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Dixy: A Connection Between the "Typographic Appearance" and the Brain of Children*

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This study presents a comparison between three different fonts in order to know the possible influence they may have when used in educational materials for children with readers difficulties resulting from dyslexia. Two of the three selected fonts (*Arial* and *MeMimas*) are frequently used in textbooks in Spain. The third type of letter (*Dixy*) was specially developed for typographic research purposes, following graphic features that according to literature and previous studies on reading patterns favor the dyslexic, and could improve reading skills in these individuals. To examine the quality of reading (speed and accuracy) between fonts, a small—but significant—sample was used. Ten children in Madrid, from eight to 10 years old were examined while reading words and pseudowords with three different fonts (*Arial*, *MeMimas*, and *Dixy*). The result of the study shows the influence of the shapes of the letters in the legibility of texts with familiar and unfamiliar words (pseudowords) in children with dyslexia. The study showed that using the font *Dixy*, despite not being known by the children, reading is more accurate than using fonts known to them, such as *Arial* and *MeMimas*. As to the reading speed, the results indicate that, although the *Dixy* is a font never seen before by the children, reading speed is similar to a known font for them, as is the *Arial*, and greater than a hand writing font such as *MeMimas*.

Keywords: legibility, letter font, dyslexia, reading, children, readers difficulties

Introduction

With this study, we intend to identify the trends on the influence over the legibility of texts provided by some of the main letter fonts used in teaching materials (books, manuals, games, and videos among others) for children with reading difficulties.

Legibility is the characteristic which indicates us how easy and fast a text can be read with regards to its graphic features (Carter, 1997, p. 12) (letter font (Duñabeitia, Perea, & Carreiras, 2009; Fiset et al., 2008; Hillier, 2007, 2006; Feely, Rubin, Ekstrom, & Perera, 2005; Perera, 2003; Sassoon & Williams, 2000), size (Hughes & Wilkins, 2002; Hughes & Wilkins, 2000), inclination, weight (Sassoon & Williams, 2000), spacing (Reynolds, 2006; Feely et al., 2005; Sassoon & Williams, 2000), back-image contrast, text justification (Sassoon, 1993; Sassoon & Williams, 2000), and spacing (Reynolds, 2006; Sassoon, 1993; Sassoon &

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Williams, 2000) among others).

Legibility is subjective, this subjectivity depends on the demands made by groups of individuals with the same or similar characteristics (children, adults, elders, visual impaired individuals, dyslexic children, and dyslexic adults among others) (Sassoon, personal interview, March 21, 2008), as well as on the automatisms which intervene in the reading (neuronal process) (Urger, 2009). For those studying legibility in letter fonts, it is well-known that the legibility demands on the letter fonts present in a children without reading difficulties, will not be the same as those present in a children with reading difficulties (Sassoon, personal interview, March 21, 2008), according to the different theories explaining the causes of dyslexia (Peer, 2009). Likewise, the use of reading models used by an expert reader will not be the same as the one used by a new reader or by an individual with reading difficulties, such as a dyslexic individual.

The existence of studies, mainly neuronal, on reading models (word-shape model, letter-to-letter model, and the dual model), which attempt to explain the functional processes when we read have thrown results that validate that there are differences between word reading among dyslexic and non-dyslexic individuals (Shaywitz et al., 1998; Seidenberg, 2005; Friedmann & Gvion, 2001, 2005; Hillier, 2009).

Each typeface, hair line, joint writing, and printing, *Serif* (with tailing lines) and *Sans Serif* (without tailing lines), provides different characteristic which, according to the group targeted by the text, could offer a greater or lesser degree of legibility. If we take into consideration that the main usefulness of a typeface is to communicate by written means (Ambrose & Harris, 2007; Thangaraj, 2004; Clark, 2007; Baudin, 1989), then carrying out a study on the legibility needs that favor a certain group, could provide greater data for designing a typeface for a specific end.

The existence of studies, carried out in the United Kingdom (Sassoon & Williams, 2000), on legibility with regards to reading processes of children in general, evidences that word shape may influence on the reading quality of children.

Existing research carried out with regards to the graphical characteristics of letters and legibility (Duñabeitia et al., 2009; Fiset et al., 2008; Hillier, 2007, 2006; Feely et al., 2005; Perera, 2003; Sassoon & Williams, 2000; Hughes & Wilkins, 2002, 2000; Sassoon, 1993; Sassoon & Williams, 2000), in particular the works by Wilkins and colleagues (2002, 2007, 2009) and Sassoon (1993) indicated that typefaces used in teaching materials for children are chosen by adults, psychologists, professors, or children with high reading skills, who believe are capable of "knowing" what is best for those children showing reading difficulties, like dyslexic ones, ignoring, on one hand, the opinion of children themselves (Sassoon, 1993), and, on the other, reliable researches on the topic (Wilkins, Cleave, Grayson, & Wilson, 2009). Typefaces used in teaching materials for children, in most school centers in Spain, are based on a pedagogic model focused on the psychomotor development of children. The justification for the use of this type of model, according to said pedagogical perspective, is that there is not enough psychomotor development to perform more complex strokes (Sassoon, personal interview, March 21, 2008). Majchrzak (2004) considered that it forgets that the importance of the reading and writing actions is based on the development of intellectual skills and not of manual and handmade skills, in other words, based on the understanding of what is written (reading) and the creation of ideas (writing) and not on the reproduction of senseless letters.

The existence of a suitable typeface which could provide a greater degree of legibility in texts, could contribute to innovation and to the improvement in the way to reach the market, not only by companies which

products are mainly texts, such as editorial houses, but also by all companies developing products for children where reading understanding is a critical factor for the use of the same product.

Currently, within the literature, a validated typeface that shows legibility in texts, particularly those aimed towards dyslexic children in a Spanish-speaking context, has been found. Validated typefaces are focused on an English-speaking context (Sassoon, 1993; Reynolds, 2006; Walker, Reynolds, Robson, & Guggi, 2005; Hughes & Wilkins, 2002; Feely et al., 2005; Perera, 2003; Hillier, 2007, 2006).

Material and Methods

In this study, the test designed and validated to measure legibility in typefaces, was used (del Real, 2009). The test was applied, in an exploratory manner, by three experts on 10 children in age range from eight to 10 years old from the Autonomous Community of Madrid (six boys and four girls) diagnosed with dyslexia.

In a calmed space, suitable for reading (classrooms on the *Colegio Agora de Madrid*) each one of the children, in an individual fashion, was requested to read three sheets with texts of words, and three sheets with texts of pseudowords (both arranged without sense and in text format) one by one (Wilkins, Jeanes, Pumfrey, & Laskier, 1996). Each of the three sheets (words and pseudowords) had 40 words/pseudowords with a different typeface and with different words/pseudowords (to prevent a better reading due to practice and not the typeface). Figure 1 shows extracts of the test with the different typefaces. In the reading, two factors were taken into consideration: (1) Reading mistakes, according to the different theories on dyslexia (Peer, 2009), incurred by the children; and (2) Time taken to read each of the sheets (a maximum of 40 words/pseudowords in a maximum of 60 seconds). In order to confirm the mistakes and the time, the tests were recorded and later listened to. The data obtained in the tests were analyzed with the statistical Software *PASW Statistics 18.0*.

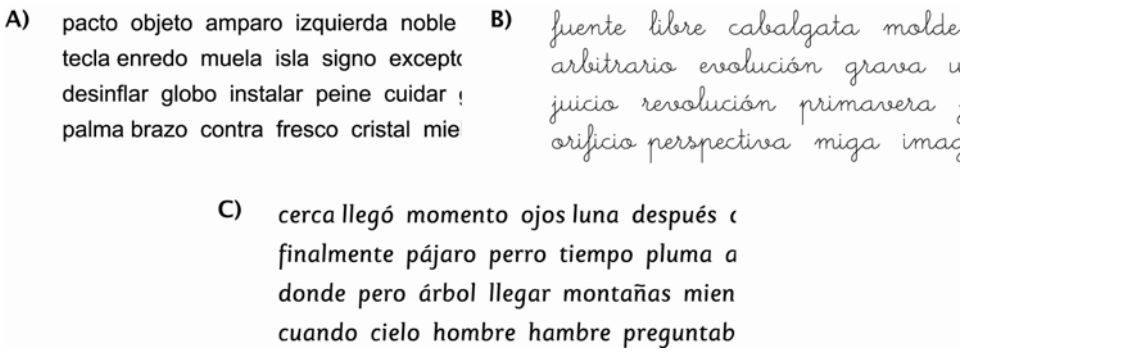

Figure 1. Extracts of the test performed with the three typefaces used in the study: (A) with *Arial* font; (B) with *Memimas* font; and (C) with *Dixy* font. The image is shown at a 50% scale in relation to the original.

Results

Reading Accuracy

As for the reading accuracy, the numbers of mistakes incurred by during the reading tests were:

(1) Reading of words and pseudowords with *Arial* font: In the reading of 40 words, a minimum of zero mistakes and a maximum of 13 were observed, resulting in an average of six mistakes. In the reading of 40 pseudowords in *Arial* font, a minimum of six mistakes and a maximum of 23 mistakes were observed, resulting in an average of 12 mistakes.

(2) Reading of words and pseudowords with *Dixy* font: In the reading of 40 words, a minimum of one

error and a maximum of eight mistakes were observed, resulting in an average of three mistakes. In the reading of 40 pseudowords in *Dixy* font, a minimum of two mistakes and a maximum of 15 mistakes were observed, resulting in an average of seven mistakes.

(3) Reading of words and pseudowords with *Memimas* typeface: In the reading of 40 words, a minimum of two mistakes and a maximum of 12 mistakes were observed, resulting in an average of seven mistakes. In the reading of 40 pseudowords in *Memimas* typeface, a minimum of five mistakes and a maximum of 18 mistakes were observed, resulting in an average of 10 mistakes (see Table 1).

Table 1

Mistakes Incurred Into During the Reading of Words and Pseudowords

	N	Minimum	Maximum	Average
Total number of mistakes incurred into *Arial* words	10	0	13	6
Total number of mistakes incurred into *Dixy* words	10	1	8	3
Total number of mistakes incurred into *MeMimas* words	10	2	12	7
Total number of mistakes incurred into *Arial* pseudowords	10	6	23	12
Total number of mistakes incurred into *Dixy* pseudowords	10	2	15	7
Total number of mistakes incurred into *MeMimas* pseudowords	10	5	18	10
N valid (according to list)	10			

Reading Speed

As for the reading speed, the number of words/pseudowords read in 60 seconds, according to each test, was:

(1) Word and pseudoword reading in *Arial* typeface: The number of words read during the reading test of 40 words with *Arial* typeface (see Table 2) was of 15 words minimum for 40 words maximum, which results in an average of a 36 words total. The minimum time in the reading of words was 26 seconds and the maximum was 60, resulting in an average of 49 seconds.

The number of pseudowords read during the reading test of 40 pseudowords with *Arial* typeface (see Table 3) was of 17 pseudowords minimum for 40 maximum, with an average of 32 pseudowords per test. The minimum time in the reading of pseudowords in *Arial* typeface was 44 seconds and the maximum was 60, resulting in an average of 57 seconds per test.

(2) Word and pseudoword reading in *Dixy* typeface: The number of words read during the reading test of 40 words with *Dixy* typeface (see Table 2) was of 22 words minimum for 40 words maximum, which results in an average of a 35 words total. The minimum time in the reading of words was 29 seconds and the maximum was 60, resulting in an average of 46 seconds.

The number of pseudowords read during the reading test of 40 pseudowords with *Dixy* typeface (see Table 3) was of 17 pseudowords minimum for 40 maximum, with an average of 32 pseudowords per test. The minimum time in the reading of pseudowords in *Dixy*typeface was 45 seconds and the maximum was 60, resulting in an average of 56 seconds per test.

(3) Word and pseudoword reading in *MeMimas* typeface: The number of words read during the reading test of 40 words with *MeMimas* typeface (see Table 2) was of 16 words minimum for 40 words maximum, which results in an average of a 34 words total. The minimum time in the reading of words was 25 seconds and the maximum was 60, resulting in an average of 51 seconds.

The number of pseudowords read during the reading test of 40 pseudowords with *MeMimas* typeface (see Table 3) was of 15 pseudowords minimum for 40 maximum, with an average of 32 pseudowords per test. The

minimum time in the reading of pseudowords in *MeMimas* typeface was 50 seconds and the maximum was 60, resulting in an average of 58 seconds per test.

Table 2

Words Read and Reading Time During the Word Reading Test

	N	Minimum	Maximum	Average
Number of words read in *Arial* typeface	10	15	40	36
Number of words read in *Dixy* typeface	10	22	40	35
Number of words read in *MeMimas* typeface	10	16	40	34
Time in seconds read of the sheet with words in *Arial* typeface	10	26	60	49
Time in seconds read of the sheet with words in *Dixy* typeface	10	29	60	46
Time in seconds read of the sheet with words in *MeMimas* typeface	10	25	60	51
N valid (according to the list)	10			

Table 3

Words Read and Reading Time During the Pseudoword Reading Test

	N	Minimum	Maximum	Average
Number of pseudowords read in *Arial* typeface	10	17	40	32
Number of pseudowords read in *Dixy* typeface	10	17	40	32
Number of pseudowords read in *MeMimas* typeface	10	15	40	32
Time in seconds read of the sheet with pseudowords in *Arial* typeface	10	44	60	57
Time in seconds read of the sheet with pseudowords in *Dixy* typeface	10	45	60	56
Time in seconds read of the sheet with pseudowords in *MeMimas* typeface	10	50	60	58
N valid (according to the list)	10			

Discussion

The results obtained in this exploratory research indicate that the letter font types used in texts for dyslexic children may influence the reading. In spite of the fact that *Dixy* was unknown to children, the results throw evidence that this letter font, compared to the *Arial* and to the *MeMimas*, is the one with which dyslexic children make the least mistakes in word and pseudoword reading (reading accuracy). As for the reading speed, the research could indicate that *Arial* is the typeface which could favor reading speed, followed closely (one-second difference) by *Dixy* and *MeMimas*. It is important to point out that *Arial* is a typeface widely known by children and that *Dixy* is a typeface never before seen by children; therefore, the difference in reading speed between these two typefaces indicates that texts in *Arial* could have been more rapidly read due to the knowledge on the letter font type and not to the letter font type which due to its graphic characteristics in its shapes, favors reading speed. *Memimas* is the typeface with which children make a greater number of mistakes when reading words; furthermore, it is the typeface that takes them longer to read both in words as well as in pseudowords text reading in comparison with *Arial* and *Dixy*.

Conclusions

With these results and still taking into consideration their exploratory value due to the reduced number of cases, it is possible to conclude that clear evidence that dyslexic children: (1) could make more mistakes in the reading of texts with graphical characteristics shown by cursive typefaces; and (2) typefaces designed or modified specifically to fulfill legibility needs present in reading by children (such as the *Dixy*) could contribute

to reading improvement for children with reading difficulties, has been identified.

It is important to mention that the use of a suitable typography, such as *Dixy*, could significantly contribute to innovation and to the improvement in the way to reach the market, not only by companies which products are mainly texts, such as editorial houses, but also by all companies developing products for children where reading understanding is a critical factor for the use of the same product.

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