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Typefaces that make reading easier for dyslexic people

SUMMARY

Worldwide, around 10% of people have dyslexia, a neurological disability that impairs a person's ability to read and write. There is evidence that the typographic presentation of the written document has a significant effect on a text's accessibility for people with dyslexia. One of the most significant factors that affects readability of the text is a typeface and/or its variations. In this paper, we present the reading process from neurophysiological and psycholinguistic perspectives. Though dyslexia is primarily related to deficits in phonological processing, the visual processing disorders also have an impact on reading. So we present simulations of visual distortions that help imagine what the printed text looks like for many people suffering from dyslexia. In the second part of the paper we present a set of common typefaces that are friendly for dyslexics and selected font types designed specifically for people with dyslexia.

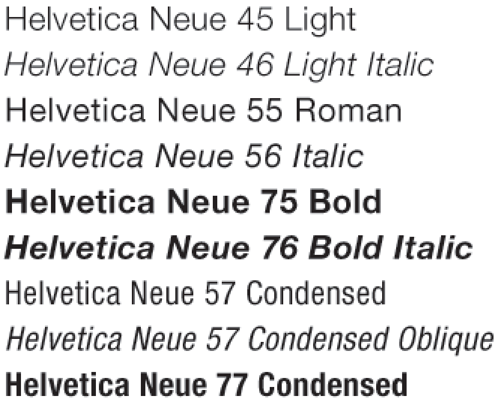
Keywords: dyslexia, typefaces, readability, legibility, eye-tracking research

INTRODUCTION

Characters used in writing, i.e. letters, digits, ideograms, special symbols, etc., receive their unique shape in typography through typefaces. Individual typefaces are characterised by uniform graphic characteristics: style, rhythm (regular repetition of the strokes in letters and spaces between them), proportions, the presence or absence of sheriffs (transverse or oblique lines which finish the letters) as well as their composition or shape. Each typeface has a name (e.g. Avant

Garde, Bodoni, Garamond, Helvetica, Optima, Times New Roman, Univers) and is a copyright-protected work (cf. Wolański 2008).

Individual typefaces have their varieties, often significantly different from one another, yet they always have common graphic and structural elements. A variety of a typeface differs from the other varieties in terms of sloping, width and thickness. Some typefaces, such as Romantiques, are designed in one variant only while others have many varieties, e.g. Helvetica, which has more than 40 of them (cf. Fig. 1).



Helvetica Neue 45 Light

Helvetica Neue 46 Light Italic

Helvetica Neue 55 Roman

Helvetica Neue 56 Italic

Helvetica Neue 75 Bold

Helvetica Neue 76 Bold Italic

Helvetica Neue 57 Condensed

Helvetica Neue 57 Condensed Oblique

Helvetica Neue 77 Condensed

Figure 1. Sample varieties of typefaces in the Helvetica Neue family
Source: *Helvetica* (2016)

Typographic writing, externalised in a specific typeface and its variations, marks the beginning of reading, which is a complicated cognitive process involving the reception of linguistic and paralinguistic information through the sense of sight. Therefore, typographic readability of writing and the legibility of its characters, as well as the process of reading as such, became the subject of systematic research and experiments towards the end of the 19th century, although the first attempts in this area can be traced back even to the 18th century.

Around 1790, Jean Anisson, the Director of the Imprimerie Nationale in Paris, undertook the first study on the readability of writing. Experiments in this area were also conducted by some ophthalmologists: Herman L. Cohn in Austria, and Louis Émile Javal in France. Based on his observations, the latter identified two distinctive actions of the eyeball: fixations, i.e. moments when the gaze is fixed at one point, and saccades, or skips to the next part of the text (Javal 1879). In the last decade of the 19th century, Edmund Landolt, a Swiss ophthalmologist, noticed that eyeball movements differed, depending on the language of the text being read.

At the turn of the 19th and 20th century it was proved that the processing of text-based information occurs mostly during fixations. In 1922, Charles H. Judd and Guy T. Buswell described fixations observed during an experiment and their duration (Judd and Buswell 1922). In the early 1930s, large-scale studies on the process of reading and readability of printed text were carried out in the USSR, in a number of Moscow research centres: the OGIZ Scientific-Research Institute (Association of State Publishers), the Scientific-Research Institute of Printing and the Scientific-Research Institute of Psychology (under the leadership of V.A. Artemov).

All of these observations and experiments paved the way to modern research on visual perception, readability of writing, reading speed and cognitive processes occurring when people read a text or view a static or moving image. Currently, eye-tracking or saccadic measurements are carried out in almost all areas of science: in the humanities, e.g. in literary studies (cf. Mastalski 2015) and translation studies (cf. Płużyczka 2011, 2012), in social science, e.g. in education (cf. Nowakowska-Buryła and Joński 2012; Błasiak et al. 2013; Rożek 2014) and in medical sciences, for example in neurology (e.g. Ober et al. 2009; Borys 2015).

PHYSIOLOGICAL, PSYCHOLOGICAL AND NEUROLOGICAL ASPECTS OF READING

The act of reading as a linguistic communication activity takes two principal forms: silent reading (reception of graphic characters) and reading aloud (reception of graphic characters followed by transformation into sounds). Reading aloud for oneself and for others was a common practice until the 18th century. It was used to spend free time in the family (e.g. between spouses) and in a social group (e.g. in the army). It also strengthened ties between people. Silent reading became widespread at the turn of the 19th century. Initially, silent reading proceeded differently, depending on the person's education. During silent reading, ordinary readers moved their lips slightly, and/or pronounced the text to be able to understand it. Educated people would read quietly with their mouth closed (Chartier 1999: 132–133). Today, thanks to widespread literacy, reading has become a common skill.

The process of reading can be analysed on many levels: physiological, psychological, psycholinguistic or, finally, neurological. In 1879, the French ophthalmologist Louis Émile Javal noticed that eyes did not move continuously along the text being read but, instead, moved in leaps. He called those rapid leaps of sight 'saccades' (French: *le mouvement saccadé*). Moreover, he established that the saccadic movement of the eye was ballistic in nature, i.e. it was impossible to change its direction between the start and the stop (after: Huey 1968). With saccades, the gaze moves to subsequent text fragments, and then fixes on a particular chunk of text after each saccade. When reading texts in Latin alphabet, saccades run from left to right (whereas in Hebrew and Arabic they run in the opposite direction) and fixations do not overlap with the boundaries of orthographic words (cf. Fig. 2).

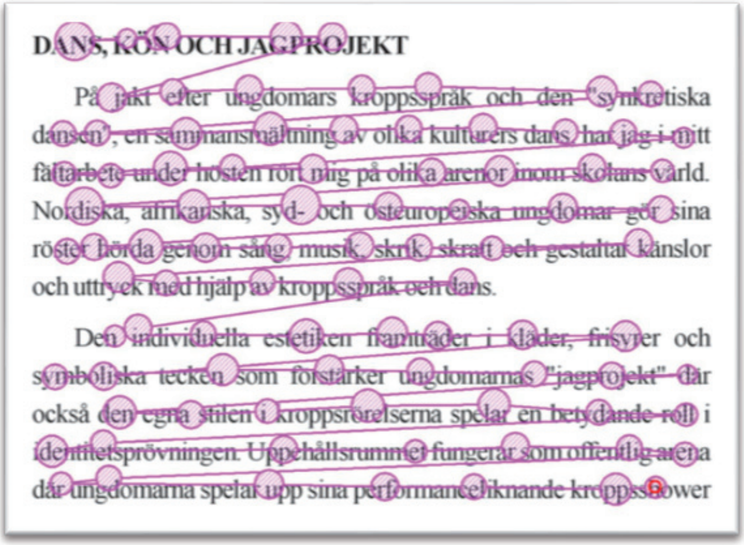


Figure 2. A typical distribution of saccades and fixations during the process of reading
Source: *Eye tracking* (2016)

The average length of a saccade spans 7–9 letters. Marcel A. Just and Patricia A. Carpenter (1987) experimentally proved that the area of text that the reader is able to cover with a single fixation depends on the difficulty of the text. For example, when reading fairly easy texts, such as popular science articles from ‘Newsweek’ or ‘Time’ magazines, college students covered an average of 1.2 words during a single fixation. Research on the English language also found that fixations fell on 67.8% of words occurring in a text (Paulson and Goodman 1999). Most authors agree that fixations fall on approx. 80–85% of content words and approx. 35–40% of structure (functional) words in English (cf., e.g., Grabe 1991; Rayner 1998, Paulson and Goodman 1999; Richardson and Spivey 2008).

The reader’s gaze may also move in the direction opposite to the one determined by the alphabet. These movements are called regressive saccades, or regressions. Eyeball movements to the left within the same line of text or to the previous lines represent 10–15% of all saccades (Rayner 1998; Richardson and Spivey 2008). Regressions occur when recipients struggle to understand the word they have just read or when they want to double-check the general meaning of the text they are reading.

In addition to fixations, the process of reading also involves the so-called refixations, i.e. additional fixations on the same word. Refixations fall on approx. 15% of words in a text. As a rule, the underlying reason is that the word was insufficiently processed during the first fixation.

Experiments on reading speed were carried out already in the first half of the 20th century. The pioneers in this field included U.S. researchers Charles H. Judd and Guy T. Buswell (1922) as well as Miles A. Tinker and Donald G. Paterson (Paterson and Tinker 1928, 1929ab, 1931abc 1932; Tinker 1955, 1965, Polish edition 1980). However, the real breakthrough in this field came with the combination of eye-tracking research with digital techniques. Computers enable very accurate measurements of where the reader's gaze is focused and for how long. Research of this kind, conducted by Marcel A. Just and Patricia A. Carpenter (1980), showed that the average duration of a saccade during the reading process ranged from 10 to 20 milliseconds, and the duration of a fixation was variable, amounting to an average of 250 milliseconds. Similar results can also be found in other sources (cf., e.g., Rayner 1998; Richardson and Spivey 2008).

Just and Carpenter (1987) calculated the average reading rate for a moderately difficult text for ordinary readers, such as students participating in their experiment, obtaining a value of 240 words per minute. Other studies have demonstrated that the reading rate for an uncomplicated text reached 500 words per minute for a person skilled in speed reading (two words per a single fixation) (Smith 1971). According to other calculations, the maximum speed of the so-called 'integral reading' ('word for word') of an English text may reach 750–800 words per minute. During a single fixation, readers need to cover about 20 letters with their gaze, and the average fixation time must amount to 250 milliseconds. Any faster integral reading would exceed human physiological capabilities (Nagy, Herman and Anderson 1985).

As proven by neurophysiological research, the cognitive processing of a text is only possible for the fragment of a text which goes to the centre of the macula lutea of the retina (Latin: *fovea centralis*), located in the posterior pole of the eyeball. The human brain does not focus on the entire physically available field of view but, instead, selects only those fragments whose image is formed in the area of the retina which is best-equipped with photoreceptor cells (Lindsay and Norman 1991.

As proven by the research conducted by David H. Hubel and Tornsten Wiesel (1981 Nobel Prize winners recognised for discoveries concerning information processing in the visual system), the image of reality recorded by humans, including letters, does not reach the cerebral cortex in the same form as the form that goes to the retina. In the upper hills (*superior collicula*), the image of each letter is first decomposed into constituents: straight lines (horizontal, vertical and diagonal) and curves. The fragmented image is sent to the cerebral cortex where it is put together again. The visual cortex, which is the last element of the visual pathway, is connected with two channels of the brain: macrocellular and microcellular. The latter is used to transfer smaller and finer shapes, such as letters (Bednarek 1999; Vetulani and Cieśliński 2011).

During a fixation, a fragment of text is perceived (perceptual encoding phase) and its meaning is sought in the reader's mental dictionary (lexical access phase). In the 1980s, Marcel A. Just and Patricia A. Carpenter (1987) formulated the so-called eye-mind hypothesis, which assumes that there are no significant delays between the two phases, i.e. the cognitive system has access to the perceptually encoded visual information almost immediately after gaze starts to fixate on a particular section of text. With reference to that hypothesis, Ida Kurcz and Anna Polkowska used the following phrase: 'hypothesis on the immediate information transfer from eye to mind' (Kurcz and Polkowska 1990: 46). In the course of their experiments, Just and Carpenter (1987) found that perceptual encoding takes 50 milliseconds whereas the remaining time of a fixation (i.e. an average of approx. 200 milliseconds) is devoted to lexical access or, in other words, to finding the respective word in the reader's mental dictionary.

There are many issues where authors of psychological or psycholinguistic descriptions of the act of reading do not take a firm stance. For instance, it is not known whether words are recognised through access to subverbal representations (features of letters, letters), or through representations of the entire word in the reader's mental dictionary. According to Frank Smith (1971), the only representations which relate to printed words are the characteristics which define letters in a specific word (straight lines and curves, angles, etc.). According to this researcher, letters have their distinct functional characteristics which enable us to recognise a word printed with different typefaces and/or different typeface varieties as the same word each time (cf. Fig. 3).

Figure 3. By referring to the attributes defining letters in a particular word (straight lines and curves, angles, etc.), we can read a word printed with different typefaces and different typeface varieties

Source: Authors' own work based on: F. Smith (1971)

According to another hypothesis, the units of recognition are letters in the word, not the characteristics that constitute those letters (Healy 1981). The phenomenon of the so-called ‘word superiority’ has also been proven. It means that a letter occurring in an existing word (e.g. the letter *r* in the word *work*) is more readily recognised than the same letter occurring in a sequence which does not represent a word (e.g. *bcapr*) or in isolation (Reicher 1969).

A proof to support the claim that words have integrating perceptual properties going beyond the constituent letters can be found in a simple experiment: a text consisting of words with a scrambled letter order does not lose much of its readability. It is enough to retain the first and the last letter in the scrambled word and to make sure that the scrambled word contains all the letters, i.e. has the same length as the original word (cf. Fig. 4) (Vetulani and Cieśliński 2011).

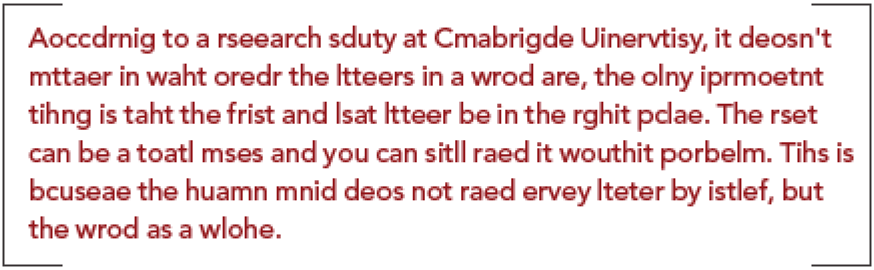


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Figure 4. An experimental proof that words have integrating perceptual properties that go beyond their constituent letters

Source: Scrambled Text (www.brainhq.com/brain-resources/brain-teasers/scrambled-text)

This experiment also indicates that the identification of a word in the course of reading does not occur on a letter-by-letter basis but, instead, happens as a result of parallel (simultaneous) processing. According to Dominic W. Massaro (1975), in order to facilitate the perception of letters which have not been fully processed (for example, letters in the middle of a word), we rely on implicit knowledge and orthographic redundancy.

Moreover, neither psychologists nor psycholinguists have provided a clear answer to the question of whether images of words are identified via direct access to their meanings in the reader’s mental dictionary or whether such access is mediated phonologically. The visual strategy, called ‘Chinese’ by analogy to the morphemic Chinese writing system, assumes that the reader uses the graphic image of a word as an iconic code that opens meanings in the mental dictionary (Treiman and Baron 1981). In turn, the phonological strategy, called ‘Phoenician’ by reference to the creators of the alphabet based on the grapheme-phoneme correspondence (GPC), posits that the substance of a word must be processed from the graphic to the phonemic form in order to reach the meaning (Venezky 1970;

Baron and Strawson 1976). Moreover, it cannot be excluded that the above-described mechanisms for identifying meaning can be applied in the reading process in respect of different text elements (Jorm 1985).

In addition to all of the controversies described above, one must consider one general problem, namely that it is not clear whether word recognition is an ascending process (stimulus-driven) or a descending process (context-driven). According to the concept which views reading as an ascending (bottom-up) process, readers analyse visual stimuli individually and sequentially, which enables them to recognise the meaning of subsequent elements of the text until the entire phrase has been understood (Johnson 1977). The concept which views reading as a descending (top-down) process assumes that readers use several stimuli to formulate hypotheses about the text they see. Therefore, further reading is a function of expectations formed on the basis of the knowledge about the world and language, and reader's experience. For instance, it is easy to supply the missing element in the following sentence: *The cat hunted down*_____ (Smith 1971). Other researchers describe reading as an interactive process involving various skills and types of knowledge: automatic recognition skills, vocabulary and structural knowledge, formal discourse structure knowledge, content/world background knowledge, synthesis and evaluation skills/strategies, and metacognitive knowledge and skills monitoring (cf. Grabe 1991: 379).

VISUAL PERCEPTION OF TEXT IN DYSLEXIA

Many definitions of dyslexia, including the popular definition published in 1994 by the International Dyslexia Association (previously The Orton Dyslexia Society), contain a statement that specific difficulties in reading and writing involve, among others, 'difficulties in decoding individual words, which usually reflect insufficient phonological processing skills' (after: Bogdanowicz 1997: 149). For many years, research focused exclusively on finding and proving disorders of the phonological subsystem in patients with dyslexic problems – see, for instance, comments to the test tasks in the guide to the diagnostic tool entitled *Diagnoza dysleksji u uczniów klasy III szkoły podstawowej* [Diagnosing dyslexia in 3rd grade primary school students] (Bogdanowicz et al. 2008). Meanwhile, neurophysiological studies have shown that dyslexic problems are caused to an equal extent by irregularities in the structure and functioning of macro- and microcellular brain channels in the visual system (cf. Bednarek 2002; Vetulani and Cieśliński 2011). Damage in the microcellular pathway, which is designed to transfer smaller and more subtle shapes such as letters, is responsible for problems in visual information processing, such as the confounding of letters <v> and <y> (Vetulani and Cieśliński 2011).

The results of experimental studies coincided with the observations made during a speech therapy practice (cf. e.g. Korendo 2011). According to Marta Korendo, diagnostic and therapeutic practice can easily reveal evidence of impaired visual perception, usually consisting in ‘confounding similar letters (while reading, rewriting and writing), skipping lines of text while reading, ignoring the left side of the space, changing the order of characters in texts while reading, skipping diacritics, problems with reading short words, difficulty in finding words and passages in a text that has been read [...]’ (Korendo 2011: 117–118). For example, cases of confounding letters <b, p> can serve as evidence for problems with the processing of auditory information (failure to recognise the opposition between voiced and voiceless consonants) and for impaired visual processing (incorrect analysis of images rotated in space), yet the confounding of letters <u, n> clearly indicates a problem with visual perception (examples after: Korendo 2011: 118).

Evidence of impaired visual perception is also provided by adult dyslexics. Sam Barclay, a dyslexic British graphic designer and typographer, has written a book entitled *I Wonder What It’s Like to be Dyslexic*, where he vividly shows how the brain of a dyslexic person distorts the text while reading.

A simulation of the most common text distortions is also shown by Toni-Lee Capossela (1998). This work presents, among others, the confluence of a series of adjacent words, an incorrect perception of letters which represent spatial variations of a single character (e.g. <d, b, p, q>) or the movement of some letters above or below the baseline of written text (cf. Fig. 5).

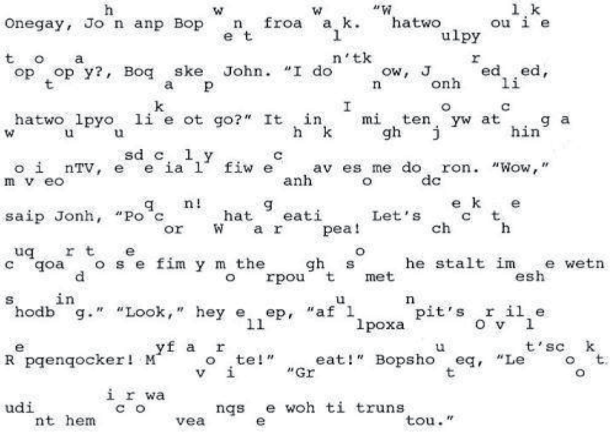


Figure 5. A simulation showing how text is transformed when perceived by a dyslexic person
Source: T.-L. Capossela (1998: 98)

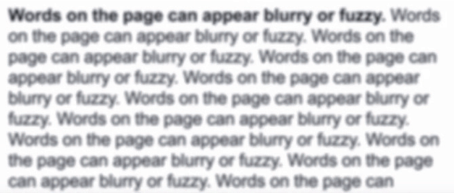
The deformed visual perception of text seems to be confirmed by the eye movements recorded during the process of reading. In eye-tracking studies conducted by Maria Pia Bucci et al. (2012), saccades and fixations were recorded during the process of reading and word search in a text. The study involved three children: an 11-year-old child with dyslexia, and 9- and 11-year-old children without dyslexia. The study found that the dyslexic child had more fixations and regressions. The eye movements of the 9-year-old without dyslexia were less accurate than those of the non-dyslexic 11-year-old but were nevertheless much more precise than the eye movements of the 11-year-old child with dyslexia (cf. Fig. 6). The saccades and eye fixations of a dyslexic child very often run above or below the actual boundaries of the text, which may indicate that the dyslexic brain tries to locate writing in places where no writing is actually present.

Figure 6. Comparison of eye movements for a dyslexic and a non-dyslexic child
Source: M.P. Bucci et al. (2012)

The occurrence of saccadic movement disorders in people with dyslexia has been also confirmed by other researchers (e.g. Pavlidis 1985; Rosenbloom and Morgan 1990; Adamczak 2011; Adamczak, Nagalewska and Miśkowiak 2012). They have demonstrated that these movements are characterised by a reduced accuracy of saccades, a longer response time of a saccade and an increased number of regressive saccades, both while reading and during other activities which involve the visual system. Research carried out in Poland has shown that approx. 40–45% of children diagnosed with dyslexia have problems passing a test checking saccadic movements (Adamczak 2011: 90; Adamczak, Nagalewska and Miśkowiak 2012: 711).

Most researchers believe that the malfunction of saccadic movements coexists with dyslexia and is an effect rather than a cause of dyslexia. A dyslexic person who has difficulty understanding the meaning of a written text must return to earlier passages more frequently, which creates the impression of irregular saccadic movements (cf. e.g. Evans, Drasdo and Richards 1996).

Dyslexia and the Meares-Irlen syndrome, also known as visual stress, are two different disorders. Nevertheless, as indicated by various estimates, between 10% and even 60% of dyslexic persons are affected by a wide range of visual stress symptoms (Evans 2001; Wilkins 2003). Evenly printed lines of text cause discomfort and inability to concentrate. The visual perception of text becomes distorted: words become fuzzy or blurred (cf. Fig. 7a), some letters become erased (cf. Fig. 7b), letters and words overlap, creating a halo effect (cf. Fig. 7c), letters bend, creating the effect of a waving line of printed text (cf. Fig. 7d), some letters and words move closer whereas others move away from one another, creating vertical corridors (cf. Fig. 7e), letters rise and fall, creating a wave effect (cf. Fig. 7f), the text forms a three-dimensional convergent perspective (cf. Fig. 7g), or blurred text begins to spin around a central point with a correct focus (cf. Fig. 7h).



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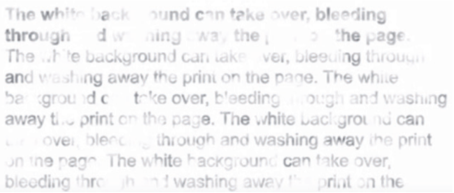

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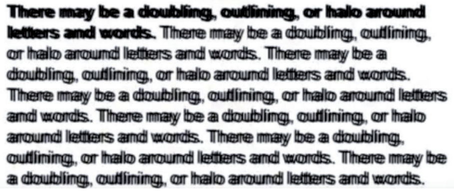

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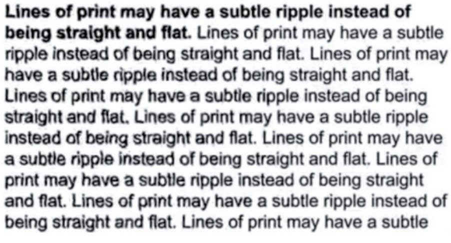

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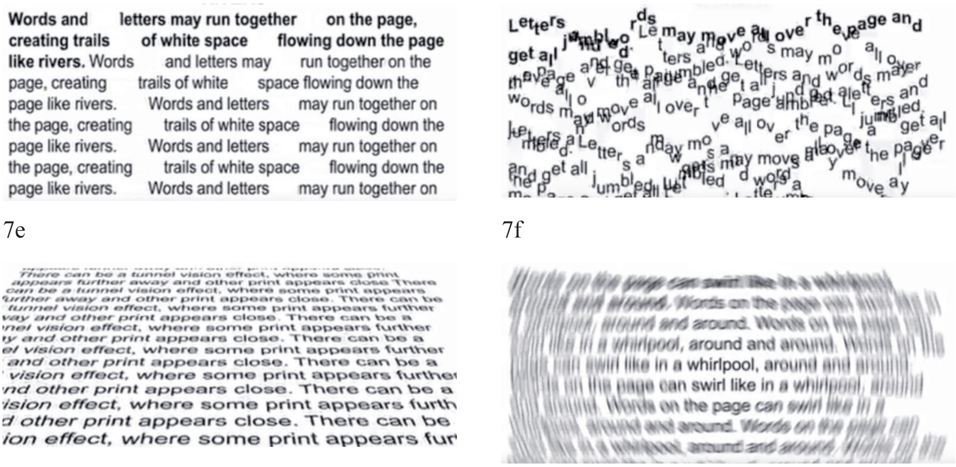


7e 7f

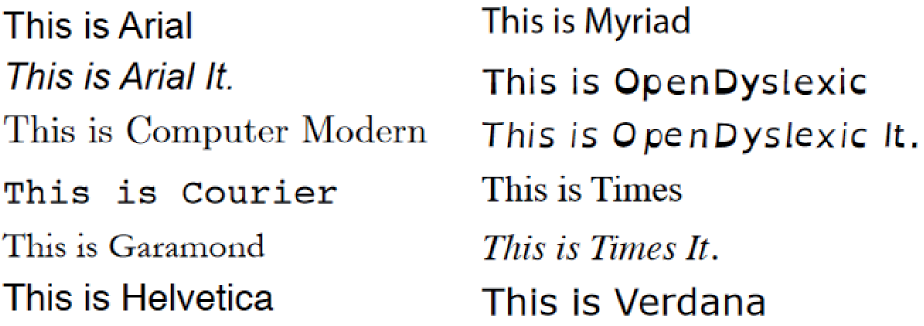
7g 7h

Figure 7a–h. Text distortions during reading as a symptom of visual stress
Source: Irlen Institute (2013)

Contemporary advanced eye-tracking methods as well as the knowledge of visual perception disorders in people with dyslexia allow, on the one hand, to identify dyslexia-friendly typefaces among the typefaces that are in common use and, on the other, to design special typefaces which take into account the singularities of text perception by people affected by this disorder.

STANDARD TYPEFACES WHICH ARE DYSLEXIA-FRIENDLY

In 2013, Luz Rello and Ricardo Baeza-Yates conducted a comprehensive eye-tracking study in Spain involving the most popular typefaces used in various publications (Rello and Baeza-Yates 2013). Their analysis covered nine typefaces (some of them in two versions), of which eight were standard typefaces and one was specifically designed for people with dyslexia (OpenDyslexic, in a straight and cursive style). In total, the experiment analysed twelve variants of typefaces: Arial, Arial Italic, Computer Modern Unicode (CMU), Courier, Garamond, Helvetica, Myriad, OpenDyslexic, OpenDyslexic Italic, Times, Times Italic and Verdana (cf. Fig. 8).



This is Arial
This is Arial It.
This is Computer Modern
This is Courier
This is Garamond
This is Helvetica
This is Myriad
This is OpenDyslexic
This is OpenDyslexic It.
This is Times
This is Times It.
This is Verdana

Figure 8. Typeface variants analysed by Luz Rello and Ricardo Baeza-Yates in their experiment

Source: Authors' work based on: L. Rello and R. Baeza-Yates (2013: 2)

The experiment was conducted with the participation of 48 subjects (22 women and 26 men) officially diagnosed with dyslexia (yet without diagnosed problems with visual acuity). Their ages ranged from 11 to 50. During the study, all the subjects were asked to read 12 texts typeset with 12 variants of typefaces. The texts represented the same genre and the same stylistic variation, and consisted of 60 words each (the average word length ranged from 4.92 to 5.87 characters). The texts did not contain any numeric expressions written with digits or any abbreviations (acronyms). Three parameters were measured: the total time taken to read the text (in seconds), the total time of all fixations (in seconds) and participants' preferences with regard to specific typefaces (on a five-point Likert scale).

It was assumed that the preferred outcome was the shortest possible time needed to read the text. However, the aim was not to achieve mechanical reading but, instead, reading comprehension. After completion of the reading task, the subjects were tested for text comprehension. Fixation time was an equally important criterion for the readability of a typeface. It was assumed that the shorter the fixation time, the better the readability of the text since a longer fixation time may indicate problems with image processing. In addition, the participants were given an opportunity to express their own preferences with regard to each of the tested typefaces.

The experiment showed that the shortest reading time and the shortest fixations were achieved with the widely available sans-serif typefaces in the straight variation (Helvetica, Arial, Verdana), the specifically designed typeface called OpenDyslexic (sans serif, the straight variation) and Courier (monospaced serif fonts). On the other hand, serif typefaces and/or cursive variations performed worse in the study. Detailed results of the experiments are shown in Table 1.

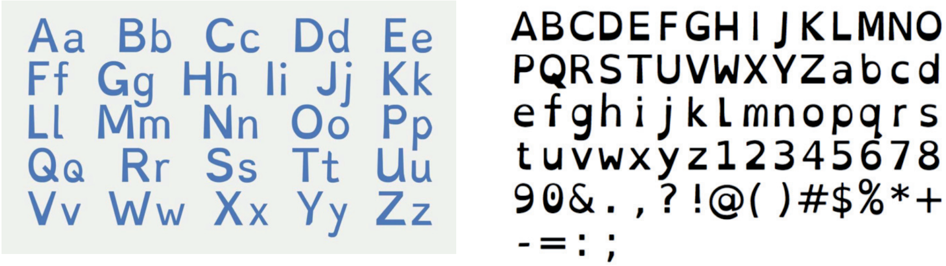
Table 1. Results of an experimental study on readability of 12 variants of typefaces

Font Type	Reading Time [s]			Font Type	Fixation Duration [s]		Font Type	Preferences Rating	
	Median	Mean and standard deviation	%*		Median	Mean and standard deviation		Median	Mean and standard deviation
Arial	24.22	28.35 ± 12.39	100	Courier	0.22	0.22 ± 0.05	Verdana	4	3.79 ± 0.98
OpenDyslexic	23.81	29.17 ± 15.79	103	Verdana	0.22	0.23 ± 0.07	Helvetica	4	3.62 ± 1.08
Modern	26.06	29.58 ± 12.05	104	Helvetica	0.24	0.24 ± 0.06	Arial	4	3.60 ± 1.13
Courier	29.73	29.61 ± 10.87	104	Arial	0.23	0.24 ± 0.07	Times	4	3.45 ± 1.15
OpenDyslexic It.	25.44	29.68 ± 14.44	105	Times	0.24	0.25 ± 0.07	Myriad	3.5	3.40 ± 0.99
Helvetica	27.18	31.05 ± 15.04	109	Myriad	0.25	0.25 ± 0.07	Modern	3	3.31 ± 0.98
Verdana	28.97	31.16 ± 13.03	110	Times It.	0.25	0.26 ± 0.06	Courier	3	3.14 ± 1.39
Times	29.30	31.68 ± 11.81	112	OpenDyslexic	0.24	0.26 ± 0.07	Arial It.	3	2.90 ± 1.10
Times It.	28.55	32.38 ± 12.34	114	OpenDyslexic It.	0.26	0.26 ± 0.07	Times It.	3	2.86 ± 1.20
Myriad	26.95	32.66 ± 14.80	115	Garamond	0.25	0.27 ± 0.07	Garamond	2	2.57 ± 1.15
Garamond	30.53	33.30 ± 15.45	117	Modern	0.25	0.27 ± 0.08	OpenDyslexic	3	2.57 ± 1.15
Arial It.	29.68	34.99 ± 16.60	123	Arial It.	0.28	0.28 ± 0.08	OpenDyslexic It.	2	2.43 ± 1.27

* We include the relative percentage for Reading Time, our main readability measure, with respect to the smallest average value, Arial.

TYPEFACES DESIGNED SPECIFICALLY FOR PEOPLE WITH DYSLEXIA

Over the last decade, a least seven different typefaces were specifically designed for people with dyslexia: Lexia Readable by Keith Bates (2006), Sylexiad by Robert Hillier (2006), Gill Dyslexic and Dyslexie by Christian Boer (2008), Read Regular by Natascha Frensch (2008), OpenDyslexic by Abelardo Gonzalez (2011) and the Polish Doferm by Marcin Kasperek (2013). Among them, Dyslexie (cf. Fig. 9a) and OpenDyslexic (cf. Fig. 9b) have gained the greatest popularity.



9a 9b

Figure 9ab. Two most popular typefaces designed specifically for people with dyslexia
Source: dyslexiefont.com, opendyslexic.org

Designed in 2008 by Christian Boer, A Dutch graphic artist, Dyslexie is a sans-serif typeface in four varieties: straight (antiqua), inclined (italic), bold, and bold inclined. The designer's main aim was to create a typeface where individual letters would be easiest to distinguish from one another. According to Boer, who is dyslexic himself, the main problem with reading for dyslexic people consists in their inability to distinguish between similar letters, formed by the duplication of morphological elements, such as strokes in letters <v, w> or <i, j>, or those which are mirror images of other letters, such as <p, b, d, q> (cf. Fig. 10).

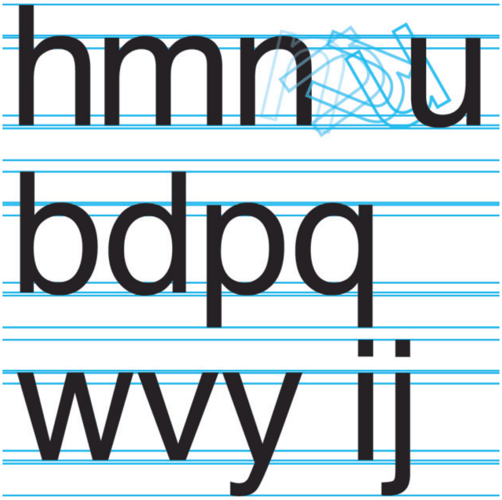


Figure 10. Morphological similarity of letters in standard typefaces
Source: dyslexiefont.com

In Dyslexie, letters are strongly thickened at the bottom. They support imagination by ‘adding weight’ to the characters in order to prevent them from reversing, rotating or ‘flying away’ (cf. Fig. 11a). The axis in certain letters (e.g. <i, j, l>) is more inclined, which brings them closer to handwritten characters and, thus, easier to distinguish (cf. Fig. 11b). The openings in letters are suitably wide, which is intended to improve their readability (cf. Fig. 11c). Similar-looking letters (e.g. <v, w, y>) were designed with different heights to maximise their distinctiveness (cf. Fig. 11d). Unsymmetrical arcs were introduced to augment the difference between ‘twin characters’. In the case of <b> and <d>, the arcs are slightly cut: at the bottom in the former and at the top in the latter (cf. Fig. 11e). The upper and lower extensions of letters were significantly increased in comparison with standard typefaces to enhance their shapes and to increase the distinctiveness of individual characters (cf. Fig. 11f). The greater-than-standard x-height (the difference between the baseline and central line of the letter) also improves the distinctiveness of characters without upper and lower extensions (cf. Fig. 11g). In order to improve the readability of entire sentences and components of complex utterances, capital letters as well as punctuation marks dividing and ending the sentence were enlarged and thickened (cf. Fig. 11h). Letter spacing and word spacing was enlarged in comparison to standard typefaces in order to prevent adjacent letters and words from merging (cf. Fig. 11i).

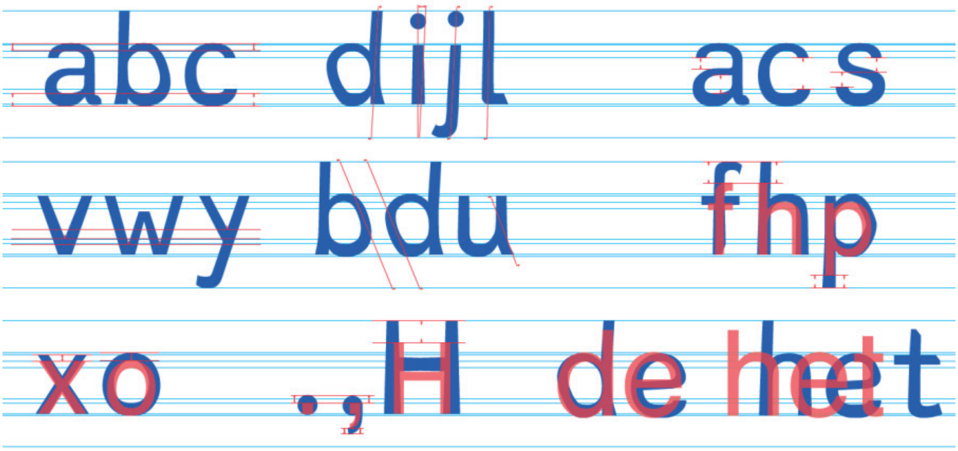
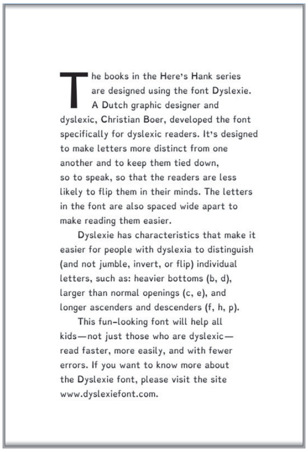


Figure 11a–i. Dyslexie was designed to enable readers to distinguish between letters as easily as possible

Source: dyslexiefont.com

Dyslexie was subjected to a number of independent studies. For example, a relatively large group of children aged 8 to 12 was tested during the experiments conducted by Tineke Pijpker from the University of Twente in the Netherlands. The experimental group consisted of 22 children with dyslexia whereas 42 children represented the control group. In addition, each group was subdivided by reading fluency (higher and lower levels of proficiency). The content of text read by the children was tailored to their age. Each child read a text typeset in Dyslexie and in Arial (on a white and yellow background). The researchers measured the reading speed and the number of errors made in the course of reading. As regards speed, no statistically significant differences were found with regard to the typeface and background. However, the group of dyslexic children with lower levels of reading proficiency made significantly fewer errors when reading a text in Dyslexie (cf. Pijpker 2013: 18–27).

Dyslexie is used many countries to typeset children's books, for instance in the 'Here's Hank' series by Henry Winkler and Lin Oliver. Each of the books from this series contains a page with an explanation that the publication was typeset with a special typeface for dyslexics, which is also easy to read for non-dyslexic children (cf. Fig. 12ab).

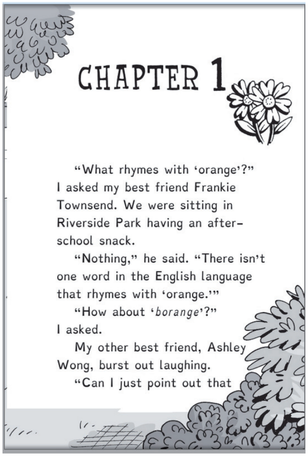


The books in the Here's Hank series are designed using the font Dyslexie. A Dutch graphic designer and dyslexic, Christian Boer, developed the font specifically for dyslexic readers. It's designed to make letters more distinct from one another and to keep them tied down, so to speak, so that the readers are less likely to flip them in their minds. The letters in the font are also spaced wide apart to make reading them easier.

Dyslexie has characteristics that make it easier for people with dyslexia to distinguish (and not jumble, invert, or flip) individual letters, such as: heavier bottoms (b, d), larger than normal openings (c, e), and longer ascenders and descenders (f, h, p).

This fun-looking font will help all kids—not just those who are dyslexic—read faster, more easily, and with fewer errors. If you want to know more about the Dyslexie font, please visit the site www.dyslexiefont.com.

12a



CHAPTER 1

“What rhymes with ‘orange’?” I asked my best friend Frankie Townsend. We were sitting in Riverside Park having an after-school snack.

“Nothing,” he said. “There isn't one word in the English language that rhymes with ‘orange.’”

“How about ‘*borange*’?” I asked.

My other best friend, Ashley Wong, burst out laughing.

“Can I just point out that

12a

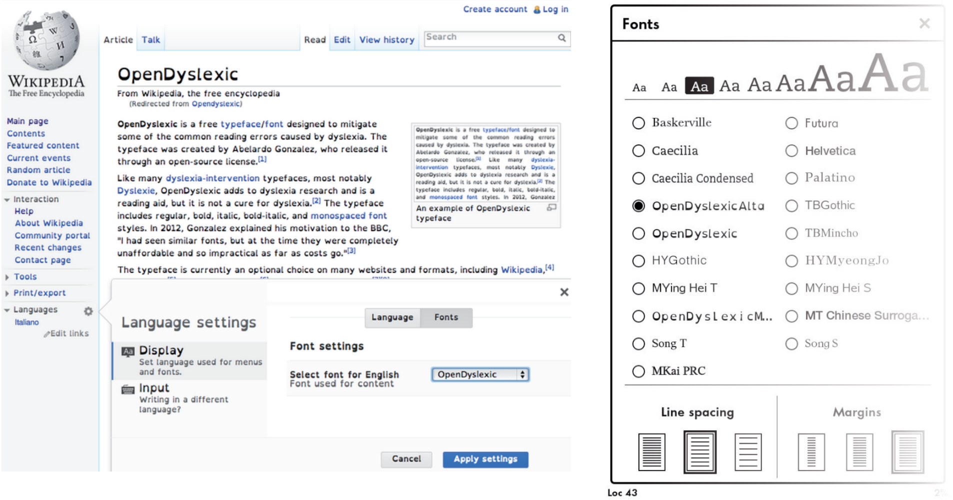
Figure 12ab. An introductory page and a chapter opening page in one of the ‘Here's Hank’ books, typeset with Dyslexie
Source: H. Winkler and L. Oliver, *The Soggy, Foggy Campout* (2016)

OpenDyslexic, designed in 2012 by Abelardo Gonzalez and released through an open-source license, was intended as a free alternative to Dyslexie, which was available only in a paid version at the time, even for private use. OpenDyslexic is a san-serif typeface in five varieties: straight (antiqua), inclined (italic), bold, bold inclined, and monospace (fixed character width). When embarking upon the project, the author's basic idea was to design characters with maximum distinguishability. Letters in OpenDyslexic are ‘heavy’ at the bottom, which is intended to help readers to place them in the baseline of the printed text, often perceived by dyslexics as disrupted. The idea to thicken the lower parts of the letters made OpenDyslexic very close to Dyslexie.

OpenDyslexic is offered among available fonts by some websites, including the Polish-language version of Wikipedia. It can be also used on Android and iOS mobile devices, such as smartphones and tablets. Amazon has included OpenDyslexic among fonts available in its new Kindle e-readers (cf. Fig. 13ab). The Polish typeface also contains letters with Polish diacritics.

DOES THE TYPEFACE MATTER? A SUMMARY

The results of contemporary experimental studies clearly show that typefaces (as well as their varieties) have a big impact on text readability and may facilitate the perception of written information for dyslexic people. Three categories of typefaces are most reader-friendly for people with this type of disorder. First-



OpenDyslexic

From Wikipedia, the free encyclopedia
(Redirected from Opendyslexic)

OpenDyslexic is a free typeface/font designed to mitigate some of the common reading errors caused by dyslexia. The typeface was created by Abelardo Gonzalez, who released it through an open-source license.[1]

Like many dyslexia-intervention typefaces, most notably Dyslexie, OpenDyslexic adds to dyslexia research and is a reading aid, but it is not a cure for dyslexia.[2] The typeface includes regular, bold, italic, bold-italic, and monospaced font styles. In 2012, Gonzalez explained his motivation to the BBC, "I had seen similar fonts, but at the time they were completely unaffordable and so impractical as far as costs go."[3]

An example of OpenDyslexic typeface

The typeface is currently an optional choice on many websites and formats, including Wikipedia,[4]

Select font for English: OpenDyslexic
Font used for content

● OpenDyslexicAlta

13a 13b

Figure 13. OpenDyslexic as an available font in Wikipedia and Kindle e-readers
Source: Wikipedia, documentally.com

ly, those are sans-serif antiqua styles such as Arial, Helvetica or Verdana. These typefaces are characterised by clear and simple forms of letters, a large x-height, strongly marked lower extensions (in letters <g, j, p, q, y>) and upper extensions (in <b, d, f, h, k, l, t>), making it easier for readers to distinguish between certain letters, such as <i> and <j>, <n> and <h> or <a> and <d>. These styles also use wider letter spacing, which prevents the optical merging of certain letters into a single character, for example <rn> into <m> (as in *stern* and *stem* or *darn* and *dam*). Secondly, some dyslexia-friendly typefaces were specifically designed for people with this disorder (such as OpenDyslexic or Dyslexie), and contain rounded shapes somewhat resembling handwritten letters. These typefaces have all of the above-mentioned properties of san-serif antiquas but also make a clear distinction between the so-called ‘mirror image twins’, such as <p, b, d, q, g>, <a, e>, <m, n, u>, <l, ł, t>, as well as other characters, for example, <l> (lowercase ‘l’), <I> (uppercase ‘I’) and <1> (digit ‘one’). Thirdly, monospace typefaces (e.g. Courier), where all characters have the same width, are highly readable for dyslexics despite their unsophisticated structure.

The decoding of printed characters, which directly influences the automation of reading, is among the first difficulties encountered by a dyslexic person who is learning to read. If this task is facilitated, dyslexic readers will be able to pay more attention to overcoming other difficulties associated with the reception of a written text. Therefore, when preparing various publications (electronically and on paper) for dyslexic students who are learning to read, it is important to use typefaces which were found to be dyslexia-friendly in the course of experimental studies. The only question that arises in this context is whether we should actually help dyslexics by using dedicated typefaces to facilitate the text recognition process despite the fact that in real life they will need to read various messages typeset with other fonts. Perhaps this solution is workable only at the initial stages of education, when children are learning to read. Once a dyslectic student has mastered the decoding of characters, it might be reasonable to consider a gradual abandonment of dedicated typefaces. These issues, however, require further exploration through experimental research.

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