DYSLEXIA
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A Special Font for People with Dyslexia: Does it Work and, if so, why?

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In 2008 Christian Boer, a Dutch artist, developed a special font ("Dyslexie") to facilitate reading in children and adults with dyslexia. The font has received a lot of media attention worldwide (e.g., TheGuardian.com, Slate.com, TheAtlantic.com, USA Today, and io9.com). Interestingly, there is barely any empirical evidence for the efficacy of Dyslexie. This study aims to examine if Dyslexie is indeed more effective than a commonly used sans serif font (Arial) and, if so, whether this can be explained by its relatively large spacing settings. Participants were 39 low-progress readers who were learning to read in English. They were asked to read four different texts in four different font conditions that were all matched on letter display size (i.e., x-height), but differed in the degree to which they were matched for spacing settings. Results showed that low-progress readers performed better (i.e., read 7% more words per minute) in Dyslexie font than in standardly spaced Arial font. However, when within-word spacing and between-word spacing of Arial font was matched to that of Dyslexie font, the difference in reading speed was no longer significant. We concluded that the efficacy of Dyslexie font is not because of its specially designed letter shapes, but because of its particular spacing settings. Copyright © 2016 John Wiley & Sons, Ltd.

Keywords: font; text-reading; dyslexia; spacing; letter shapes

It would be revolutionary if the reading performance of children and adults with dyslexia could be improved by using a special font. This is exactly what a Dutch graphic designer, Christian Boer, aimed to do when he developed the font "Dyslexie" in 2008 (Boer, 2016). Dyslexie has been used in several primary schools in the Netherlands, and Dutch publishers have printed books in this font (Boer, 2016). Since 2011, the font has also become more prominent in English, and English-speaking countries such as Australia have started to print books in Dyslexie.

What makes the Dyslexie font unique? As can be seen in Figure 1, the most striking difference is in the letter shapes. The rationale behind this, according to the designer, is that people with dyslexia struggle to distinguish between similar-looking letters (Boer, 2016).[1] Boer therefore set out to make the letters

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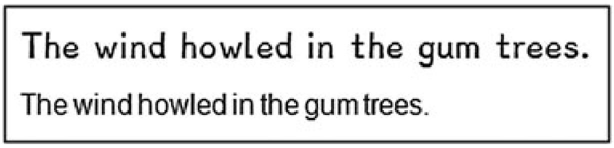

Figure 1. Dyslexie font and Arial font, both in 12-point font size.

look as different as possible by, for example angling and changing the heights and forms of similarly shaped letters (e.g., b and d). In addition, Boer postulated that people with dyslexia have the tendency to rotate or reverse letters. Therefore, he designed the base of the letters to look 'heavier' (i.e., thicker) to prevent them from turning around. Capital letters and punctuation marks were made bolder to alert the reader to the beginning and end of sentences. Finally, when presented in text, it becomes clear that Dyslexie has above-average between-word spacing compared with standard fonts such as Times New Roman and Arial (Figure 1).

Now that the font has achieved international interest, it is timely to review the existing empirical studies. Although Dyslexie has been around for seven years, there is still no peer-reviewed evidence available on its efficacy. To this end, we first communicate the outcomes of three unpublished masters' theses written in Dutch (de Leeuw, 2010; de Brouwers, 2012; Pijpker, 2013) and two Dutch publications in practitioner journals without peer-review procedures (Kuster, Braams, and Bosman, (2012); Ossen, 2012).

De Leeuw (2010) was the first to examine the efficacy of the Dyslexie font for typical readers and children with dyslexia. She compared reading efficiency and accuracy on the Dutch one-minute reading test (comparable to sight words and phonemic decoding in the Test of Word Reading Efficiency; Torgesen, Wagner, & Rashotte, 1999) using Arial font as a comparison. She found no differences in word reading efficiency (speed). For children with dyslexia, accuracy was slightly higher for words read in Dyslexie font (on average 1.29 errors out of 80.24 words) than in Arial (on average 1.71 errors out of 81.71 words). However, the accuracy showed ceiling effects, which are typically found in Dutch children, both with and without dyslexia (e.g., Tilanus, Segers, & Verhoeven, 2013). These results are therefore hard to interpret and do not seem to justify using Dyslexie over Arial. Reading efficiency and accuracy performance for pseudoword reading did not differ for the two fonts. Also, for typical readers there were no performance differences on any of the measures. However, it should be noted that this study exclusively looked at word list performance, whereas Dyslexie was specifically developed for text reading.

Subsequent studies on Dyslexie also included measures of text reading. De Brouwers (2012) included single word reading, replicating the null results of de Leeuw (2010), and text reading, where she also found no beneficial effect for Dyslexie over Arial. A null result for text reading was also found by Kuster, Braams, and Bosman (2012). Ossen (2012), however, reported better performance for reading efficiency on Dyslexie compared with Arial. Descriptively, the difference between Arial and Dyslexie was 31 s on average (624 and 592 s respectively) and the majority of the children (31/39) read more words per minute in Dyslexie than in Arial font. However, we cannot assign an interpretation to this difference, because no statistical tests were conducted. Ossen tried to explain why her results were different from Kuster and colleagues by arguing that the age range of the Kuster et al. participants was quite large (7–13 years old) compared with her study, which only included children in grades 4–6 (approximately 9–12 years old). As all children were asked to read the same text, the text could have been too easy for the older children, which might have introduced ceiling effects that masked potential improvements. Another reason for different results could have been that in Ossen's study, the children were familiarized with Dyslexie font before they were assessed, which was not the case in Kuster's study. Pijpker (2013) conducted the most recent study comparing Dyslexie font and Arial. She found that only the poorest-performing children with dyslexia read significantly more accurate in Dyslexie font than in Arial font, and only with a yellow background colour. No such differences were found for text reading speed or with a normal white background.

In sum, there is no extant evidence that Dyslexie font facilitates single-word reading speed or accuracy. The results for text reading are more mixed. What could explain these differences? The answer may lie in how the previous researchers matched (or did not match) Dyslexie to the comparison font. When looking at Figure 1, it becomes clear that 12-point Arial differs from 12-point Dyslexie not only in letter shapes but also in display letter size and spacing. Except for Kuster et al., who did match for display letter size, the previous studies did not match the two fonts on these two aspects. As a result, it is unclear whether their results reflect the influence of font type, font size, spacing, or a combination (see also Gianotten, 2012). For example, the beneficial effects reported by Ossen (2012) could merely be an effect of the spacing and font size.

In fact, it has been shown that children with dyslexia benefit from increased spacing and font size with standard fonts (Legge & Bigelow, 2011; O'Brien, Mansfield, & Legge, 2005; Perea, Panadero, Moret-Tatay, & Gómez, 2012). The theoretical explanation is that children with dyslexia are more vulnerable to the effects of visual crowding (Martelli, Di Filippo, Spinelli, & Zoccolotti, 2009), the phenomenon that letters are harder to identify when presented closely together. As for display letter size, Kuster and colleagues were the only group that controlled for this factor. However, Kuster et al. used a research design in which children were asked to read the same text in Arial and Dyslexie, with only 1 week intervening. This resulted in strong repetition, or practice effects: The text was always read faster on the second presentation, regardless of font. It is true that the researchers balanced the order of text presentation, which should have controlled for the practice effects. However, the combination of the large age range on a simple task and repetition of the same text would have added noise to the data, making it harder to find any effect of font type.

As is now obvious, the existing studies on Dyslexie do not answer whether it is an effective reading aid. Thus, the primary aim in the present study is to investigate empirically whether children with reading impairments perform better when reading text in Dyslexie than when reading text in Arial. Therefore, we developed a research design to directly investigate whether Dyslexie improves reading performance in children with reading difficulties. If children are found to perform better with Dyslexie than a comparison font, the next question becomes why this may be the case. Therefore, the second, more theoretical, aim of this paper is to determine factors that could underlie improved reading performance. Specifically, we address the question of whether superior performance with Dyslexie can be explained by its relatively large spacing parameters. By doing so, we aim to bring together the fields of typography (i.e., design of fonts) and cognitive science (see also to Dyson, 2013, for an overview on how psychological research could be relevant for typographic practice).

To avoid repetition or test–retest effects in our study we used four texts of a similar level of difficulty. The use of different texts does introduce a source of noise, but we preferred this design to one of repetition because we had four (versus two in previous studies) different text-presentation conditions and test–re-re-retest effects are not well understood. In addition, we used a design in which all texts appeared in all four conditions, which properly controls for potential differences in text difficulty. In Condition 1 the texts were presented in Dyslexie, while in the other three conditions the texts were presented in Arial font. Condition 2 was Arial text matched to Dyslexie in letter display size and Condition 3 was Arial text matched to Dyslexie font for overall spacing (similar degree of increase for spacing within and between words). Finally, Condition 4 was Arial text matched—on average—to the specific spacing settings of Dyslexie, with relatively large spacing between words (or, equivalently, relatively small spacing within words). Refer to Figure 2 for examples for each of the four font conditions. Our dependent measure was children's reading fluency (number of words read accurately per minute) for each of the texts. We used Arial font as a comparison font for three reasons: (i) for comparison with previous studies that used this as the control font; (ii) together with Times New Roman, Arial is a highly frequently encountered font; and (iii) an increasing percentage of reading is performed from a screen, for which sans serif fonts are preferred (Bernard *et al*., 2003; Moret-Tatay & Perea, 2011).

By comparing Conditions 1 and 2 we will address our first research question, namely whether Dyslexie is superior to Arial when matched on letter display size only. If Dyslexie makes it easier for children to read text, they will read more quickly in Condition 1 than in Condition 2. Conditions 3 and 4 were included to address our second research question, namely whether superior reading performance in Dyslexie can be explained by its spacing settings. If Dyslexie is easier to read because of its overall larger spacing, reading efficiency will not differ between Conditions 1 and 3. However, if it is not the *overall* larger spacing but the relatively large spacing *between* words (as compared to the spacing *within* the words) that is beneficial, it is expected that the children will perform better in Condition 1 than in Condition 3 and that performance in Conditions 1 and 4 will not differ.

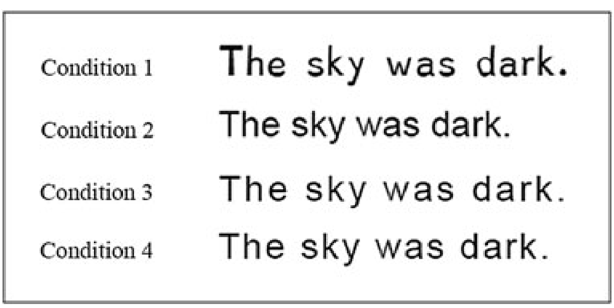

Figure 2. Font conditions. Condition 1: Dyslexie font, Condition 2: Arial font—matched on letter display size, Condition 3: Arial font—matched to Dyslexie font on letter display size and overall spacing, Condition 4: Arial font—matched to Dyslexie font on letter display size and separately for within and between spacing.

METHOD

Participants

Participants were 39 low-progress readers (20 boys) from Grades 2 to 6. Their average age was 116.5 months (SD: 12.2). The children were recruited via a reading remediation centre and affiliated reading tutorial centres in disadvantaged areas in Sydney, Australia. The Research Ethics Committee of Macquarie University approved all study procedures.

Materials

Screening measure: single-word reading accuracy

We assessed single-word reading accuracy with the Castles and Coltheart (CC2; Castles *et al*., 2009) to ensure that we only included below-average readers in our sample. The CC2 measures reading aloud accuracy for regular words, irregular words, and nonwords. The test contains 120 items (40 for each word type) printed on cards in lowercase Arial 36-point font. The words increase in difficulty throughout the test. A discontinue rule (five consecutive errors) is applied separately for each word type. For each child and each word type, we calculated a percentile score from published norms for Australian children. We confirmed that all participants scored below the 25th% percentile on at least one of the three subtests, which qualified all of our participants as low-progress readers.

Experimental measure: text-reading fluency

The Wheldall Assessment of Reading Passages (WARP) consists of passages (200 words each) designed to measure text-reading fluency. For the current study we used four passages that were not included in the published version of the WARP (Wheldall, 2013; Wheldall & Madelaine, 2013). We decided to use these materials because our participants are regularly assessed with the standardized version of the WARP and we wanted to avoid familiarity effects with the included passages. Earlier research has shown that the four passages we selected are of very similar difficulty level (Wheldall & Madelaine, 2006).

The passages in the published WARP are printed in Palatino Linotype 18-point font with a vertical line spacing of 0.815 points with one point corresponding to 0.353 mm (Zorzi *et al*., 2012). We used this as the basis for our different font and spacing conditions. First we converted passages into Dyslexie (Condition 1) and into Arial (Conditions 2–4). Next, all passages in all conditions were rematched on the display font size using the x-height metric (Bernard, Chaparro, Mills, & Halcomb, 2003) and to the line spacing (spacing between lines) of the Palatino Lynotype 18-point font. These conversions resulted in the passages used for Conditions 1 and 2.

In designing Dyslexie font, Boer adjusted the spacing setting for each individual character. However, to create Conditions 3 and 4, we settled on approximations —adjusting average spacing settings across all characters collectively. For Condition 3, we increased both between- and within-word spacing of Condition 2 by 1.5 points. To create Condition 4, we increased the spacing of Condition 2 by 1.3 points between words and by 1.0 point between letters within words. As a result, Condition 4 mimics Dyslexie's specific characteristic of having a relatively larger between-word to within-word spacing ratio compared to other fonts. Table 1 contains a summary of the adjustments made to create the four conditions for each passage. All passages were read from a printed page.

Procedure

Every participant read four different passages, one in each of the four font conditions. Every passage appeared in all four font conditions to avoid confounds between text and font. In addition, the texts were presented in different orders to control for order effects like fatigue. We used two sets of Latin square matrices (ABDC, BCAD, CDBA, and DACB; 1243, 2314, 3421, and 4132) to predefine the order and condition of the passages for all participants. This resulted in 16 (4×4) different text and condition combinations. For example, participant 1 would get code A1B2D4C3, meaning that she/he would read text order ABDC with text A in font Condition 1, text B in font Condition 2, text D in font Condition 4, and text C in font Condition 3. The dependent variable was words read correctly per minute.

The second author tested all participants individually between February and May 2014. In Australia, this corresponds to the first half of the academic year. The children in the clinic were tested during a 20-min training session in cubicles that were also used for their regular training sessions. They were given a 10-min break before testing to avoid fatigue. The CC2 was administered first, unless we already had recent (within 3 months) data on file. This was the case for six children, for whom the test session (WARP only) took approximately ten minutes. All children from the tutorial centres had already completed the CC2 in the past 3–4 months. As a result, the children could be tested in a 10-min session. Testing occurred in either a staff room or behind a partition wall in the classroom.

RESULTS

The participant means for every condition are presented in Table 2. A repeated measures ANOVA was conducted with font condition as a within-subjects variable with four levels. The main effect of font condition was significant, $F(3;\ 114) = 3.59$, $p = 0.016$, $\eta_p^2 = 0.086$, indicating that one or more conditions differed. To test our specific empirical predictions we conducted three pairwise comparisons, using the MMATRIX function in GLM Repeated measures ANOVA:

Table 1. Details of the font, letter size, x-height, and word spacing adjustments for each condition

Condition	Font	Size (pts)	x-height	Spacing
1. Dyslexie	Dyslexie	14	3.0 mm	Original spacing dyslexie font
2. Font size match	Arial	16	3.0 mm	Original spacing Arial font
3. Font size match and overall spacing match	Arial	16	3.0 mm	Increased 1.5 points between and within words
4. Font size match and balanced spacing match	Arial	16	3.0 mm	Increased 1.3 points between words, and 1.0 point within words

Table 2. Mean scores, standard deviations of words read correctly per minute for each font condition

Font condition	*Words read per minute*	
	M	*SD*
1. Dyslexie	75.74	37.17
2. Arial standard spacing	70.44	34.65
3. Arial with overall increased spacing	71.77	36.62
4. Arial matched spacing	73.64	38.99

(i) Dyslexie versus Arial, matched on letter size only; (ii) Dyslexie versus Arial, matched on letter size and overall spacing; and (iii) Dyslexie versus Arial, matched on letter size and both within and between word spacing.

The first pairwise comparison, between Dyslexie and Arial with standard spacing, showed that Dyslexie (Condition 1) was read significantly more quickly than Arial (Condition 2; 5.3 words per minute improvement), $F(1;\ 38) = 10.67$, $p < 0.01$, $\eta_p^2 = 0.22$, Cohen's $d = 0.70$.[2] Although the average difference in words read per minute was smaller, Dyslexie (Condition 1) was also read significantly more quickly (about four words per minute improvement) than Arial with increased overall spacing (Condition 3), $F(1;\ 38) = 7.73$, $p < 0.01$, $\eta_p^2 = 0.17$, Cohen's $d = 0.51$. However, the reading efficiency for Dyslexie (Condition 1) and Arial matched on specific within-word spacing and between-word spacing (Condition 4) did not significantly differ (about 2.1 words per minute improvement), $F(1;\ 38) = 1.30$, $p > 0.10$.

DISCUSSION

The first aim of our study was to test the efficacy of Dyslexie font for children with reading impairments. We found that low-progress readers were more efficient in reading texts printed in Dyslexie than in Arial when matched on display size (75.7 vs. 70.4 words per minute—an increase of 7%). Our second aim was to investigate if better reading outcomes for Dyslexie could be explained by its particular spacing settings. Such a finding would be in line with the observation that reading performance of individuals with reading impairments suffers if letters and words are presented closely together (e.g., Zorzi *et al*., 2012). Indeed, after we matched the spacing settings between the two fonts, there was no longer an advantage for Dyslexie. Therefore, our results indicate that increased spacing facilitates reading speed in reading impaired children, regardless of whether the font itself is specifically designed for dyslexic readers. In particular, it seems to be the specific balance of a relatively larger spacing between words than within words that is most effective.

As mentioned in the introduction, previous researchers (Zorzi *et al*., 2012, and later Perea, Panadero, Moret-Tatay & Gómez, 2012) have already demonstrated that children with reading impairments, or dyslexia, are faster to read texts with increased spacing overall (both within and between word). This phenomenon has typically been explained within the Crowding Theory of dyslexia, which states that it is harder for individuals with dyslexia to distinguish between visual objects, including letters, when they are presented closely together. This theory is intuitively appealing. However, because crowding experiments have typically focused on the identification of single letters or objects (e.g., Collis *et al*., 2013), it is still quite a leap to generalize these effects to text reading (van den Boer & Hakvoort, 2015). To draw stronger conclusions about an explicit link between the effect of spacing and sensitivity to crowding effects in children with dyslexia, future research would have to include more explicit measures of crowding into research on reading. A finding that performance on basic crowding tasks also predicts sensitivity to spacing settings would provide more leverage for a link between crowding and sensitivity to increased text spacing.

A further interesting finding of the current study is that not just overall spacing, but a specific balance in the size of spacing between and within words seems to be important for children with reading difficulties. Specifically, the children did best in the conditions where the spacing *between* words was relatively larger than the spacing *within* words (i.e., when Dyslexie and Arial were matched for within and between word spacing; Condition 4). This effect could be explained by the fact that increasing the overall spacing (both between- and within-words) might interfere with the integrity of word boundaries, making it harder to delineate where one word ends and the next begins (Perea *et al*., 2012). In other words, in addition to increased letter spacing, an increased distance between words may help children with reading impairments to better determine when a new word starts. Reynolds and Walker (2004) examined whether six-year-old typical readers benefit from increased overall (letter) spacing or between-word spacing. Reading rate of the six-year olds did not significantly increase when either overall spacing or in-between-word spacing was increased. However, for larger between-word spacing the mean reading rates did increase in the expected direction (by 3.84 s over 100 words). The outcomes of this study as compared with ours might be explained by the younger age of the children and the fact that our sample consisted of children with reading impairments. Future research comparing reading fluency of both impaired and typical readers of different ages is needed to determine who precisely benefits from what kind of increased text spacing.

The Impact of Letter Appearance

It is important to note that Dyslexie was developed as a tool to instantly improve reading performance for individuals with reading impairments; this is, the aim was to assist them with online reading performance without training or familiarity with the font. As far as we know, there have not been any studies on the use of Dyslexie in reading instruction, although previous researchers have argued that the effects of the font might be enhanced if children are first familiarized with it (e.g., Ossen 2012). Furthermore, beneficial effects of font familiarity have been found with adult readers (Gauthier, Wong, Hayward & Cheung, 2006; Sanocki & Oden, 1991; Walker, 2008).

The phonological deficit hypothesis of dyslexia (Snowling, 2000) posits that poor readers have difficulties learning the relationships between letters and sounds. Therefore, this theory may predict that if children with dyslexia receive their phonics instruction (i.e., learn grapheme-phoneme correspondence rules) in the context of a font with very visually distinct letters, they may learn more quickly. There is some evidence that beginning readers are more accurate in reading words printed in a more distinct font than printed in a more similar font (e.g., Verdana vs. Sassoon Primary; Wilkins, Cleave, Grayson, & Wilson, 2009). An important question therefore is as follows: How distinct are the Dyslexie font letters? And, is the degree of distinctness significantly larger than other common fonts like Arial?

Wilkins and colleagues (2009) determined degree of font distinctness by horizontally moving letters of each separate font until they reached maximum overlap and then calculated the proportion of pixels overlapping (i.e., the peak of overlap). We used a slightly different, but comparable approach to that used by Wilkins *et al*. Rather than finding the peak overlap, we computed distinctiveness of every pair of letters within a font. This was performed by computing the pairwise pixel overlap between every letter (uppercase and lowercase, aligned centrally) within each font using a custom script written in MATLAB. Then we directly compared the median pixel overlap among Dyslexie letters to the median pixel overlap among Arial letters. In contrast to what was aimed for by the font designer, we found that the Dyslexie letters are actually *less* visually distinct (i.e., the letters are more similar to each other) than the Arial letters.[3] When looking at the fonts (see Figures 1 and 2 in the introduction) the most straightforward explanation seems to be the 'heavy bases' of the letters in Dyslexia, while Arial letters have a more uniform thickness. The author created these heavy bases to help dyslexic readers suppress their supposed tendency to mirror-reverse or rotate letters (for example, rotating d by 180 degrees to produce p). Notably, reading researchers had already refuted this theory four decades ago (Fisher, Liberman, & Shankweiler, 1978). The key implication here is that if future researchers want to assess whether a font with particularly distinct letters helps children with reading difficulties to more easily acquire grapheme–phoneme correspondence rules, Dyslexie font does not have the appropriate characteristics.

Until now, the majority of research studies on Dyslexie have been conducted in Dutch. We present the first study conducted with children reading English. An important question is whether there would be reasons to expect cross-linguistic differences in the efficacy of Dyslexie font; for example, because the letter-sound mappings in English are less predictable than in Dutch (Frost, Katz, & Bentin, 1987; Schmalz, Marinus, Coltheart, & Castles, 2015). We would argue that the answer is no, as early recognition of letter features is a process that takes place before language specific characteristics (like print-sound-correspondences and word forms and meaning) come into play (e.g., Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). According to most contemporary reading theories, visual information such as the specific shape and size of letters is no longer relevant once the identities of the letters are determined.[4] In other words, because processing of font characteristics like letter type, size and spacing takes place in the early visual-processing stage of the reading process, font should not differentially influence reading across different languages (Perea *et al*., 2012). However, this generalization may not hold when comparing languages with different script types (e.g., alphabet vs. syllabary) or that have vastly different numbers of letters in their inventory (Chang *et al*., 2015).

It remains to be investigated whether there are individual differences in the effects of spacing, and in particular which underlying factors drive these differences. Relevant candidates to investigate with regard to typical reading development are reading experience and reading proficiency. However, effects within low-progress readers could also be driven by specific weaknesses in the reading system. For instance, Friedmann and Rahamin (2014) have demonstrated that increased letter spacing helped some but not all of their participants with a specific subtype of dyslexia (letter-position dyslexia). This observation underscores the need to perform targeted assessments of a poor reader's abilities to predict text alterations (and other remediation strategies) that might have the most benefit.

In conclusion, we demonstrated that low-progress readers are 7% more efficient in reading text in Dyslexie compared with Arial, matched on letter display size. However, when the spacing settings for Arial are matched to Dyslexie, the advantage disappears. Therefore, the benefit of Dyslexie seems to stem fully from its specific spacing settings. In contrast, the font's hallmark letter shapes, which are intended to be more distinct than those in standard fonts, do not provide a benefit. In fact, our analyses show that compared with Arial, the inter-letter distinctiveness of Dyslexie is actually *lower*. The practical implication is that to directly increase the average reading efficiency of low-progress readers one can simply change the font's spacing settings. There is no need to alter the shape of the letters.

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NOTES

1. The authors would like to stress that the vast majority of contemporary reading researchers do not share the idea of the artist that dyslexia is primarily caused by early visual problems (which could be leading to problems in distinguishing between letter shapes). There is now general consensus in the field of reading research that dyslexia has multiple causes and that in most individuals with dyslexia the cognitive problems that underlie their dyslexia are beyond the early visual letter level.
2. Partial Eta-squared is a measure of the amount of variance that is explained by difference in font. For instance, in the first comparison the $\eta_p^2 = 0.22$ implies that 22% of the variance is explained by the font difference. A Cohen's d of 0.70 adds that the mean difference (the average effect in words divided by the SD) is medium to large relative to that same variance (small effect: $d = 0.2$, medium effect: $d = 0.5$, large effect: $d = 0.8$).
3. Results of a Wilcoxon Rank Sum Test (non-parametric version of paired *t*-test) showed that both Arial lowercase and uppercase were more distinct than Dyslexie lower and upper case, $Z = 6.04$, $p < .001$, and $Z = 10.12$, $p < .001$ respectively.
4. However, note that these theories cannot explain how readers are able to semantically distinguish between a person's name, (e.g., "Pat") or verb (e.g., "pat"), which does

require the retention of visual information (case status) of letters (Schubert & McCloskey, 2013).

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