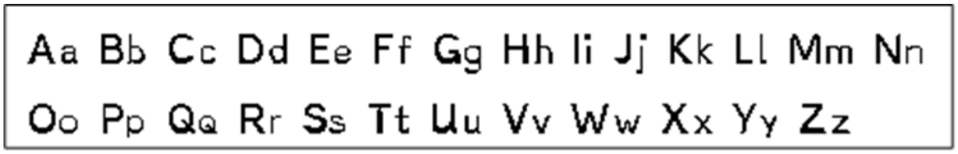


Figure 2. Dyslexie alphabet

Research by de Leeuw (2010) investigated the differences in reading performance between Arial point 14 and Dyslexie point 12. Of the 43 participants, 21 were diagnosed with Dyslexia. It was found that neither Dyslexics nor normal readers increased their reading speed at a statistically significant level. It was found that dyslexics made fewer reading errors while using Dyslexie, as compared to normal readers who committed more errors. This may suggest that Dyslexie may improve the reading accuracy in Dyslexics, and decrease the reading accuracy in the normal reader population. Pjipker (2013) investigated the reading performance of children with Dyslexia with a special font and a colored background. In this study, 64 children, ages 8-12 were used, which consisted of 22 children with dyslexia. Within the experimental group, the participants were divided by their reading level (13 children fell within the low reading level and nine children fell within the high reading level). The control group consisted of 42 non-dyslexic children who were divided into groups by reading level (12 children in the low reading level and 30 children in the high reading level). It was unclear as to how the participant’s reading level was determined, which raises methodological questions. Overall, no significant differences were found in the reading performance of dyslexic and non-dyslexic readers, based on font type. Similar to the findings of de Leeuw (2010), Pjipker's findings suggest that individuals with dyslexia with higher reading levels, committed fewer errors as compared to dyslexics with lower reading levels. This may suggest that depending on the reading level, individuals with Dyslexia may improve in overall reading accuracy with the use of Dyslexie font.

Among the two studies by de Leeuw (2010) and Pjipker (2013), the participants and how the participants were grouped by reading level differed. It seems more likely that a font type intervention would be more beneficial to be implemented at an early age, as compared to readers at a university or fifth grade level. At a university level, the participants with dyslexia most likely utilize compensatory strategies, whereas the reading processes in elementary students are still being developed. It is unclear as to whether or not the age groups used to evaluate the efficacy of a font type intervention were appropriate. It is important to have a representative sample of the deficit that is being investigated. In the case of the de Leeuw (2010) and Pjipker (2013), 22 of 64 and 21 of 43 students were dyslexic. The method in which the students were broken into reading groups was uncertain. Understanding the criteria used for establishing reading groups is crucial, because deficits within the reading process vary greatly, and can be presented in a multitude of ways. Neither of these studies contained a measure of orthographic processing, which is pertinent to the effectiveness of a font type intervention, as it directly impacts the visual representation of words.

The utilization of effective reading interventions is a crucial component to help remediate reading difficulties experienced by students of all ages. In particular, this study examines the the effectiveness of Dyslexie font with upper elementary aged students who were formally identified with a primary reading disability.

We examined the following hypotheses:

1. Students will read sight words with fewer dysfluencies in Dyslexie font as compared to Arial font.
2. Students will read more sight words correctly in Dyslexie font as compared to Arial font.
3. Students with a higher standard score on orthographic processing (less than a 1.5 standard deviation deficit) will perform worse on pseudoword lists than students with a lower standard score (at least a 1.5 standard deviation deficit) in orthographic processing.

Method

Participants

Thirty-six fourth and fifth grade students, 24 boys and 12 girls, with a mean age of 10 (SD = .958) from two rural public school districts in Virginia participated in this study. All participants were identified as having a primary identification of a Specific Learning Disability in reading. Potential participants were excluded if they were identified with a secondary disability.

This research was given approval by the Institutional Review Board (IRB) at James Madison University, as well as by the directors of special education in the districts. Consent was obtained from the participant's primary caregiver prior to participation in this study. At the beginning the research session, participants gave verbal assent.

Materials

Two word lists and one pseudoword list were developed for this study when permission to modify the font of existing standardized instruments was not granted by the publisher. The word lists were developed following the procedures used in the Wechsler Individual Achievement Test, Third Edition (Wechsler, 2009). Each word list began with commonly encountered words and progressed to more complex, less commonly encountered words, for example, *she, rug, dragon,* and *adherent*. Thirteen commonly encountered, high frequency words at each grade level from 1st through 6th, and eleven words from 7th grade were selected (K12, n.d.). The pseudoword list consisted of 53 made-up words that progressed from simple phonemic rules through more complex rules. Examples of pseudowords used include *ik, dras, midcam,* and *protion*. (The word and pseudoword lists are included as Appendix 4, 5, and 6).

Reliability and construct validity of these word lists were established by comparison to the Wechsler Individual Achievement Test, third edition (WIAT-III) word list and pseudoword list. Twenty-two participants with learning disabilities were examined, aged 10 to 12. Word list one and two were highly correlated with the WIAT-III word list, in the number of words read correctly, r = .88 and .87, p < .001 and incorrectly, r = .86 and .82 , p < .001. The pseudoword list used in the present study and the pseudoword list from the WIAT-III were highly correlated, r = .90, p < .001, for both words read correctly and words read read incorrectly, r = .96, p < .001. This suggests that the participant's performance on the standardized measure and the developed real word and pseudoword lists are comparable.

Each list was printed in both 20-point Arial and 18-point Dyslexie font to produce words of 0.5 inches in height. Each word list was printed on an 8 x 11 ½ piece of standard, white paper, consisting of three columns and nine rows of words.

Feifer Assessment of Reading. The Rapid Automatic Naming and Orthographic Processing composite scales from the Feifer Assessment of Reading (FAR; Feifer & Gerhardstein Nader, 2015) were used to classify students as having an orthographic or central reading disability. The FAR was standardized with a norming sample of 1,074 individuals, grades pre-school through college seniors. The FAR has a high degree of internal consistency (Rapid Automatic Naming Composite $\alpha = .79$; Orthographic Processing Composite $\alpha = .96$). and construct validity related to other reading assessments, such as the Process Assessment of the Learner, second edition (Berninger, 2007).

Rapid automatic naming tasks investigate the rate in which a participant can name presented figures, symbols, and shapes. The Rapid Automatic Naming composite consisted of two tasks. Task one allots 30 seconds for the participant to name figures such as the sun, glass, and dog, shoe. There were a total of 72 objects. The second task required the participant to name as many of 84 stenciled letters as possible in 30 seconds. Orthographical processing tasks investigate the participant's ability to manipulate, store, and recall words or portions of a word, using the visual system. The Orthographical Processing task exposed one word to the participant on a blank page for one second, and then presented four options for the participant to choose. The participant was required to choose which letter or group of letters were presented in the word that was previously presented for one second. A similar example from this task could be: Being presented with the word “mars” for one second, and then given the following four response items: “l”, “n”, “s”, and “t”. The correct response in this example item is the letter “s”. The items begin with simple, one letter response items, and progresses to more complex items. Within the Orthographical Processing task, there were a total of 77 items that the participant could have been exposed to.

Procedure

Each session began by gaining assent and rapport-building activities and then the Orthographic Processing and Rapid Automatic Naming subtests were administered. The word lists were then administered along with distractor tasks and short reading passages, used in another research study, in a counterbalanced order, balancing font and word list order. Appendix 1 contains the detail of this counterbalancing.

Results

There were no significant performance differences observed between students from the two districts on the number of words read correctly on the real word list in Arial font $t(28) = 2.04$, $p = .051$ or on the Orthographical Processing composite score of the Feifer Assessment of Reading $t(33) = .21$, $p = .83$. These two analyses were completed as a sampling of performance data among the two school systems.

To test hypothesis 1, we compared the number of words read incorrectly on word lists in Dyslexie to those in Arial. There was no significant difference between the number of words read incorrectly in Dyslexie ($M = 7.75$), $SD = 3.33$) compared to Arial ($M = 8.58$, $SD = 4.87$), $t(25)=1.17$, $p = .25$. To test hypothesis 2, a paired-samples t-test compared the number of words read correctly in the Dyslexie font to the Arial font.

There was no significant difference in the number of words read correctly in Dyslexie (*M* = 37.68, *SD* = 10.59) compared Arial (*M* = 40.40, *SD* = 10.67), *t*(24)=2.01, *p* = .055.

Multiple independent samples t-tests were used to determine significance between the relationship of high and low orthographical processing ability, characterized by one and one-half standard deviation difference from the mean (i.e. Low is comprised of a standard score of 77 or less and high is comprised of a standard score of 78 or greater). An analysis of variance revealed no significant difference between the number of correct responses on the pseudoword list in both Arial and Dsylexie, when controlling for orthographical processing. Table 1 and 2 present the differences between performance on the real word list and the pseudoword list, while providing additional information related to performance differences among a high and low level of orthographical processing.

Table 1

Effect of high vs. low orthographical processing on performance of real word lists

Groups	*High v Low Ortho*	*N*	*Mean(SD)*	*Sig. (2-tailed)*	t
Number Correct Arial	Low	17	38.58(11.34)	.224	1.20
	High	11	44.45(13.40)		
Number Incorrect Arial	Low	17	10.53(5.93)	.30	1.06
	High	11	8.27(4.65)		
Number Correct Dyslexie	Low	16	38.97(13.96)	.22	1.27
	High	12	47.83(22.94)		
Number Incorrect Dyslexie	Low	16	9.81(4.90)	.95	.06
	High	12	9.67(8.16)		

Table 2

Performance on pseudoword lists by High vs. low orthographical students

Groups	*High v Low Ortho*	*N*	*Mean(SD)*
Number Correct Arial	Low	9	12.56(3.36)
	High	9	11.78(3.49)
Number Correct Dyslexie	Low	13	11.62(4.57)
	High	5	15.20(6.14)

Discussion

Initially, we had concern related to the method in which Pjipker (2013) and de Leeuw (2010) used to identify their sample as “Dyslexic” or troubled readers as this can lead to a non-standardized method and an inappropriate identification procedure, regarding Dyslexia subtypes . The use of a screener rather than an evidence-based process makes the issue of to whom the results generalize unclear. Participants chosen for the current study had been identified as having a reading disability through rigorous, normative assessment procedures. Although the identification procedure was more stringent than the previous two studies, no significant difference was found between fourth and fifth grade students with reading disabilities on their ability to accurately read sight words at a fast pace.

More specifically, a font type intervention should positively impact individuals who specifically have Orthographic Dyslexia. This subtype of Dyslexia pertains to visual factors of the reading process, which we hypothesized to be positively impacted by the aesthetic characteristics of Dyslexie, such as the weighted bottom portion of each letter, the italicized extensions as well as the spacing among letters and between words. However, when controlling for orthographical processing, there were no significant differences found between individuals from a low and a high orthographical processing ability, as measured by the Feifer Assessment of Reading (2015), on the number of words read correctly in one minute, or the number of committed dysfluencies.

In particular, we hypothesized that students with a higher orthographical processing ability would perform worse on Pseudoword reading lists than participants who scored low on the orthographical processing measure. The reasoning behind this is related to special education eligibility. If a student was identified as an individual with a Specific Learning Disability in reading, the assumption is that there lies one of two processing deficits: Orthographical Processing, Phonological Processing or both. If a student scored highly on the orthographical processing measure, the assumption is that there is reason to believe that the participant may have a deficit in phonological processing, if there is also an experienced reading difficulty. Data collected does not support this hypothesis, as there is a mixed array of supporting evidence. Participants with a high orthographical processing score did commit more errors than participants with a low orthographical processing score while reading pseudowords in Arial. However, participants identified a greater number of pseudowords correctly in Dyslexie than the low orthographical processing group. Additionally, no difference was found between individuals' performance on sight word reading tasks in Arial or Dyslexie, without controlling for orthographical processing. As a result, it is believed that at a word level, Dyslexie does not significantly improve the reading performance of individuals with a Specific Learning Disability. This study controlled for several characteristics of Dyxlexie that are known to aid a student's reading performance, such as font size, font type, as well as the spacing between words and lines. It is possible that the benefits of Dyslexie may be present in those controlled characteristics that are believed to aid successful reading and not in the distinctive characteristics that make up Dyslexie, such as the formation of the letters, the weighted bottoms, the italicized legs, and the spacing between letters and words. This is consistent with a recent study by Marinus et al. (2016) which suggest that the benefit from Dyslexie is not by the individual characters, rather the unique spacing between words. This along with Tinker's finding that a font size of 8, 10, and 12 is best for reading speed and accuracy (1963) suggest that there is an optimal size of font and spacing between words that may benefit struggling readers.

Although no significant differences were found among the reading performance of our participants, it is believed there may be alternative benefits. Firstly, the font itself is novel and unique. This may increase the motivation a student may experience, which may positively impact the student's desire to read in the font. Van Someren (2013) found that participants reported an enjoyment of Dyslexie font and felt that it helped improve their reading ability. Although no benefits of using Dyslexie were found in the current study, our results suggest that the font does not negatively impact reading development. Any resource that increases a student's desire to read and exposure to literature is beneficial. As a result of a non-significant difference between dysfluences committed in both Arial and Dyslexie, it is likely that any mistake a student was to makeswhile reading would have been committed regardless of font type.

Limitations

This study drew from a very specific population, which consisted of fourth and fifth grade students with an identified Specific Learning Disability. Additionally, these participants were required to solely have a disability identification of Specific Learning Disability pertaining to reading. Students who were identified as Specific Learning Disability but also had Attention Deficit/Hyperactivity Disorder, writing concerns, math difficulties or other areas of suspected educational disabilities were excluded. As a result, the population was limited to a total of 36 students, split between two different rural school systems in Virginia.

Our design was created so that two different theses could draw from the same participant pool, which resulted in a necessary 36-participant sample size. As a result, we may have low generalizability, pertaining to the impact that Dyslexie may have on earlier grades, such as first or second grade students, which may provide important information into the impact on emerging readers and the development of early literacy curriculum.

Implications for school psychologists

Within the realm of education, Specific Learning Disability constitutes 47% of children who receive special education services (Gargiulo, 2006), which further demonstrates the importance of effective reading interventions. With the numerous reading interventions available, an intervention that requires the manipulation of a font would be incredibly beneficial. However, the use of Dyslexie is not supported in the current study. It is imperative for school psychologists to be consumers of research and to have an understanding of how to appropriately select intervention programs that may be beneficial to the population served, especially in regard to linking interventions with cognitive ability. As schools have limited resources and funding, it is critical to be an informed consumer so that funding leads to maximum, potential benefit for students.

Suggestions for future research

The development of effective reading interventions is crucial to combat concerns related to reading difficulties that students face, particularly if the intervention chosen was empirically supported by outside reviewers, and if it was as easy as changing the font on a screen. The current study suggests that there is no difference between reading performance of Arial and Dyslexie, regardless of the control of orthographical processing. Although the effectiveness is not demonstrated at a word based level, the effectiveness of the font may be demonstrated in a large passage, sustained reading level, with the manipulation of space, as theorized by the current study and by Marinus et al. (2016). A future direction could investigate the impact of altering the spacing between letters and words, within a sustained reading passage. This would provide further information pertaining to an optimal spacing required to benefit struggling readers.

The methodology of this study should be replicated with different grade levels to increase generalizability, particularly with a population of first and second grade students. There may be more of a profound impact on emerging readers, rather than students who have already learned the principles of reading and utilize compensatory strategies to remediate experienced difficulties. If this study could be duplicated and similar data were collected, it would provide valuable information into the effectiveness of this study and the conclusion of overall ineffectiveness at a word based level. In addition to duplication, an important ability to measure that was not able to be measured in this current study due to time restraints, is phonological processing. By obtaining a measure of phonological processing, this would allow the participants to be more concisely separated into dichotomous groups, rather than the need to make assumptions related to reading ability, solely off of a participant's performance on the orthographical processing measure.

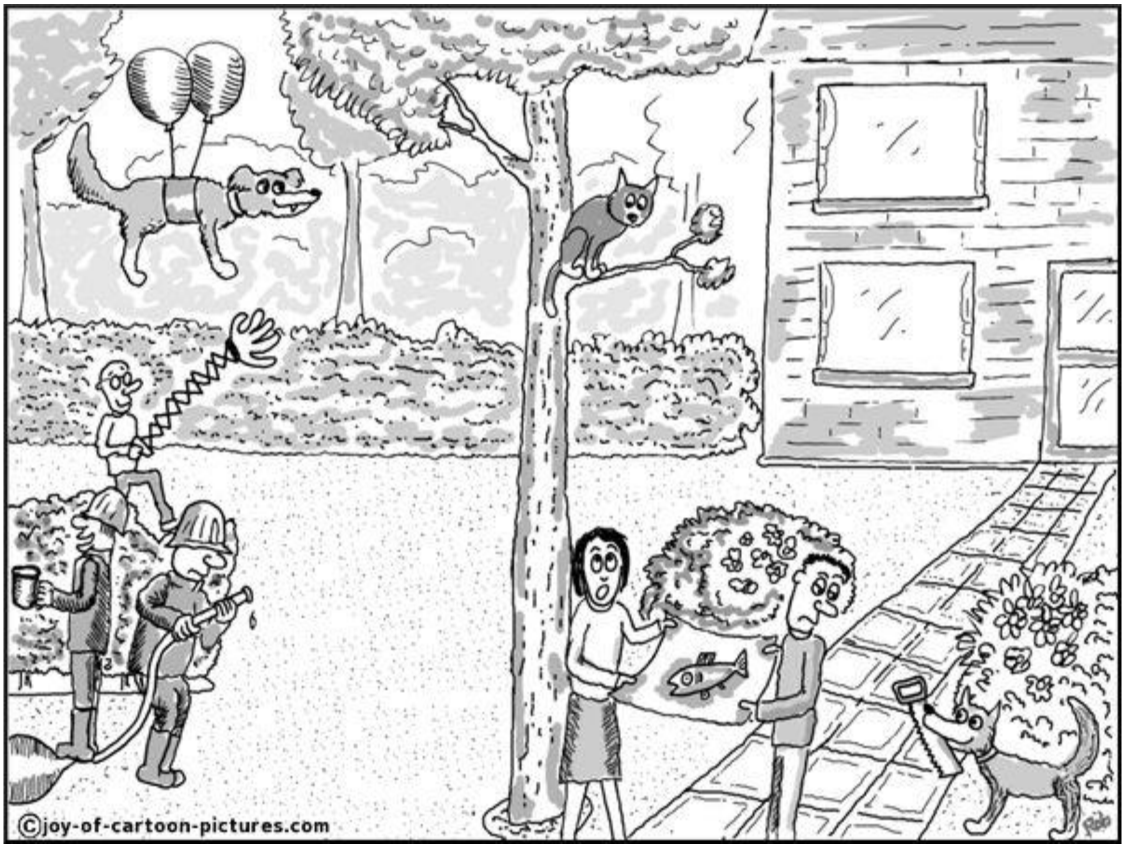
Another direction of research could look at the optimal font size for reading performance. Tinker (1963) found that fifth and sixth grade students had the same reading speed while reading words in an 8, 10, or 12-point font. He also proposed that reading in a size 6 or 14-point font reduced reading speed. Although his study has been cited numerous times for optimal font size, it is believed that a duplication of Tinker's study may be in order, due to being over 60 years old; to further support these claims. Additionally, linking an optimal font size with an optimal spacing between letters and words could produce valuable information for reading curriculum development for early literacy.

Finally, a future direction of research could look into a font's impact on the automaticity of word recognition in differing fonts and font size, through measures of a continuous performance task.

Appendix 1

1	Crockett	Arial	Real List 1	Arial	Parks	Dyslexie	Real List 2	Arial	Tesla	Times	Pseudo List	Dyslexie
2	Crockett	Dyslexie	Real List 1	Arial	Parks	Times	Real List 2	Arial	Tesla	Arial	Pseudo List	Dyslexie
3	Crockett	Times	Real List 1	Arial	Parks	Arial	Real List 2	Dyslexie	Tesla	Dyslexie	Pseudo List	Arial
4	Crockett	Arial	Real List 1	Arial	Parks	Dyslexie	Real List 2	Dyslexie	Tesla	Times	Pseudo List	Arial
5	Crockett	Dyslexie	Real List 1	Dyslexie	Parks	Times	Real List 2	Arial	Tesla	Arial	Pseudo List	Arial
6	Crockett	Times	Real List 1	Dyslexie	Parks	Arial	Real List 2	Arial	Tesla	Dyslexie	Pseudo List	Arial
7	Crockett	Arial	Real List 1	Dyslexie	Tesla	Dyslexie	Pseudo List	Dyslexie	Parks	Times	Real List 2	Arial
8	Crockett	Dyslexie	Real List 1	Dyslexie	Tesla	Times	Pseudo List	Dyslexie	Parks	Arial	Real List 2	Arial
9	Crockett	Times	Real List 1	Dyslexie	Tesla	Arial	Pseudo List	Arial	Parks	Dyslexie	Real List 2	Dyslexie
10	Crockett	Arial	Real List 1	Dyslexie	Tesla	Dyslexie	Pseudo List	Arial	Parks	Times	Real List 2	Dyslexie
11	Crockett	Dyslexie	Real List 1	Arial	Tesla	Times	Pseudo List	Dyslexie	Parks	Arial	Real List 2	Dyslexie
12	Crockett	Times	Real List 1	Arial	Tesla	Arial	Pseudo List	Dyslexie	Parks	Dyslexie	Real List 2	Dyslexie
13	Parks	Arial	Real List 2	Arial	Crockett	Dyslexie	Real List 1	Arial	Tesla	Times	Pseudo List	Dyslexie
14	Parks	Dyslexie	Real List 2	Arial	Crockett	Times	Real List 1	Arial	Tesla	Arial	Pseudo List	Dyslexie
15	Parks	Times	Real List 2	Arial	Crockett	Arial	Real List 1	Dyslexie	Tesla	Dyslexie	Pseudo List	Arial
16	Parks	Arial	Real List 2	Arial	Crockett	Dyslexie	Real List 1	Dyslexie	Tesla	Times	Pseudo List	Arial
17	Parks	Dyslexie	Real List 2	Dyslexie	Crockett	Times	Real List 1	Arial	Tesla	Arial	Pseudo List	Arial
18	Parks	Times	Real List 2	Dyslexie	Crockett	Arial	Real List 1	Arial	Tesla	Dyslexie	Pseudo List	Arial
19	Parks	Arial	Real List 2	Dyslexie	Tesla	Dyslexie	Pseudo List	Dyslexie	Crockett	Times	Real List 1	Arial
20	Parks	Dyslexie	Real List 2	Dyslexie	Tesla	Times	Pseudo List	Dyslexie	Crockett	Arial	Real List 1	Arial
21	Parks	Times	Real List 2	Dyslexie	Tesla	Arial	Pseudo List	Arial	Crockett	Dyslexie	Real List 1	Dyslexie
22	Parks	Arial	Real List 2	Dyslexie	Tesla	Dyslexie	Pseudo List	Arial	Crockett	Times	Real List 1	Dyslexie
23	Parks	Dyslexie	Real List 2	Arial	Tesla	Times	Pseudo List	Dyslexie	Crockett	Arial	Real List 1	Dyslexie
24	Parks	Times	Real List 2	Arial	Tesla	Arial	Pseudo List	Dyslexie	Crockett	Dyslexie	Real List 1	Dyslexie
25	Tesla	Arial	Pseudo List	Arial	Crockett	Dyslexie	Real List 1	Arial	Parks	Times	Real List 2	Dyslexie
26	Tesla	Dyslexie	Pseudo List	Arial	Crockett	Times	Real List 1	Arial	Parks	Arial	Real List 2	Dyslexie
27	Tesla	Times	Pseudo List	Arial	Crockett	Arial	Real List 1	Dyslexie	Parks	Dyslexie	Real List 2	Arial
28	Tesla	Arial	Pseudo List	Arial	Crockett	Dyslexie	Real List 1	Dyslexie	Parks	Times	Real List 2	Arial
29	Tesla	Dyslexie	Pseudo List	Dyslexie	Crockett	Times	Real List 1	Arial	Parks	Arial	Real List 2	Arial
30	Tesla	Times	Pseudo List	Dyslexie	Crockett	Arial	Real List 1	Arial	Parks	Dyslexie	Real List 2	Arial
31	Tesla	Arial	Pseudo List	Dyslexie	Parks	Dyslexie	Real List 2	Dyslexie	Crockett	Times	Real List 1	Arial
32	Tesla	Dyslexie	Pseudo List	Dyslexie	Parks	Times	Real List 2	Dyslexie	Crockett	Arial	Real List 1	Arial
33	Tesla	Times	Pseudo List	Dyslexie	Parks	Arial	Real List 2	Arial	Crockett	Dyslexie	Real List 1	Dyslexie
34	Tesla	Arial	Pseudo List	Dyslexie	Parks	Dyslexie	Real List 2	Arial	Crockett	Times	Real List 1	Dyslexie
35	Tesla	Dyslexie	Pseudo List	Arial	Parks	Times	Real List 2	Dyslexie	Crockett	Arial	Real List 1	Dyslexie
36	Tesla	Times	Pseudo List	Arial	Parks	Arial	Real List 2	Dyslexie	Crockett	Dyslexie	Real List 1	Dyslexie

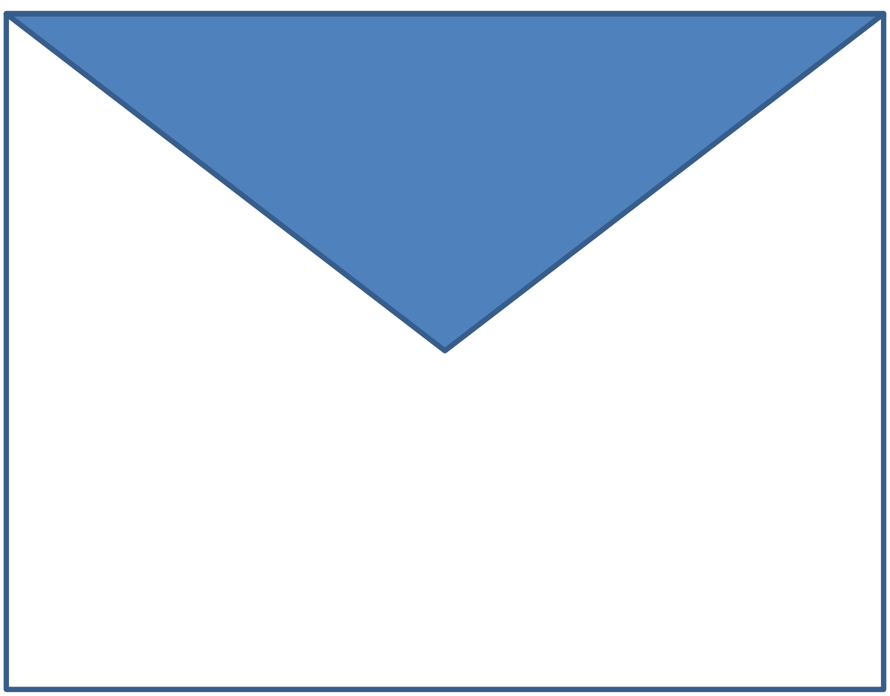
Appendix 2



Appendix 3

Block Design 1

Block Design 2



Appendix 4

Word List 1

cat	was	this
not	how	them
more	make	down
blue	four	they
spell	zoo	door
mom	may	clown
run	leaf	rose
jump	gain	gloves
limit	focus	fruit
burger	girl	phone
tulip	people	lime

smart	practice	bucket
don't	myself	turkey
special	stereo	beautiful
deer	america	flier
favorite	morning	chocolate
wealthy	however	carpenter
funnier	everything	volume
haiku	against	dessert
alphabet	failure	experience
mistletoe	considered	furniture
arkansas	junior	capitalize
university	given	difference
evidence	secretary	questions

there’s	worst	expensive
rescue	foreign	tongue
answered	illustration	billionaire
misguided	susceptible	icicles
deprivation	mythology	preposition
adolescence	decaffeinated	

Appendix 5

Word List 2

she	on	the
but	which	then
two	first	only
little	fly	with
shell	frog	rug
dad	food	game
fun	moon	coat
bud	funny	main
amount	correct	mule
chips	boy	fax
lilac	with	lemon

part	cattle	method
couldn’t	smiled	dragon
thought	wrestle	knight
won’t	something	flies
camping	together	sickness
fight	healthy	distrust
noisier	dancing	settlers
demonstrated	thursday	special
rhythm	estimate	satisfaction
competitor	religious	subject
spaghetti	wouldn’t	language
development	pumpkin	necessary
pajamas	emperor	paranoid

clumsy	existence	choose
young	tornadoes	minute
approach	exhaustion	doughnut
harmonious	obviously	etiquette
uniformity	adherent	inappropriate
politician	solstice	

Appendix 6

Pseudoword List

ik	nib	
ak	ot	bip
wub	doj	vus
hosh	dith	chaz
cley	dras	jeem
slert	plok	saft
phat	glatch	maft
zumbot	zorb	luffle
brone	detlat	midcam
stite	staw	wubtog
sloit	maut	clote

pumzar	ketbim	lamnot
natpom	detashment	wumved
cavaric	sanmeb	adving
emeration	protion	narium
flamelish	dippossers	bankeye
opkersion	spothew	burgingly
phisonnelly	imparalize	affertlam

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