

DYSLEXIA TYPEFACE: DOES IT AFFECT READING FLUENCY?



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Abstract

There are different approaches used to reduce reading skills deficits. One such approach, which belongs to the group of visual adaptations, is to change the font used in the texts. The main research goal is to assess the level of reading success in people with dyslexia (reading difficulties) by using a specialized Cyrillic font - Dyslexic FZF. The research was conducted on 24 persons with dyslexia from North Macedonia and obtained data about oral reading fluency and reading lists of meaningful and meaningless words with the Dyslexic FZF font and the font Times New Roman. The data of the two consecutive readings were compared. Results suggest that when using the new dyslexia typeface, Dyslexic FZF, participants were able to read more words per minute than with the Times New Roman font. A statistically significant difference in the results occurs in the errors made while reading.

1. Introduction

Considering that 10% of the world's population is dyslexic, text presentation has a great impact on reading ability. Four decades of dyslexia research suggest that the reading difficulties originate from the alphabetical and phonological coding more than visual, semantic, or syntax deficits (Vellutino et al., 2004). Anyway, the usage of specially created fonts shows that in some persons with dyslexia, especially those having orthographic dyslexia, the readability of the text is increased, as well as the speed of reading. Many approaches have been suggested to reduce reading skills deficits. One such approach is to change the font used in the texts. Many sources cite the use of sans serif before serif fonts when reading by people with reading difficulties. However, the reasons for using Sans Serif fonts are not discussed (BDA, 2014; Rello & Baeza-Yates, 2013). The serif refers to the small lines that are projected at the ends of the letters, seen in fonts such as Times New Roman. Sans serif fonts, such as Arial, do not have this projection of the endings when writing letters (Brenard, Chaparro, Mills & Halcomb, 2003).

The readability of a text depends on a number of features of the font in which the text is written. Features are always interrelated and generally include character size, space between characters and rows, and font shape (Kuster et al., 2018). Research shows that larger fonts, with greater spacing and more space between the characters themselves, allow for greater readability (Perea et al., 2012). When creating font size, which essentially means the height of the characters, typographers determine the lowest and highest point of the character, while adding a minimum of extra space, enough for the letters not to touch each other (Legge & Bigelow, 2011; Spelbrink, 2012). This additional space allows the letters to be visually separated from each other.

According to the stated characteristics in reading in people with dyslexia and manipulation of the basic typographic parameters, there is a possibility to create fonts that will be adapted to the needs of these people. Several fonts of this kind have already been created (Sylexiad, Dyslexie, Read Regular, and Open Dyslexic), which basically contain a greater differentiation of the characters than the existing ones.

All the aforementioned fonts for people with dyslexia are made in Latin script, which means that in countries that use the Cyrillic alphabet, including the Republic of North Macedonia, existing fonts cannot be used. Realizing this fact, the first Cyrillic font for people with dyslexia was recently developed by members of the Faculty of Philosophy in Skopje. The font, called Dyslexic FZF, based on the Latin Open Dyslexic font, contains the main features that most fonts for people with dyslexia have. It is a Sans Serif font in which all the letters of the Macedonian alphabet, and numerical and punctuation marks are specifically made.

The main features of the font are the weighted bottoms of each character, the increased character dimension, and the increased spacing (both between characters and lines). Since there is a pronounced ratio between thicker and thinner parts, the font has greater contrast. Dyslexic FZF is characterized by certain slopes of the vertical and horizontal baselines of the letters, as well as enlarged openings of the alphabetic signs, such as e, c, and a. It also makes a distinction between alphabetical and numerical characters, with numbers having a larger dimension for easier text separation (Karovska Ristovska & Filipovska, 2018).

2. Material and Method

The main research goal is to assess the level of reading success in people with dyslexia (reading difficulties) by using a specialized Cyrillic font - Dyslexic FZF. The need to conduct such research stems from previous data found in the literature that are contradictory (de Leeuw, 2010; Wery & Diliberto, 2017). However, it should be noted that previous research on the effectiveness of fonts for people with dyslexia has been done exclusively for Latin fonts and the functionality of Cyrillic fonts has not been investigated.

On the other hand, there are differences in the orthography of languages that can also affect the efficiency of a font, and the specific orthography that a child is acquiring has been identified as a central environmental factor influencing reading acquisition and dyslexia (Borleffs et al., 2017). Research has suggested for transparent orthographies, as the case in the Macedonian language, with highly regular grapheme-phoneme correspondences be more easily acquired than complex and opaque orthographies with a high proportion of irregular and inconsistent spellings (Aro & Wimmer, 2003; Seymour, Aro, & Erskine, 2003). Therefore, the results regarding the functionality of dyslexia fonts may be different in countries that use different languages.

This research is formulated as research with an applied character that has an evaluation nature. In order to be determined the effectiveness of the Dyslexic FZF font, the comparison in reading

was made with the widespread used standard serif font Times New Roman.

The basic (null) hypothesis was formulated as the following:

- H0 – There are no differences in reading with the Times New Roman and Dyslexic FZF fonts in people with dyslexia.

Additionally, three supporting hypotheses were set as well:

- H1 – The number of reading mistakes made with both fonts will be insignificantly different.
- H2 – People with dyslexia can read correctly a larger percent of meaningless and meaningful words when reading with the Dyslexic FZF font;
- H3 – There is no impact difference of Dyslexic FZF font in younger and older participants.

The success of reading in people with dyslexia (reading difficulties) with the Cyrillic font Dyslexic FZF was examined with 2 tests:

- Oral Reading Fluency (ORF)
- Test for reading sequences of meaningless words and meaningful words.

The research was conducted with each respondent individually. For the ORF test, each respondent received two different printed texts, the first one typed in Times New Roman font and the second in Dyslexic FZF. The texts assessed fluency in reading with both fonts. We assessed the fluency by calculating the number of words read correctly in one minute and at the same time measuring the accuracy and reading rate. This assessment was conducted with a text that had a minimum of 200 words and that was at the level of the student's instruction or appropriate for the age of the respondent. For the accuracy part, we noted the errors made during reading.

Finally, respondents were asked to read two lists of meaningless words (25 words in Times New Roman font and 25 in Dyslexic FZF) and two 25 meaningful word lists in both fonts. Such a task was necessary having in mind that the reading process involves decoding visual information to access a series of speech sounds, and word meanings and dyslexic readers have problems with this visual expertise that allows fast identification, recognition, and categorization of letters (Fraga Gonzalez et al., 2014). Being presented with single meaningful words without context, as well as words without meaning at all, can provide information about the ability to correctly recognize and pronounce words with the Dyslexic FZF typeface i.e. does the ability change or stays the same when the new typeface is used.

The sample included 24 people with dyslexia at different ages (from 8 to 41 years). Ten people were female, while 14 respondents were male. The sample was adjusted, i.e., respondents who were tested applied for the study on their own. The consent of all respondents was obtained, while for respondents under the age of 18, consent was obtained from their parents.

Due to the fact that there is only one sample group that is tested twice for each task, a paired t-test was used to test the hypothesis.

3. Results

After the conducted testing of the group for oral reading fluency, results presented in table 1, show that the persons with dyslexia were able to read more words in one minute with the Dyslexic FZF font (N= 980). The number of correctly read words with Times New Roman font was 934. The mean difference between the two consecutive readings is just 2.5. It is evident that the difference between the fonts, in this case, is not large and that is why the paired t-test did not confirm that this difference in the results is statistically significant ($p = 0.198$).

Table 1. Oral Reading Fluency test – number of words read correctly.

Font	N	M	p-value
Times New Roman	934	51.89	p = 0.165
Dyslexic FZF	980	54.44	

Table 3. Number of meaningless and meaningful words read correctly.

Font	Meaningless words		Meaningful words	
	N	M	N	M
Times New Roman	338	18.78	372	20.67
Dyslexic FZF	372	20.67	406	22.55
p-value	p = 0.007		p = 0.009	

The number of errors made while reading the list of words is also significant. According to data in table 4, respondents made fewer mistakes with the Dyslexic FZF font in reading meaningful and

Besides the words read correctly, during the 1-minute ORF test, the mistakes made while reading was also taken into account. While reading the text with Times New Roman font, examinees made 58 mistakes. Unlike that, reading the text typed in Dyslexic FZF, examinees made 30 reading errors (see table 2). Because of the almost double difference in the results in this section, the paired t-test showed a statistically significant difference ($p = 0.001$). Besides words that were read incorrectly, this also means that examinees reduced the incidence of skipped, completely unread, or substitute words.

Table 2. Oral Reading Fluency test – number of words read incorrectly.

Font	N	M	p-value
Times New Roman	58	3.22	p = 0.001
Dyslexic FZF	30	1.67	

Regarding the second testing task, reading lists of meaningless and meaningful words, the results suggest that in both cases examinees were able to read more correct words with the font Dyslexic FZF. The conducted paired t-test also confirmed that this difference in the results is statistically significant (Table no.3). With the Times New Roman font respondents read 75% of all words on the meaningless word list correctly, unlike the 83% with the Dyslexic FZF.

meaningless words. Only 17% of the meaningless 25 words were read incorrectly.

Table 4. Number of meaningless and meaningful words read incorrectly.

Font	Meaningless words		Meaningful words	
	N	M	N	M
Times New Roman	122	6.78	78	4.33
Dyslexic FZF	76	4.21	44	2.44
p-value	p < 0.001		p = 0.009	

The most common types of errors made by respondents with dyslexia when reading the list of words and the two texts were substitution (replacing the whole word with another word with a different meaning); omission (omitting letters from the word); addition (adding letters in the initial, medial or final position of the word); repetition (most often repetition of the first syllables of the word); self-correction.

In order to see if the font impacts reading fluency differently in younger children and adults, we divided and analyzed the gained results into two groups: participants under the age of 15 and participants over 15 years of age. Results suggest (Table 5) that the font Dyslexic FZF has a greater impact in two areas of the participants aged 15 and above. Statistically significant differences in this group were found in the number of errors made

with the font Dyslexic FZF and the meaningless words read correctly.

Table 5. Age differences

Group	<i>P value</i>			
	ORF words read correctly	ORF words read incorrectly	Meaningful words read correctly	Meaningless words read correctly
Over 15	0.26	0.04	0.26	0.02
Under 15	0.38	0.04	0.12	0.89

For the research group aged under 15, results indicate that the difference for the fewer errors made with the Dyslexic FZF font is statistically significant. A statistically significant difference for this group is found only in this one area.

4. Discussion

The main aim of this research was to assess the level of reading success in people with dyslexia (reading difficulties) through the use of a specialized Cyrillic font - Dyslexic FZF. That is why we tested the oral reading fluency in dyslexic readers with two different fonts – Times New Roman and Dyslexic FZF. The above results show us that Dyslexic FZF font does improve reading fluency in persons with dyslexia. Even though there is no significant difference in the number of words read correctly, fluency is increased by the decrease of mistakes during reading where significant difference does occur. The main ability of fluent readers is that they can read text with accuracy, speed, and proper expression (National Institute of Child Health and Human Development, 2000). As Wolf and Katzir-Cohen (2001) explain, reading fluency represents the ability to read accurately and at a rate that enables comprehension; and is a foundation of skilled reading (Christodoulou et al., 2014). And because fluency is intertwined with reading comprehension (Kim & Wagner, 2015), readers who make fewer mistakes while reading can understand the text better (Álvarez-Cañizo, Suárez-Coalla & Cuetos, 2015). Due to this fact, the null hypothesis has been rejected because there is a difference in the fluency when reading with the two different fonts, i.e., the reading fluency is increased for dyslexic readers when reading with the Dyslexic FZF font. Fewer mistakes when reading mean that respondents were able to read more accurately, and accuracy is the essential foundation of reading fluency. To be considered a fluent reader, reading must be accurate, first and foremost (International Literacy Association, 2018).

That Dyslexic FZF font improves accuracy is evident by the further research results of reading lists of meaningful and meaningless words. Since the paired t-test showed that the number of both meaningless and meaningful words read correctly is significantly increased when reading with the Dyslexic FZF font, we can confirm the second sub-hypothesis.

When considering the results of reading errors and connecting them with the first sub-hypothesis, it is evident that this hypothesis should be rejected. All respondents made fewer reading mistakes when using the Dyslexic FZF font and this proved to be statistically significant.

Regarding the age differences in the impact of the Dyslexic FZF font, the results from this research show a greater impact on reading in the group of participants that are 15 years of age or above. These results might not be as surprising having in mind that younger and older dyslexics differ in their abilities connected to the process of reading. While the younger ones still struggle to gain the necessary reading skills, older dyslexic readers have been exposed to print for many years and can rely on their orthographic processing more successfully (Miller-Shaul, 2005). Experience is one way to explain why adults have a slightly greater benefit than younger participants using the font Dyslexic FZF. One older study that can be related to these findings is the study of Bruck (1990) which states that adult dyslexic readers are more sensitive to orthographic patterns, and that is why their abilities for word recognition are getting close to those of regular readers. According to the findings, the third sub-hypothesis is rejected as well. There is a difference between the groups regarding age.

Most of the studies that have been already made and whose main objective is to assess the effectiveness of dyslexia-oriented fonts suggest that there are no significant differences in reading with these kinds of typefaces and others used on regular basis. One such research is the research of Rello and Baeza-Yates (2013) who compared the reading performance of participants with dyslexia while using two fonts that were created for people with dyslexia and ten other fonts. They concluded that reading text in Open Dyslexic or in Open Dyslexic Italic did not lead to a decrease in reading time compared to the other ten fonts. Kuster et al. (2018) confirm similar results for the Dyslexie font.

The research results show that children with dyslexia did not read text written in Dyslexie font faster or more accurately than in Arial font. One of the possible reasons why the results differ from the previously mentioned research results is their orientation towards speed and not fluency.

One research like the one we conducted, is the research of Ramsey (2014). Ramsey's research examined the fluency of reading with Dyslexie-DYS and Times New Roman Font (TNR) in two groups of respondents (readers with reading difficulties and those without reading difficulties). It was concluded that 25% of the respondents had higher scores on fluency when reading the DYS font compared to the TNR font reading. This suggests that some people may react differently to different fonts, and although there is no evidence that one font is better than another for all people with reading difficulties, it is possible that certain fonts are better for specific subgroups of people with reading difficulties (for example, people with magnocellular deficits, people with comorbidity ADHD and others).

Bachmann and Mengheri (2018) in their study of the use of the EasyReading font as a compensatory tool for dyslexia readers have proven the effectiveness of this font. They compared two groups of respondents (with or without reading difficulties - a total of 533 fourth graders) and found that the font was effective in both groups of respondents, especially in terms of fluency and accuracy. Interesting results were obtained in Pijpker's (2013) master study concerning the effect of the Dyslexie font on reading performance in dyslexic and non-dyslexic children. Again, reading in Dyslexie font did not lead to a decrease in reading time or reading errors compared to reading in Arial in none of the groups. But when they divided the dyslexic readers into a group that read relatively well and one that read relatively poorly, they found an effect of the font in the poor dyslexic readers group, that is, they made fewer errors when reading the Dyslexie font than when reading in Arial. The results of the poor dyslexic readers' subgroup correspond to the ones we obtained, considering there was only one group of dyslexic readers.

However, the dilemma remains, as with all research on the effectiveness of these fonts, whether the success is due to a specific feature of the font or the simultaneous presence of multiple elements (line spacing, letter spacing, and serial disconnection). A good point to this dilemma is the research of Marinus et al. (2016) which examined the Dyslexie font and Arial in low-performing readers. The results showed that with Dyslexie, examinees were able to read 7% more words per minute but only in a condition where they had not controlled for spacing. After the fonts were matched for within-word and between-word spacing the effect disappeared. Researchers concluded that the effect is due to the greater distance between the letters that characterize the font.

Another point that might need to be considered when trying to understand the results of this research is the transparency of the Macedonian language. The orthographic depth of languages

should be another perspective to analyze the effectiveness of dyslexia-oriented typefaces. Most of the studies which examine dyslexia fonts use samples of persons using language with oblique transparency. Considering the results, we gained in this research; they are in line with the research of Bachmann and Mengheri (2018) that was already mentioned. Besides the thing that their results also confirm an increase in fluency and accuracy, the children included in the research were Italians. Knowing that the Italian language, as well as Macedonian, belongs to the group of languages with transparent (shallow) orthography, it might be the case that dyslexia fonts have a greater impact on reading in this group of languages. For this to be confirmed, more research needs to be conducted and data from shallow orthography languages to be obtained.

The last thing about the specificity of this research and the results, besides orthography, is the Cyrillic alphabet of the language. There is no data to make a comparison of the results of this study with the results of other research made on samples using Cyrillic alphabets. Having such data would be of great significance in understanding the nature of the results and effectiveness of the font Dyslexic FZF and other dyslexia-oriented fonts.

5. Conclusions

The Cyrillic font Dyslexic FZF seems to affect oral reading fluency in dyslexic readers by decreasing the number of reading mistakes. Anyway, it is not completely clear whether this effect comes from the font itself or some of its features (increased space between characters and lines). Even if the reason is the second one, and the space feature between characters and lines can be managed easily in any word typing processor, it is useful to have one complete font where such typographical characteristics are already included.

The legibility of a text depends on several features and the use of a computer font only cannot facilitate the reading experience in persons with dyslexia dramatically. But together with other new technology and strategies, can make a slight difference. In the end, the preference of a font is individual, and one cannot fit all. Moreover, not all participants in this research showed better results with the new Dyslexic FZF font.

Also, there are different types of dyslexia and not all types could benefit from visual support such as fonts. The greatest impact of dyslexia-oriented fonts would be in orthographic dyslexia. That is why when analyzing research results regarding this issue, the orthography depth of the language, as well as the different kinds of dyslexia, have to be considered.

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