The effect of the Dyslexie, Arial and  Times New Roman font on reading speed, text comprehension and reader preference.

A  randomised within-subject experiment with dyslectic and non-dyslectic readers.

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**Abstract**

In 2008, Christian Boer developed a font named “Dyslexie” which was designed to facilitate the reading process of people with dyslexia. The little amount of research that has been done on the impact of this font remains inconclusive. This investigation intends to gain a broader view on its impact by studying three factors of the reading process: reading speed, reading comprehension and reader preference. The Dyslexie font was compared with Times New Roman and Arial. The experiment was performed with 180 participants, both dyslectic and non-dyslectic. The results show that Dyslexie enhances the reading speed for all participants, however not significantly. Times New Roman showed the best reading comprehension while Arial was the most preferred font. The contradictory findings show that further interdisciplinary and detailed investigation on the influence of dyslexia is needed.

Table of contents

[Table‌ ‌of‌ ‌figures‌ ‌and tables 5](#_Toc72761868)

[2 Introduction 6](#_Toc72761869)

[2.1 What is dyslexia? 6](#_Toc72761870)

[2.2 Causes of dyslexia 9](#_Toc72761871)

[2.3 A short historical overview of dyslexia (research) 12](#_Toc72761872)

[2.4 Research question and purpose 13](#_Toc72761873)

[2.5 Overview 14](#_Toc72761874)

[3 Background 16](#_Toc72761875)

[3.1 The font Dyslexie 16](#_Toc72761876)

[3.2 Status quo 17](#_Toc72761877)

[3.3 Type font research and screen reading 22](#_Toc72761878)

[3.4 Reading speed 25](#_Toc72761879)

[4 Methodology 27](#_Toc72761880)

[4.1 Participants 27](#_Toc72761881)

[4.2 Procedure 28](#_Toc72761882)

[4.3 The investigation 28](#_Toc72761883)

[4.3.1 Reading speed experiment 29](#_Toc72761884)

[4.3.2 Reading comprehension experiment 30](#_Toc72761885)

[4.3.3 Survey 31](#_Toc72761886)

[4.4 Data processing 33](#_Toc72761887)

[5 Results 34](#_Toc72761888)

[5.1 Reading speed 34](#_Toc72761889)

[5.1.1 Data reading speed 34](#_Toc72761890)

[5.1.2 Analysis reading speed 35](#_Toc72761891)

[5.2 Reading comprehension 40](#_Toc72761892)

[5.2.1 Data reading comprehension 40](#_Toc72761893)

[5.2.2 Analysis reading comprehension 40](#_Toc72761894)

[5.3 Absolute evaluation of the fonts 43](#_Toc72761895)

[5.3.1 Data absolute evaluation of the fonts 43](#_Toc72761896)

[5.3.2 Analysis absolute evaluation of the fonts 45](#_Toc72761897)

[5.4 Relative evaluation of the fonts 54](#_Toc72761898)

[5.4.1 Data relative evaluation of the fonts 54](#_Toc72761899)

[5.4.2 Analysis relative evaluation of the fonts 55](#_Toc72761900)

[6 Conclusion and Reflection 57](#_Toc72761901)

[7 References 61](#_Toc72761902)

[8 Appendix 65](#_Toc72761903)

[8.1 Appendix 1: Texts 65](#_Toc72761904)

[8.2 Appendix 2: Multiple Choice questions reading comprehension test 67](#_Toc72761905)

[8.3 Appendix 3: Absolute evaluation fonts 69](#_Toc72761906)

## Table‌ ‌of‌ ‌figures‌ ‌and tables

[Figure 1 Special adaptations to the font 16](file:///C%3A%5CUsers%5Cmayar%5CDocuments%5CMASTERPROEF%5CRoels_Maya_Masterproef_%2022-5.docx#_Toc72583586)

[Figure 2 Example presentation of the fonts 31](#_Toc72583587)

[Figure 3 Histograms of speed per font for all participants 37](#_Toc72583588)

[Figure 4 Boxplot of speed per font of all participants 38](#_Toc72583589)

[Figure 5 Spaghetti plot of the reading speeds per font, dyslectic (yes) vs non-dyslectic (no) 38](file:///C%3A%5CUsers%5Cmayar%5CDocuments%5CMASTERPROEF%5CRoels_Maya_Masterproef_%2022-5.docx#_Toc72583590)

[Figure 6 Effect plot of the fonts on having dyslexia (yes) or not (no) 39](#_Toc72583591)

[Figure 7 Effect plot of the fonts (left) and of dyslexia (right) 40](#_Toc72583592)

[Figure 8 Average scores per font, dyslectic participants (yes) vs non-dyslectic (no) 42](#_Toc72583593)

[Figure 9 Categorical representation of teh scores per font, dyslectic participants (yes) vs non-dyslectic (no) 44](#_Toc72583594)

[Figure 10 Evaluations of all criteria, dyslectic participants (left) vs no-dyslectic 46](#_Toc72583595)

[Figure 11 Absolute evaluations of the fonts by the dyslectic participants 48](#_Toc72583596)

[Figure 12 Absolute evaluations of the fonts by the non-dyslectic participants 49](#_Toc72583597)

[Figure 13 Relative evaluations of the fonts, dyslectic participants vs non-dyslectic 56](#_Toc72583598)

Table 1 Overview of research on the Dyslexie font 20

Table 2 text-font division 29

Table 3 Time & Speed of all participants 34

Table 4 Time & Speed of dyslectics vs of non-dyslectics 35

Table 5 Time & speed of all participants 36

Table 6 Average scores on the comprehension test of all participants 41

Table 7 Average scores on the comprehension test, dyslectic participants vs non-dyslectic 41

Table 8 Categorical representation of the scores achieved by the dyslectic participants with the standardised residual 43

Table 9 Average evaluations of the criteria aesthetic (esthetisch) and legibility (duidelijk) of all participants 45

Table 10 Average evaluations of the criteria pleasant (aangenaam) and professional (professioneel) of all participants 45

Table 11 Average evaluations of the criteria use themselves (zelf gebruiken) and read a book in (boek in lezen) of all participants 45

Table 12 Average evaluations of the criteria scientific (wetenschappelijk) and children's book (kinderboek) of all participants 46

Table 13 Absolute evaluation of the fonts, dyslectic participants vs non-dyslectic 56

# Introduction

## What is dyslexia?

         Dyslexia is an impairment that influences the language abilities of a person. This is manifested through lessened fluency and accuracy in reading and writing (Łockiewicz & Jaskulska 2016). Dyslexia can be characterised by a phonological deficit (difficulties processing/linking graphemes to phonemes), including deficient phonological awareness (difficulties in manipulating phonemes), phonological working memory (difficulties in recalling phonemes), and rapid automatised naming (RAN, problems in rapidly recognising and naming symbols) (Ylinen et al. 2019). The phonological deficit, the problems in processing visual and auditory stimuli are regarded as the core deficit of dyslexia (Ahissar 2007). The impairments do not only influence the mother tongue: difficulties are also found in learning new languages, often because people with dyslexia struggle with the inconsistencies and irregularities of the foreign spelling systems (Łockiewicz & Jaskulska 2016).

 The definition and description of the disorder has changed over the years. The abovementioned definition is applied in this study because this is one of the most recent definitions of dyslexia. One of the earliest formal definitions stems from the World Federation of Neurology. They formulated a working definition of dyslexia in 1994:

Dyslexia is one of several distinct learning disabilities. It is a specific language-based disorder of constitutional origin characterised by difficulties in single word decoding, usually reflecting insufficient phonological processing. These difficulties in single word decoding are often unexpected in relation to age and other cognitive and academic abilities; they are not the result of generalised developmental disability or sensory impairment. Dyslexia is manifested by variable difficulty with different forms of language, often including, in addition to problems with reading, a conspicuous problem with acquiring proficiency in writing and spelling. (Lyon 2003: 2)

In the 2003 definition, which is also discussed in the article of Lyon (2003), other aspects are added. For example, it is also specified that dyslexia occurs because of a specific cognitive deficit. Other possible influencing factors, such as inadequate education and other disabilities that could possibly explain a reading problem are mentioned. However, other factors such as socioeconomic status and intelligence quotient are not included:

Dyslexia is a specific learning disability that is neurobiological in origin. It is characterised by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge. (Lyon 2003: 2)

These two definitions are merely two examples of how dyslexia can be defined. Because there is disagreement on how to define dyslexia, a plethora of different definitions can be found in the literature. Tønnessen (1997) distinguishes three kinds of definitions, based on three principles.

1.  The symptom principle. These definitions focus on a discrepancy between observed and expected achievement.

2.  The causality principle. Definitions according to the causality principle often relate dyslexia with an impairment in phonological processing. However, it remains unclear if these phonological anomalies are to be considered as being symptoms or causes.

3.  The prognosis principle. The definitions based on this principle focus on the effect of the treatment on the disorder (Tønnessen 1997: 80).

In an earlier article, Tønnessen (1995) applies these three principles to existing definitions. Definitions based on the symptom principle and the causality principle are discussed. In the symptom principle, the definitions focus on the discrepancy between expected and observed achievements. Three discrepancies can be studied: a discrepancy between reading skills and IQ, between reading and listening comprehension and between reading age and chronological age. The issue with this kind of definition is that there are no accurate and reliable measurements to compare both factors (Tønnessen 1995). Definitions that are constructed in the light of the causality principle, are often ‘definitions by exclusion’ i.e. they state what does not cause dyslexia. As is written above in the definition of the World Federation of Neurology, several factors such as intelligence and opportunity are indicated as not being the cause of the disorder. This kind of definition poses the problem that, for example, people who grow up in a less fortunate socioeconomic environment can not have dyslexia in theory because this then taken as the cause of the reading problems (Tønnessen 1995). However, this is a matter of methodology. Thus, both kinds of definitions are not without problems. Therefore Tønnessen (1995)  proposes to formulate a hypothesis rather than a definition. Tønnessen (1995) proposes the hypothesis approach because he considers empirical facts and theories interwoven which hinders the reader to see which one is at the basis of the findings (Tønnessen 1995). To gain results that are not influenced by the underlying theory, Tønnessen (1995) proposes this approach; First of all, his hypothesis would define dyslexia minimally with symptoms that have a high degree of intersubjective observability. Second, it would avoid causal factors since these beg the research question by anticipating the results. Most importantly, this definition needs to be treated as a hypothesis (Tønnessen 1995).

         However, the hypothesis strategy applies to the scientific field. The definition of  dyslexia is of great importance from both a scientific and legal perspective. Tønnessen (1997) argues that providing a clear definition is crucial to provide a legal basis for the accommodation of people with this disorder. Also, a good definition is of great aid to teachers who are expected to look for signs of this disorder in the development of the child (Tønnessen 1997).

         The debate on whether there exists an appropriate definition of dyslexia, brings us to the dyslexia debate. Kirby (2020: 474 ) describes the debate as “encompass[ing] critiques of both dyslexia ‘the reality’ (the ‘objective’ phenomenon), and dyslexia ‘the label’ (the ‘subjective’ term used to describe these)’. These critiques vary from claiming that dyslexia does not really exist to claims about the definition of it, namely it being too vague according to some. Others argue that socio-economic factors should be regarded more whereas others say that the diagnosis is just a way for parents to find an excuse for the learning difficulties of their child (Kirby 2020: 473). Thus, it can be concluded that ‘what’ dyslexia actually is and how it is defined is still to this day contested.

## Causes of dyslexia

Five different causes of dyslexia have been suggested in previous scholarship (Van den Broeck 2016): 1) a phonological deficit, 2) problems with rapid automatized naming, 3) the visual attention span, 4) sensomotoric problems and, lastly, 5) psychological problems. I discuss each one in turn.

According to Ramus (2003) and Vellutino, Fletcher, Snowling & Scanlon (2004) the phonological deficit hypothesis proposes that Dyslexia is caused by problems in the processing of phonology. This deficit is present before the person starts to learn how to read and write and causes problems in their later life. More specifically, the problems consist of the fact that the articulation of a word is not or not sufficiently connected to the written form of the word. The failing connection is taken to cause a slow decoding process which in turn would cause errors in the accuracy when reading and a slow reading speed. From within this theory on the cause of dyslexia, the training of phonological awareness is seen as a possible way to train a dyslectic in order to ameliorate the reading abilities of the dyslexic. Zegeurs and Snellings (2016) argue that a refined connection between letters and sounds are at the basis of a fast, fluent and flexible word recognition system. For people diagnosed with dyslexia, the information process time when connecting the letters to their appropriate sounds is longer than for a non-dyslexic person.

According to van den Bos, Zijlstra & Van den Broeck (2003) problems with rapid automatized naming (RAN) can be indicative of the reading abilities of the dyslexic. RAN can be measured in an experiment in which the participant is asked to name a set of known symbols within a restricted time. In transparent languages (a language in which there is a one on one relation of phonemes and graphemes), such as Dutch, RAN is the strongest predictor of reading skills (Zegeurs and Snellings 2016).  However, the study van den Boer & de Jong 2015 could indicate that RAN is on the basis of word identification and thus it is merely an indicator of the speed with which phonological information is retrieved. Because of this, RAN would focus more on the reading process than the reading skill itself. It is thus no indicator of actual comprehension.

The visual attention span hypothesis maintains that less skillful or impaired readers are able to only process a small number of orthographical elements. This results in a less efficient reading and possibly a letter per letter phonation. Some evidence for this hypothesis has been provided by eye-tracking research. However, it is not possible to perceive if or to what extent the orthographical elements are activated by the reader. This theory is related to a theory that is important to this research, namely the theory of the magnocellular deficit. The magnocellular system influences the orthographical or lexical skills which are necessary for reading fluency (Castles et al., 2010). The magnocellular system is responsible for eye movements while reading and thus the visual focus on the text. The timing and tracking of the movements may be impaired when dyslectic, causing a distorted focus (Bosse et al. 2007). This may explain why dyslectics see letters “moving around” (Liederman, et al., 2003; Stein, 2001). In reality, this causes a switching or mirroring of letters, which cause typical errors while reading (Braams, 2001). This difficulty was an important basis in the development of the Dyslexie font by Christian Boer. Boer wanted to create a font that prevented the switching and mirroring and would accordingly guide the readers' eyes more easily, with the intent to prevent lapses, errors in the interpretation of the text and an extremely low reading speed. Another important aspect in the visual attention span hypothesis is the number of times a reader needs to move his or her eye to read one line. An extensive amount of eye movements has shown to cause a slower reading pace and a greater chance of errors (Bellochi et al. 2013).

The hypothesis by Hämäläinen, Saliminen & Leppänen (2013) regards dyslexia as a sensomotoric problem.  This causes the person to have a decreased sensitivity for subtle differences between tones and sounds. Hämäläinen, Saliminen & Leppänen (2013) argue that this is a risk factor for dyslexia.

Lastly, Zegeurs and Snellings (2016) also indicate a cause that is very different from the theories that have already been discussed. They plead to also take the mental state of the person with dyslexia into account, since stress, worries, insecurity and low self-esteem can lead to a delay in information processing. This could have negative effects on the reading abilities of the person in question. Therefore, they propose psycho-education as one of the possible interventions to ameliorate reading abilities. It focuses on the emotional aspect of having dyslexia. In this education, the children would be explained what dyslexia actually entails. It tries to encourage them to accept their deficits but also recognise their qualities and talents.

## A short historical overview of dyslexia (research)

In 1887, dyslexia was first formally identified by Adolph Kussmaul. He detected difficulties in reading and spelling and termed it ‘word-blindness’ because he thought that these problems originated from an ocular deficit (Kussmaul 1877). In the same year, Rudolf Berlin coined the word dyslexia but with a totally different meaning when compared to Kussmaul’s word-blindness: Berlin applied ‘dyslexia’ to people who had lost the ability to read because of a stroke (Berlin 1884). The basis for the definition of developmental dyslexia was formed in 1896 by W. Pringle Morgan (1896). Morgan (1896) related dyslexia to what is now regarded as the three main features: isolated poor reading skills with a normal or high general cognitive ability and a probable genetic basis (Morgan, 1896). At the start of the 20th century, this was further elaborated in the UK by James Hinshelwood (1907) and James Kerr (1897), and by Samuel T. Orton (1925) in the USA.

From the 1930s on, the word ‘word-blindness’ fell out of use because it became clear that these people did not have any visual deficits. In the 1950s, with the introduction of Chomsky’s Universal Grammar, dyslexia became identified as a problem concerning phonological processing. Because of this, the study of dyslexia entered the realm of linguistics and educational psychology as it was now regarded as a linguistic and psychological condition. Before, the focus was more on the neurological processes (Stein 2018). In the 1960s, organisations and societies devoted to Dyslexia emerged in Great Britain. In this period, the disorder also started to receive more academic attention. Two decades later, dyslexia became politically recognised and educational provision was starting to be developed (Kirby 2020).

         From the end of the 20th century, research from neuroscience and genetics yield interesting new findings on dyslexia. FMRI studies indicate that poor readers show differences in the hemisphere responsible for language use. Also, nine gene variants were found to have a relation with having dyslexia (Carrion-Castillo, Franke, & Fisher, 2013).

## Research question and purpose

Not only the attitudes towards dyslexia differ but also the effort that is put into accommodating the people with dyslexia. Several intervention programmes have been developed and tested to ameliorate the reading ability of a person with dyslexia. Because of the vagueness and disagreement about what causes dyslexia, there are various interventions that focus on various aspects. For example, the Lindamood programme. The programme is a multisensory, bottom-up and explicit approach. It intends to develop phonemic awareness and phonemic decoding with the least possible use of texts (Alexander 2004). There is also the Orton-Gillingham which is a multisensory explicit phonics method.  Here, the emphasis is on visual and auditory feedback for sounds and the tactile-kinesthetic input of letter formation (Alexander 2004). Next to these intensive programmes, there are also tools developed. For example, Earobics20 and FastForWord21 are commercially developed computer programmes. These computer programmes address the auditory processing deficit found in a subset of subjects with dyslexia (Alexander 2004). These intervention programmes focus and are thus based on the assumption that dyslexia is caused by a phonological impairment. However, there are also interventions that are based on the magnocellular deficit hypothesis. An example of this is the use of yellow backgrounds, which is shortly discussed in paragraph 3.2.

The Dyslexie font is also a visual intervention. The special font is designed by Christian Boer. Boer intends to offer dyslectics a font that would reduce their reading errors and increase the reading speed and comprehension. However, being created on the basis of his own creativity and personal experiences, the effect of the Dyslexie font has not been empirically tested. A small number of studies have already been conducted on the impact of the Dyslexie font (De Leeuw 2010, Kuster et al. 2018, Marinus et al. 2015, Pijpker 2013, Van Someren 2013, University of Sparrow et al. 2016). This study reports on the results of an empirical evaluation of the effect of the dyslexia font. This investigation tries to answer the following questions: What is the effect of the Dyslexie font on the reading speed and reading comprehension of dyslectics and non-dyslectics in comparison to Arial and Times New Roman? How is the Dyslexie font evaluated by dyslectics and non-dyslectics in comparison to Arial and Times New Roman? And lastly: is there a relation between reading speed, reading comprehension and reader preference? These aspects are the main focus of this investigation.

Also relevant to this study is the researcher. I find it significant to tell that I am dyslectic as well. Personally, I think this can be an advantage in this investigation because I know what it is like to have this disorder. I tried to keep my experiences in mind when designing the experiment and the survey. I believe this may have made the overall experience nicer for the dyslectic participants. However, I know that I am not a representative for what all dyslectics experience. Dyslexia comes in various degrees and forms and thus my experiences can not be extrapolated.

## Overview

This investigation addresses the following: Chapter 3 outlines the theoretical background. Chapter 4 explains the methodology of the experiment. Chapter 5 presents the results of the experiment and the survey and the analysis of the data. This paper ends with a conclusion and a reflection on the strengths and weaknesses of the research, as well as suggestions for further research.

# Background

## The font Dyslexie

Before the influence of the Dyslexie font can be studied, it is useful to know how and why the font came into being. The information that is presented in this paragraph originates from an online meeting that I had with the designer of the font. Christian Boer, who designed the Dyslexie font, faced difficulties and challenges in his life because of having dyslexia. When entering higher education, he was confronted with a considerable amount of readings. Not only the extent of the texts that he had to read to pursue his studies was troublesome: the main issue was the type font. The fact that the mere form of the text hinders the accessibility of a subject and knowledge can be a source of frustration. Boer, however, found courage in this problem: he talked to his teachers about his difficulties. This led eventually to his major inspiration for his graduation project in 2008 for the University of the Arts Utrecht, which entailed designing a font that would benefit dyslectics. After his graduation, Christian Boer won the Smart Urban Stage Awards in Amsterdam because of his innovative design. Later the font would also gain recognition in the INDEX: Design to Improve Life awards in Copenhagen, the FastCompany Innovation by Design Awards in New York and the Rabobank New Generation Pitch in Utrecht. The interest in the font grew. In 2014 the font became available for the public. Afterwards, it became wider used: in books, online, on children’s toys, etc. People started using the font at home, at school and at work. Today the font has over 200.000 users of which 90% are home users.

Boer started designing the letters from his own intuition. The basis of the design are his own observations of aspects of fonts that seemed to bother or hinder his reading skills. First of all, the font was designed to have a larger line spacing and to be default bigger than normal fonts (pt. 14) in order to prevent the crowding effect and to clarify the separate parts of a text. Also, the capital of the sentence and the full stops, exclamation and interrogation mark are marked in bold with the intention that the reader could more easily locate the start and end of a sentence. Within the words, the spacing between the letters was designed to be larger also to avoid the crowding effect. Lastly, the letters were designed in a way that they contain very little symmetry. For this aspect,  Boer was met with criticism because of the fact that in traditional font design the arches of the letters should be designed with the same curve. However, this is one of the aspects he hypothesised to be very important in the process of preventing the mirroring of letters. Boer explained that the *p, q, d, b* are actually the same letters mirrored in different ways. To prevent vertical mirroring the curve of the letter was adjusted, as can be seen in Figure 1. To prevent horizontal mirroring the bottom part of the letter was made ‘heavier’. Also, the design of the letters have longer ascenders and descenders for emphasis. For letters that look similar, such as the *w* and *v*, the x-height was edited in order to make the letters more distinguishable.  In the designing process, Boer asked for feedback from fellow dyslectic friends.

Figure 1 Special adaptations to the font

1 Special adaptations to the font

The study of the impact of the font, to see if Boer’s intuitions are correct and if the font does help people with dyslexia, is still in progress. Since there are only several studies about this font that have differing conclusions, the reproduction of experiments is still important and relevant. Because of this, this study wishes to gain more insight on the influence of the font. The status quo of the research on Dyslexie is discussed in the next paragraph.

## Status quo

Several studies on the Dyslexie font have already been conducted (De Leeuw 2010, Kuster et al. 2018, Marinus et al. 2015, Pijpker 2013, Van Someren 2013, Sparrow et al. 2016). This paragraph discusses their results and the methods. This to identify certain tendencies in the results and  in the methods. Lastly, the methods are critically evaluated. First of all, the papers about the font that were available on the website of the Dyslexie font (dyslexiefont.com) are discussed. Second, I focus on research on the font that was to be found in academic sources.

The first investigation on the Dyslexie font was done by de Leeuw (2010) and focused on the aspects of reading speed, reading accuracy and the attitudes of the readers towards the font. To study the reading speed, the EMT (one-minute test) was used. The Klepel test was used, on the other hand, for reading accuracy. For the latter, a possible critique could be that testing the reading accuracy on the basis of non-words decreases the realism of the experiment. Also, dyslectics tend to use semantic reading as a compensatory mechanism (Van Der Kleij 2019), which is not possible when using non-words. The results of de Leeuw’s study indicated that the font Dyslexie had no effect on the reading speed of the participants. The analysis of the reading errors was inconclusive as some specific type of reading errors decreased and others increased. However, it was stated that the overall number of reading errors was lower for the dyslectics when reading the font printed out.

In the paper of Pijpker (2013), the investigation of the font Dyslexie is combined with another important aspect in the research on the influence of form on the reading skills: turning the background colour to yellow. Here, again, reading comprehension was not measured: the study focused on speed and accuracy. Both were tested through the Dutch Continuous Naming and Word Reading tests in which again a time limit of one minute is imposed. The study found that there is an interaction between the colour yellow and the font Dyslexie for dyslexics with a lower reading level. Next to that, there is also the positive main effect of the font on the reading accuracy of the whole group.

The literary review of Van Someren (2013) focuses on the theories that could explain dyslexia. By studying these theories, she intends to connect the effect or intended effect of the font to one or more of these theories. These are the phonological deficit, the magnocellular theory and a deficit in the visual attention span and, lastly, the effect of crowding. The study concludes that the crowding effect causes the most reading issues and influences the reading time. This is stated to be remedied through the font Dyslexie.

Lastly, the research on the font done by Sparrow et al. (2016) is conducted with the help of eye-tracking devices. The recognition of words is associated with the ocular movements of the reader to characterise the (sub)-lexical processes as it helps identify the decoding strategies. In the experiment, the ocular movements are studied while the participant reads the adjusted font. The results of the study indicate that, when reading the Dyslexie font, the reading facility is greater, as well as the reading comprehension. Seventy per cent of the participants prefer the Dyslexie font.

Some remaining characteristics of the aforementioned studies should also be taken into account. First of all, the majority of dyslexia research is performed on children. The studies of Pijpker (2013) and the one conducted by Sparrow et al. (2016) focused on children that found themselves in the developmental stage of their reading skills. Only the study of De Leeuw (2010) focused on a mature age group: university students. Secondly, De Leeuw (2010), as well as Pijpker (2013) and Sparrow et al. (2016) only compared Dyslexie to Arial. This could be because of the fact that there has already been done research on the readability of Arial versus that of Times New Roman. However, in this experiment a popular serif font (Times New Roman) is also included. Lastly, in none of these studies, the combination of reading speed, reading comprehension and reader preference was studied.

Next, the investigations found in academic sources are discussed. Marinus et al. (2016) compared the Dyslexie font to Arial. The focus of the investigation was on the spacing difference between the two fonts. Because of its larger spacing, reading in the Dyslexie font seemed to have a slight positive effect on the reading performance of the participants (7% more words were read per minute). However, when the advantage of the spacing was neutralised to focus on the effect of the shape of the letters, the effect disappeared. The authors thus stated that the reading aid would mainly be due to the spacing rather than the shape of the letters, a statement which is in conflict with the designer’s claims, who also attaches importance to the form of the letters.

In the investigation of Kuster et al. (2018), the font Dyslexie, the claims made by the designer and the research done by de Leeuw (2010) and Pijpker (2013) are critically analysed. She indicates their methodological and statistical flaws. It is stated that de Leeuw (2010) and Pijpker (2013) form conclusions without statistical underpinnings. In Kuster et al.’s (2018) own two experiments, the reading speed and accuracy and the preference of the children of the font are tested. Also, the two aspects, reading speed and accuracy and the preference, are connected in order to discern if there is any correlation. Unfortunately, reading comprehension was not tested in these two experiments. However, in each experiment, real sentences were used rather than non-words. Kuster et al.’s (2018) results, however, confirmed what was already faintly suggested in the previous studies on the font, namely that the font did not have any positive effect on the reading speed and the reading accuracy of the children. Moreover, the children also indicated to have a preference for the fonts Arial and Times New Roman rather than Dyslexie. Lastly, there was no relation between preference and reading performance found.

 It can be concluded that the studies on the Dyslexie font form no singular answer to the question of utility of the Dyslexie font because of the plurality of research methods that already have been used to study it.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Study | Method | Findings | Weakness | Target group |
| De Leeuw 2010 | measure reading speed with EMT testmeasure reading accuracy with Klepel test | no effect Dyslexie font | use of non-words, no semantic reading possibleno realism, time pressure,only compared Dyslexie to Arial | university students |
| Pijpker 2013 | yellow backgroundreading speed and accuracy with Continuous Naming and Word Reading test | interaction effect between Dyslexie font and yellow backgroundpositive effect Dyslexie font on reading accuracy | reading comprehension not measured, time pressure,only compared Dyslexie to Arial  | Children |
| Van Someren 2013 | theoretical investigation | influence of crowding effect on reading issues and timeissues can be remedied through Dyslexie | no empirical component | / |
| Sparrow et al. 2016 | testing reading facility and comprehension through eye tracking | positive effect of the Dyslexie font on reading facility and comprehension | only compared Dyslexie to Arial | Children |
| Marinus et al. 2015 | test reading speed | slight positive effect Dyslexiereading aid only due to different spacing | only compared Dyslexie to Arial | Children |
| Kuster et al. 2018 | test reading speed, accuracy and reader preference through texts | no effectother fonts preferred | reading comprehension not measured | Children |

Table 1 Overview of research on the Dyslexie font

On the basis of what we have learned from these previous studies, this study opts for a realistic set up. This set up is to be contrasted with studies in which non-words are used. In a realistic setting, which entails a real text with existing words, dyslectics can use all their compensatory mechanisms in order to gain the best possible results. The compensatory mechanisms, such as for example semantic reading, help them to have the least difficulties as possible in their everyday life. Thus, we wanted to give the participants the chance to be able to use these compensatory mechanisms. Also, the experiment of this study is designed in a way that gave the participants the possibility to read a fragment on their own tempo to prevent time pressure. In this tempo, they would focus on reading accuracy and comprehension, rather than the reading speed itself even though it was recorded. When regarding the target group of the previous studies, it can be seen that the adult group is underrepresented. This study intends to fill in the void by studying a group of adults. Concerning the fonts, Dyslexie is compared with a serif font (Times New Roman) and a sans-serif font (Arial) as well. With respect to the reading process, reading speed, reading comprehension and reader preference is studied. By combining these three aspects this study hopes to gain insights previous research may have missed.

## Type font research and screen reading

This paper discusses type fonts in relation to their effects on reading performances and dyslexia. However, type font research is a respective discipline on its own. This paragraph discusses the main developments in type font research and its posed assumptions on certain aspects of fonts. Bloodsworth (1993) states that the research of font types has been around since the 1950s. In that period, the focus was mainly on the legibility of the font type i.e. if the letters were easily distinguishable or not. On this matter he states that it is important that the letters are clearly differentiated, narrowness should be avoided, like long and heavy serifs. In addition to legibility, he also touches the subject of reader preference towards a certain font. Bloodsworth (1993) formulates the interesting paradox that style and preference are often prioritised over legibility. This can be seen in, for example, editors who maintain Times New Roman as their default font even though there is scientific evidence that indicates that there are fonts that are more legible and thus more beneficial to facilitate the reading process. Next to legibility, readability is also an important factor when evaluating fonts. Readability is the ease with which the reader takes in the printed material. In the context of a text, readability is more important than legibility since the perception of the whole word is more important than the identification of each letter in that word. In relation to reader speed, the importance of the number of eye fixations that are needed per line is discussed. Bloodsworth (1993) states that the ideal is three to four words per eye movement and two eye movements per line to secure smooth reading. Bloodsworth (1993) supports the utility of serifs i.e. leading the eye along the line. He adds that this would cause less reader fatigue. Lastly, it is important to keep in mind that the work of Bloodsworth (1993) concerns printed text.

Next to readability, the subjective experience of certain type fonts is also studied. In the study of Mackiewicz (2007), several criteria for personal evaluation are described. These criteria are at play when forming a preference for a certain kind of font. In his experiment, the participants were asked to evaluate the fonts according to the criteria *comfortable-to-read, professional, interesting,* and *attractive*. This research is focused on screen reading. In relation to this fact, Mackiewicz (2007) states that sans-serif fonts would yield better readability when reading the text on a screen, as opposed to serif fonts when printed. However, the results of the reader preference showed no significant difference between the serif and sans-serif font when it came to the factors *comfortable-to-read, attractive*, and *interesting*. It did have an effect on the variable *professional*: sans-serif fonts were regarded more professional than serif fonts. Furthermore, there has been other research done on the interpretation and perception of fonts. Chaparro et al. (2006) studied personality people linked to certain type fonts. It was also studied how a type font can influence the content of an email by letting the participants evaluate the knowledge, believability, maturity, professionalism, and trustworthiness of the email (Chaparro et al. 2007).

A more technical side of type font research is the typographical characteristics. These are instrumental to define the possible variables in the fonts. The tweaking of certain characteristics in certain fonts is subject to the study of their influence on readability and reading efficiency. The first characteristic is the body size of a font. It is typically measured in points (pt.) and is measured from the lowest point of the descender until the top of the ascender. Generally, fonts that are seized between 9 and 12 points are considered readable. In relation to the body size, there is the x-height. This is the height of the lowercase letter x in the font. The impact of the x-height on the reading performances has already been proven: fonts with a relatively large x-height are more legible (Dobres, Chrysler, Wolfe, Chahine, & Reimer, 2017; Legge & Bigelow, 2011; Williams, 2001) and are more often used for people with poorer reading skills e.g. young children (Williams, 2001). Secondly, the spacing. The spacing can differ between the lines (interline spacing), between words and between letters. Extra spacing has shown positive effect on the legibility of texts (Perea, Panadero, Moret-Tatay, & Gómez, 2012). Thirdly, the shape of a font is defined by its weight and contrast. In addition, the difference between serif and sans serif and between italic or regular is made.

 Another important aspect of this study is that the focus is on the influence on the font in the context of screen reading. The reason for this approach is threefold: first of all, a rather practical reason is that the Covid-19 crisis forced us to conduct research online. Secondly, I believe that I could find and reach a greater amount of dyslectics via the internet, than in person. It allowed me to contact all native Dutch-speaking dyslectics living in the Netherlands and Flanders. Also, this would make the threshold to participate in the experiment lower. Lastly, I believe that all the readings we do will become increasingly, and are most likely already dominantly screen readings. It is important to recognise this change in our society, in teaching methods, in news reporting etc.

In regard to screen readings, first of all, it should be recognised that there is great diversity when it comes to screens. From the study of Stoop et al (2012), it can be concluded that different kinds are to be identified and that these have different effects on the reading performances. Three main kinds are to be discerned: reading on a PC screen, on an electric reading device and web presentations or digitalized texts. When it comes to PC screens, various variables can perform an influence: the contrast of the screen, its resolution and the density of the pixels.

Myrberg and Wiberg (2015) discuss the computer vision syndrome, which has become apparent through comparing the reading comprehension and experience of participants who read a printed text to those who read the text on a computer screen. It showed that on the computer screen the participants found the reading experience less pleasant and they scored lower on the reading comprehension test. Mangen et al. (2012) state that this is due to the fact that computer screen reading lacks spatio-temporal markers such as touching the paper and turning the pages, which appears to aid the memory of the content. Mangen et al. (2012) also confirm the findings of Myrberg and Wiberg (2015) that their participants who read texts in print scored significantly better on the reading comprehension test than those who read the texts digitally. Thus, the fact that the experiment is conducted online should be taken into account when looking at the results of the reading comprehension test.

## Reading speed

It is known that some people read faster than others, but what is *fast*? Reading speed can be measured in words per minute (WPM). Traditionally, it is stated that good readers can obtain a speed of 350 WPM. On average fair readers can read up to 250 words per minute while slow readers will only reach about 150 words per minute (Fry 1963). Beginner readers, dyslectics and older readers are regarded as slow readers (Rayner et al. 2010). However, two things should be taken into consideration. First of all, people can read slowly on purpose, which does not make them necessarily slow readers. This can be the case when someone, for example, reads a book to relax. To obtain the natural reading pace of our participants, it was asked in our experiment to read at a comfortable pace. Secondly, reading speed can be influenced by a lot of factors. Some of them are font size, spacing, font type etc. The last mentioned is studied in this experiment. Another important factor is practice. Thus, when a dyslectic reader reads often, it could be that they are not identified as a slow reader. Also, it is also difficult to find average reading speeds of adult dyslectics since the majority of research focuses on the reading of children. Because of this, the three divisions will be used in this experiment to categorise the achievements per font and see if the font can cause re-categorisation.

# Methodology

## Participants

One hundred eighty participants participated in this experiment. All gave written consent in the survey. The sample size was not chosen a priori as it was preferred to strive for an as big as possible sample. The minimum age is 18, the maximum 70 and the mean age is 32. The younger part of the sample is assumed to be mainly fellow students and friends. The older parts is most likely to be parents of friends and acquaintances. A call for participants was also posted in dyslexia self-aid and discussion groups. These groups contained mostly adult people with dyslexia and parents of children with dyslexia.

Of the 180 participants, 138 are women (76%) and only 42 men (26%). No one identified as non-binary. Of dyslectic participants 47 of the 65 (72%) are women and 18 participants are men (28%). In the dataset of 180 participants, 65 were dyslectic (36%). Also, the participants were asked to rank the influence of dyslexia on their everyday life from one (no impact) to ten (a lot of impact). The mean was 5,915 and the minimum and maximum were respectively one and ten.

The education degree of the participants was divided in high school, bachelor, master and no answer. Fifty-nine of the participants have a master diploma or are currently doing their master (33%). Almost half of the participants have or are currently studying for a bachelor’s diploma, namely 88 of the participants (49%). Twenty-six of the participants have a high school diploma (14%) as their highest obtained diploma. Seven of the participants did not answer this question (3%). It is possible to conclude that there is a bias because of the high degree of education found in these participants.

Before continuing, the register of this paper is briefly discussed. In this investigation, the participants are labelled as “dyslectics” and “non-dyslectics”. However, it is known that there can not be a clear cut distinction since some people are more/less dyslectic or some simply do not know that they have this disorder. Therefore, the people who indicated they have dyslexia are labeled as “dyslectics”. Also, it is not wished to reduce our participants to people with the disorder. The decision to use the word “dyslectic” was made for the fluency of this paper and to make its readability higher.

## Procedure

The three surveys, each with different combinations of font and text, were spread using the snowball effect. Personal connections were used, as well as Facebook groups in which people can share their experience about having (a child with) dyslexia. Christian Boer, the designer of the font, and Impuls &Woordblind, which is an association for people with ADHD, ADD, dyslexia and dyscalculia, also kindly helped spread the survey using their platforms. The survey circulated from the second of December of 2020 until the ninth of February of 2021.

## The investigation

This part informs how the experiment and survey were constructed and why certain approaches and sources were used to establish the experiments and survey. First, the modality of the experiment, which was an online survey, is clarified. Thereafter, the experiment itself is outlined. There are two experiments: a text fragment with a timer and a reading comprehension test. After this, an absolute evaluation of the fonts, a relative evaluation of the fonts and, lastly, the information of the participants was asked in a survey.

The experiment was conducted via an online survey. This was not only due to the Covid-19 pandemic but also to the fact that it enabled the study to reach as many people as possible. Also, dyslectics can be hard to find. Lastly, this made the threshold to participate as low as possible.

### Reading speed experiment

Three texts in three different fonts were presented. In the first part of the experiment, the participants had to read a text. Along with the fragment, a timer was foreseen. The participants were asked to time how long it took them to read the text fragment. This, in combination with the length of the fragment, was used to calculate the reading speed of the participant (#words/#secondsx60). This was done to obtain data that would be easier to interpret as reading speed is one of the main focuses of this experiment. For the discussion of the results of the reading speeds, it is important to mention the distinction made by Fry (1963) of the three types of readers. Good readers, who read 350 words per minute, fair readers, who read 250 words per minute and slow readers, who read about 150 words per minute. In this experiment the same categories are used, however, they will be labeled as fast, medium and slow readers to avoid subjective and negative associations with the labels.

The text fragments that were used were all taken from vrt.nws, a governmental news channel. This source was used since they use the Dutch standard language. The text fragments contained 245, 282 or 213 words. They were subjected to the Flesch Kincaid readability test and scored all level 10 on the grade level, which should be easily understood by 15 to 16 year olds. This test measures the readability of texts and is developed by  Rudolf Flesch and J. Peter Kincaid. In this experiment, the Flesch-Kincaid grade level was used in specific. This level is calculated via this formula: 0.39 x (words/sentences) + 11.8 x (syllables/words) - 15.59. Thus, the core metrics are sentence length and word length (webfx.com). Regarding the content of the texts, each of them could be understood without any cultural, scientific or other foreknowledge of any kind. Each text was written in one of the respective fonts: Dyslexie, Times New Roman and Arial. To ensure that the content did not have any influence on the performance of the participant, three versions of the survey were spread in which the combination of text and font was changed. This is illustrated in Table 2. The texts can be found in Appendix 1 (8.1).

|  |  |  |  |
| --- | --- | --- | --- |
| #Text | Version 1 | Version 2 | Version 3 |
| Text 1 | Dyslexie | Arial | Times New Roman |
| Text 2 | Times New Roman | Dyslexie | Arial |
| Text 3 | Arial | Times New Roman | Dyslexie |

Table 2 text-font division

Lastly, the texts were formatted in different fonts: Dyslexie, Times New Roman and Arial. No changes to the default format of the font were made, except for the font size, which was changed to 12 points. This choice was made to be able to study the influence of the font in its most ‘natural’ form.

### Reading comprehension experiment

A short reading comprehension test containing three multiple-choice questions followed each text. The questions were based on the strategy used by the PISA tests to test reading comprehension (ETS 2019). The template for the question consisted of three cognitive processes one must manage in order to obtain a successful reading. The first one is *locate information*, which focuses on scanning and searching for relevant text and retrieving certain information. Second: *understand*. In this question, the participants were asked about literal information that was present in the text. Again, it was ensured that no foreknowledge was needed to answer this question. The last component is *evaluate and reflect*. Here the participants had to assess the quality and credibility or reflect on the content or form. According to these three cognitive processes, three questions per text were constructed. For each question, “I don’t know” was given as a possible answer to avoid guessing. The questions, along with their correct answer indicated in green, can be found in Appendix 2 (8.2).

### Survey

#### Absolute evaluation of the fonts

In the third part of the experiment, the participants were asked to evaluate each font. For each of them, they received eight statements, which can be found in detail in Appendix 3. The questions were accompanied by a Likert scale which ranged from 1 (agree) to 5 (disagree) for the participants to indicate their opinion.

The statements are based on the recurring evaluation criteria used in traditional type font research cf. §2.3.

1. Do you find the font aesthetic?
2. Do you find the font well legible?
3. I find the font comfortable to read
4. I find the font professional
5. I would use this font myself
6. I would like to read a book in this font
7. This is a font I would expect in a scientific article
8. This is a font I would expect in a children’s book

The first question and the second investigate the paradox found by Bloothworth (1993), namely that people would prefer an aesthetic font over a more readable font. The other questions are based on the criteria Mackiewicz (2007) uses to gain a view of the personal evaluation of the font. These were: *comfortable-to-read, professional, interesting,* and *attractive*. The third question represents the *comfortable-to-read* criterium. The fourth question, but also the seventh and the eighth refer to the criterium *professional*. Since the opinion of adults is being investigated, a children’s book would infer a non-professional setting, while a scientific article is at the opposite end of this spectrum. The last questions, question five and six refer to *interesting* and *attractive*. This because both the suggested activities would require commitment of the participant to the font. By combining these eight statements, a general view of how Dyslexie, Times New Roman and Arial are perceived by the general public and dyslectics is constructed and it is also investigated what the differences are.

#### Relative evaluation of the fonts

To prevent rating of fonts in relation to one another, the absolute evaluation was presented before the relative one. In the relative evaluation, the three fonts were simultaneously presented to the participants. An example of this can be seen in Figure 2.

Figure 2 Example presentation of the fonts

With this figure, the final question on the fonts was asked: *Which font did you find the most readable?* The focus is on readability since this is the most crucial element for dyslectics in order to have a successful reading. The font types were not named to avoid extra bias or influence.

## Data processing

 The data were processed in R. First, the measures of central tendency and the statistical dispersion were calculated for the reading time, the reading comprehension tests, the absolute evaluation of the fonts, the age of the participants and the impact of dyslexia on the dyslectics’ life.

 To look at the reading speed in more detail, the data was transformed into three histograms which each represent the reading speeds per font as well as into three respective boxplots. Secondly, the reading speed was linked to the factor of dyslexia. By doing this, the effect of dyslexia on the reading speed, as well as on the impact of each font on the reading speed could be studied. This is represented in a spaghetti plot. A mixed-effects regression model was used to gain a better view of the relation between the reading speeds per front and the effect of having dyslexia on these speeds. The relation is represented in an effect plot for the font and for having dyslexia. The marginal estimated means were calculated to see if the differences were significant.

 The scores on the reading comprehension tests were firstly summarised in a continuous analysis by linking the averages per font and the factor of having dyslexia or not. However, a categorical analysis of these variables was also performed because the distribution of the scores also seemed relevant. This is represented by a barplot. A chi-square test was performed to check significance.

 The data on the absolute evaluation of the fonts by the participants are represented from those of the non-dyslectics. Again, a chi-square test was used to calculate the significance per font.

 Lastly, the relative evaluation of the fonts was considered. Having dyslexia was also taken into consideration when looking at the data. This concludes the methods used in the experiment. In the following paragraph the results will be described.

# Results

## Reading speed

### Data reading speed

#### General reading speed

To start, the raw data of all the participants is considered per font. The minimum time to read the text in the Dyslexie font is 19 seconds, the maximum 243 (4 minutes 3 seconds). On average it took the participants just over a minute: 62 seconds. Second, the reading speed in Times New Roman. The minimum and maximum are respectfully 21 seconds and 365 seconds (6 minutes 5 seconds). The average is 67 seconds. Lastly, for Arial the minimum reading speed is 23 seconds and the maximum 310 seconds (5 minutes 10 seconds). The average reading speed for this font is 71 seconds.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Dyslexie | Times New Roman | Arial |
| Time (s) | Speed (wps) | Time (s) | Speed (wps) | Time (s) | Speed (wps) |
| Min | 19 | 53 | 21 | 45 | 23 | 53 |
| Max | 243 | 802 | 365 | 609 | 310 | 583 |
| Average | 62 | 277 | 67 | 257 | 71 | 243 |

Table 3 Time & Speed of all participants

Next, the reading speed is considered. This data is formatted in the unit of words per minute (wpm). The minimum reading speed in the Dyslexie font is 53 words per minute and the maximum 803 words per minute. The average is 277 words per minute. For the Times New Roman font, the minimum speed is 45 words per minute and the maximum speed is 607. The average of the font is 257 words per minute. Lastly, the minimum speed of Arial is 53, the maximum 583 and the average 243 words per minute.

#### Dyslectics vs non dyslectics

When the reading speeds of the dyslectic participants are compared to those of the participants who do not have dyslexia, it can be seen for the font Dyslexie that the average of the dyslectics is higher (24 seconds) than that of the non-dyslectics (19 seconds). This is not surprising since it is generally known that dyslectics read slower than people without the disorder. The same tendency is also to be seen in the minimum and maximum times for and also for the other fonts, as can be seen in Table 4.

The general average reading speed of both dyslectic (230 wpm) and non-dyslectic (304 wpm) in the Dyslexie font is higher than the average in the Times New Roman font (198 wpm for dyslectics, 291 wpm for non-dyslectics) or the Arial font (191 wpm for dyslectics, 273 wpm for non-dyslectics). Times New Roman had for both the dyslectic and non-dyslectic group the lowest minimum (45 wpm and 90 wpm respectively) and Dyslexie the highest maximum (680 wpm and 802 wpm respectively).

|  |  |  |
| --- | --- | --- |
|  | Dyslectics | Non-dyslectics |
| (s) | **Dyslexie** | **Times New Roman** | **Arial** | **Dyslexie** | **Times New Roman** | **Arial** |
| Min | 24 | 33 | 23 | 19 | 21 | 28 |
| Max | 243 | 365 | 310 | 115 | 170 | 165 |
| Average | 78 | 86 | 88 | 52 | 57 | 60 |
| (wpm) | **Dyslexie** | **Times New Roman** | **Arial** | **Dyslexie** | **Times New Roman** | **Arial** |
| Min | 53 | 45 | 53 | 135 | 90 | 77 |
| Max | 680 | 462 | 556 | 802 | 609 | 583 |
| Average | 230 | 198 | 191 | 304 | 291 | 273 |

Table 4 Time & Speed of dyslectics vs of non-dyslectics

### Analysis reading speed

#### General effect of the fonts

|  |  |  |  |
| --- | --- | --- | --- |
|  | Dyslexie | Times New Roman | Arial |
| Time (s) | Speed (wps) | Time (s) | Speed (wps) | Time (s) | Speed (wps) |
| Min | 19 | 53 | 21 | 45 | 23 | 53 |
| Max | 243 | 803 | 365 | 609 | 310 | 583 |
| Average | 62 | 277 | 68 | 257 | 71 | 243 |

Table 5 Time & speed of all participants

As can be seen in Table 5, the Dyslexie font yields the highest maximum and average reading speed. It is followed by Times New Roman and Arial comes last. However, it is useful to see how the data is distributed. To do this, the histograms in Figure 3 are used.



Figure 3 Histograms of speed per font for all participants

In all three histograms, the highest frequencies are present around 250 words per minute. This is also where all three averages lay. Dyslexie does have more outliers, situated around 800 words per minute, than Arial or Times New Roman, whose highest reading speeds are around 550 words per minute. When looking at the boxplots in Figure 4, it is to be noted that all three fonts have a quite similar distribution of reading speeds. It shows that Dyslexie yields slightly faster reading speeds, however, this is only a small difference.



Figure 4 Boxplot of speed per font of all participants

#### Effects of the fonts on the dyslectics vs on the non-dyslectics

 In this paragraph the focus is on the effect of the fonts on dyslectics versus the effects that may have been experienced by the non-dyslectics. In the spaghetti plot in Figure 5, it can be noticed that there is a tendency for the lines to have a dent upwards in the middle. This shows that the reading speed of the majority of the participants is higher when reading in the Dyslexie font. This applies to both the dyslectic and the non-dyslectic participants. However, from this model, it is difficult to discern the extent of the impact of the Dyslexie font on the reading speed.

Figure 5 Spaghetti plot of the reading speeds per font, dyslectic (yes) vs non-dyslectic (no)

 Therefore, a mixed regression model was calculated. It can be noticed that the dyslectic readers would be labeled as slow readers, especially in the Times New Roman and Arial font. Dyslexie, however, seems able to pull these participants towards becoming readers with a medium speed. The non-dyslectic participants, on the other hand, can in general be labelled as readers with at least a medium speed. Here, the Dyslexie font also associated with a faster reading speed, however, the difference is not as great as in the data of the dyslectic participants. Unfortunately, the interaction between the Dyslexie font and having dyslexia is not significant.



Figure 6 Effect plot of the fonts on having dyslexia (yes) or not (no)

#### Intermediate conclusion

On the basis of previous research, no clear conclusion can be made about the effect of the Dyslexie font on the reading speed of participants. The study of De Leeuw (2010) and Kuster et al. (2018) did not find a positive effect of the font on the reading speed. The study of Sparrow et al. (2016) and of Marinus et al. (2016), did find a positive effect. More specific, Marinus et al. found that in the Dyslexie font “7% more words were read per minute” (Marinus et al. 2016). Because of these contradictory findings, it is important to test the effect on the reading speed again. Also, the studies that did not confirm a positive effect used methods that do not fit to test this particular font (non-word tests, one-minute tests etc.) because of the aforementioned reasons in the paragraph (3.2) on these studies. The studies that did find a positive effect, however, did use other methods. I hypothesised that the Dyslexie font may have positive effects on the reading speed in a ‘natural’ environment: a news article (thus, with existing words) and without time limit. I expected this effect to be greater on dyslectic participants since the type of font is expected to influence their reading more. The non-dyslectics I hypothesised to be more resistant or insensate to the influence of a font.

From  the aforementioned data, two conclusions can be drawn. Figure 6 shows two things. First, the Dyslexie font reads faster than Times New Roman and Arial for both groups. There is an increase in speed to be seen for both dyslectic and non-dyslectic participants. However, the difference in speed is small and thus the hypothesis that the Dyslexie font would yield a faster reading speed is only faintly confirmed. After calculating the interaction effect of having dyslexia and the Dyslexie font, the effect showed not to be significant. The hypothesis that the Dyslexie font would yield faster reading speeds for participants with dyslexia is thus not confirmed. The second observation is, which could naturally be expected, that dyslectics read slower than non-dyslectics. Lastly, it is strange that, in general, the participants read slower in Arial, since Mackiewicz (2007) states that sans-serif fonts would yield better readability when reading the text on a screen, as opposed to serif fonts when printed. This does not show in our results and could be thus subject to further investigation.

 In general, we can say that the Dyslexie font does invoke some changes in the reading speed of the participants. This was also indicated in the study of Sparrow et al. (2016) and of Marinus et al. (2016). However, these showed not to be significant. Now that the data concerning the reading speed is discussed, the data of the reading comprehension tests are presented next.



Figure 7 Effect plot of the fonts (left) and of dyslexia (right)

## Reading comprehension

### Data reading comprehension

#### General reading comprehension

When looking at the averages of all participants, the best scores are obtained in the reading comprehension test in which the font was Times New Roman (2.58 out of 3), in second in the font Dyslexie (2.54 out of 3) and the most mistakes were made when the font was Arial (2.37 out of 3).

|  |  |  |  |
| --- | --- | --- | --- |
| (x/3) | Dyslexie | Times New Roman | Arial |
| Average | 2.54 | 2.58 | 2.37 |

Table 6 Average scores on the comprehension test of all participants

#### Dyslectics vs non-dyslectics

When comparing the achievements of the dyslectics with those of the non-dyslectics, a shift can be noticed. The dyslectics score better in the Dyslexie font (avg = 3.49) rather than in the Times New Roman font (avg = 3.49), which differs from the general comparison and in the non-dyslectic group. Arial, however, remains the font with the lowest scores for both dyslectic and non-dyslectic participants.

|  |  |  |
| --- | --- | --- |
|  | Dyslectics | Non-dyslectics |
| (x/3) | Dyslexie | Times New Roman | Arial | Dyslexie | Times New Roman | Arial  |
| Average | 3.49 | 3.46 | 2.15 | 3.57 | 3.66 | 2.5 |

Table 7 Average scores on the comprehension test, dyslectic participants vs non-dyslectic

### Analysis reading comprehension

The results for this part of the study suggest that the dyslectic participants score the best in Dyslexie, with a score of 2.49 out of 3 on average, while Times New Roman seems to be the best font for the non-dyslectics, scoring 2.66 out of 3 on average. A striking tendency, which was also to be noticed in the paragraph on reading speed (5.1), is that in general Times New Roman scores better than Arial. This is striking because, as can be seen in paragraph 5.3.2, Arial is favoured by the majority over Times New Roman when it comes to legibility and pleasantness. Thus, even though the font is considered less legible and less pleasant by the reader, it does yield better results than Arial regarding reading speed and reading comprehension. In terms of having dyslexia, it can be noticed in the Figure 8 that the average scores of the non-dyslectics for all fonts are only slightly higher than those of the dyslectics.



Figure 8 Average scores per font, dyslectic participants (yes) vs non-dyslectic (no)

Because an average score out of three does not give a very clear view of the achievements of the participants, a categorical representation of the data is also given in Figure 9. The proportions should be looked at relatively when comparing the dyslectics with the non-dyslectics since only 65 out of the 180 participants were dyslectic. When looking at the dyslectic participants, it can be noted that only a few more participants score three out of three in the Dyslexie font than in the Times New Roman font. For the non-dyslectics, the Times New Roman font appears to have the highest number of participants scoring three out of three.

Building on the assumptions of Boer, I hypothesised that text comprehension would be easier for the dyslectic participants in the Dyslexie font, since the form would not distract them from or confuse them about the content. The fact that the Dyslexie font is the font with the most scores of three out of three for the dyslectics confirms the hypothesis that the reading comprehension would be better in the Dyslexie font, but only faintly. Also, Table 8 shows that people with dyslexia have a higher chance of getting the maximum score in the text set in the Dyslexie font (cf. the standardized residual = 1.5). Thus, the data confirm the assumption of Boer. It can be derived from Figure 9, that the hypothesis does not apply to the non-dyslectic group, because the most scores out of three are for them when reading in the Times New Roman font. In both groups, the reading comprehension test in the Arial font yielded the least amount of three out of three scores.

|  |  |
| --- | --- |
|  | Score |
| Font | 0 | 1 | 2 | 3 |
| Arial | 0 (-0.7) | 14 (2.6) | 27 (1.2) | 24 (-2.7) |
| Dyslexie | 0 (-0.7) | 6 (-1.1) | 21 (-0.7) | 38 (1.5) |
| Times New Roman | 1 (1.4) | 5 (-1.5) | 22 (-0.4) | 37 (1.2) |

Table 8 Categorical representation of the scores achieved by the dyslectic participants with the standardised residual



Figure 9 Categorical representation of the scores per font, dyslectic participants (yes) vs non-dyslectic (no)

## Absolute evaluation of the fonts

### Data absolute evaluation of the fonts

#### General absolute evaluation

These data represent how the participants rated the fonts in different criteria. They were

asked to rank the font on a scale from one (totally agree) to five (totally disagree) according to the characteristics that were discussed.

The first criterion was whether or not the font was regarded as aesthetic (esthetisch) by the participants. Arial is on average regarded as the most aesthetic font (avg = 2.673), followed by Dyslexie (avg = 2.783) and Times New Roman (avg = 3.117). The second criterion was legibility (duidelijk). Arial scores on average the best for legibility (avg = 2.228) however, its average score differs very little from Dyslexie (avg = 2.239). Times New Roman is on average seen as the least legible with an average score of 2.956.

|  |  |  |
| --- | --- | --- |
|  | Esthetisch | Duidelijk |
| Dyslexie | Times | Arial | Dyslexie | Times | Arial |
| Average | 2.783 | 3.117 | 2.672 | 2.239 | 2.956 | 2.228 |

Table 9 Average evaluations of the criteria aesthetic (esthetisch) and legibility (duidelijk) of all participants

After that, it was asked how pleasant (aangenaam) the participants regarded the font. Again, the scores of Dyslexie and Arial differ very little (avg = 2.533 and avg = 2.506 respectively). In a similar vein as for legibility, Times New Roman scores the lowest for pleasantness (avg = 3.183). However, there is an opposite tendency to be noticed when looking at the professional (professioneel) criterion. Here, Times New Roman scores best (avg = 2.533). Arial scores 2.789 on average while Dyslexie is regarded as the least professional with an average score of 3.239.

|  |  |  |
| --- | --- | --- |
|  | Aangenaam | Professioneel |
| Dyslexie | Times | Arial | Dyslexie | Times | Arial |
| Average | 2.533 | 3.183 | 2.506 | 3.239 | 2.533 | 2.789 |

Table 10 Average evaluations of the criteria pleasant (aangenaam) and professional (professioneel) of all participants

The two criteria that measured the interest in the font are next. Times New Roman scores the least on average on the question of whether the participants would use this font themselves (zelf gebruiken) with a score of 3.172. Dyslexia does not score a lot better with 3.072. Arial, however, does with a score of 2.811. In the criterion in which was asked if the participant would want to read a book in the font, Dyslexie obtains a slightly better score (avg = 2.922) than Arial (avg = 2.944). Times New Roman had again the lowest average score in this criterion: 3.306.

|  |  |  |
| --- | --- | --- |
|  | Zelf gebruiken | Boek in lezen |
| Dyslexie | Times | Arial | Dyslexie | Times | Arial |
| Average | 3.072 | 3.172 | 2.844 | 2.922 | 3.306 | 2.944 |

Table 11 Average evaluations of the criteria use themselves (zelf gebruiken) and read a book in (boek in lezen) of all participants

The last two criteria are ‘scientific’ (wetenschappelijk) and if the font could be expected in a children’s book (kinderboek). Times New Roman is on average the font the most people seem to associate with scientific writing with a score of 2.406. Arial less with an average score of 3.144 and Dyslexie clearly the least with 3.567. For the other criteria, the children’s book, it is the other way around. Dyslexie is on average the font that is most associated or predicted to appear in a children’s book with an average score of 2.617, followed by Arial with 2.844. Times New Roman is the least associated with children’s books with an average score of 3.989.

|  |  |  |
| --- | --- | --- |
|  | Wetenschappelijk | Kinderboek |
| Dyslexie | Times | Arial | Dyslexie | Times | Arial |
| Average | 3.567 | 2.406 | 3.144 | 2.617 | 3.989 | 2.844 |

Table 12 Average evaluations of the criteria scientific (wetenschappelijk) and children's book (kinderboek) of all participants

#### Dyslectics vs non-dyslectics

Having dyslexia can have an influence on the rating of these fonts. Therefore the scores given to the fonts by the dyslectics are again compared by those of the non-dyslectics. The scores are summarised in Figure 10 below.

|  |  |
| --- | --- |
|  |  |

Figure 10 Evaluations of all criteria, dyslectic participants (left) vs no-dyslectic (right)

When  looking at these two graphs, two things catch attention at first glance. Remarkable is that dyslectics find Times New Roman less pleasant to read and less legible than the non-dyslectics participants. Only 18 percent of the dyslectic participants mark Times New Roman as pleasant on the Likert scale, while 45 per cent of the non-dyslectics do mark it as pleasant. When looking at the criterium ‘this is a font in which I would like to read a book in’ Dyslexie is a clear winner for the dyslectics with 51 percent while for the non-dyslectics all fonts score equally as well with 43 per cent. The other tendencies will be elaborated on in the analysis paragraph.

### Analysis absolute evaluation of the fonts

This paragraph presents the absolute evaluation of the fonts. The interpretation of the data is done by comparing the evaluation of fonts of the dyslectic participants with those of the non-dyslectic participants. Each criterion that was given is discussed. In Figure 11 and Figure 12 the data that this paragraph discusses can be seen. The percentages on the left-hand side, coloured in yellow, indicate how much per cent of the participants have indicated *agree* or *totally agree* on the Likert scale. The right-hand side, coloured in blue shows the percentages of the participants who have indicated *disagree* or *totally* *disagree*. The middle grey part is for the participants who have responded a neutral three on a scale out of five. Mainly, the (totally) agree percentages are discussed.



Figure 11 Absolute evaluations of the fonts by the dyslectic participants



Figure 12 Absolute evaluations of the fonts by the non-dyslectic participants

#### Pleasantness and aesthetic

 The first criterion is *pleasant to read* (aangenaam om te lezen). Fifty-eight per cent of the dyslectics label the Dyslexie font as pleasant to read. Seventy-one per cent of the dyslectics label Times New Roman as unpleasant. The evaluation of the pleasantness of Arial leans more towards the evaluation that Dyslexie received, with less than 10 per cent difference (58% pleasant for Dyslexie, 52% pleasant for Arial).  Arial is preferred over Times New Roman (labelled by 65% as pleasant in comparison to 45% respectively). The non-dyslectic participants do not prefer Dyslexie (53% pleasant) over Arial (65% pleasant). Of course, one can state that the font was not designed for these readers. However, it is important to measure the perception of the font by non-dyslectics to see what their reaction would be if, for example, a colleague or fellow student would use this font. At the end of the survey, there was space for the participants to leave some remarks. In these remarks, a statement on the font was font: “The font [Dyslexie] caused me a headache.” Of course, this is subjective. Some oral feedback was also given by some participants I know. Someone described the font as if it was ‘tickling’ them, another person described the letters of the font as ink blotches. These are not per se negative evaluations, but these evaluations can make a user self-conscious, hesitant or even embarrassed to use the font in a more professional or academic setting. Thus, it is important that the surroundings of the person using the font are aware of the possible benefits of the font and maybe even why it looks the way it does.

Secondly, the criterium *I find the font aesthetic* can also be linked to pleasantness. This is less applied to the actual reading, as in the previous criterium, and more focused on the actual form and look of the font. It is to be noticed from the data that the dyslectic participants like the Dyslexie font best (46 per cent), followed by Arial with 40 per cent and Times New Roman with only 36 per cent. There seems to be an aversion of Times New Roman by dyslectics, which becomes apparent in the other categories as well. In the non-dyslectic group, there is a slight shift. Here, Arial is preferred over Dyslexie (54 and 49 per cent respectively). Surprisingly, Times New Roman also scores only 35 per cent in this group. This is striking because, in the criteria that handle prestige cf. infra, Times New Roman was ranked the highest. From this, it can be concluded that these two characteristics are not necessarily related.

I hypothesised that dyslectics would find the Dyslexie font the most pleasant to read because it accommodates the reader. This is confirmed by the majority of the dyslectic participants, as 58 per cent indicate the font as pleasant to read. Also, I hypothesised that Arial would score better than Times New Roman for two reasons. One: it has been shown that dyslectics have more difficulties reading a serif font (which Times New Roman is) than a sans-serif font, such as Arial. Two: it has been shown that sans-serif fonts are more adequate for screen readings, which means that Arial should also be preferred over Times New Roman in general and thus also by the non-dyslectics. The data of both dyslectic and non-dyslectic participants confirm this hypothesis.

#### Legibility

Sixty-eight per cent of the participants dyslectic categorise the Dyslexie font as well legible. However, the font does not differ so much from Arial, which is categorized by 62 per cent of the dyslectic participants as well legible. For the non-dyslectics, Dyslexie was not chosen as the best legible font of the three fonts present in the experiment but Arial, with 72 per cent. The score Dyslexie received on legibility did not, similarly as for the dyslectic participants, differ a lot from Arial with only five per cent difference (67 per cent). In the group of the dyslectic participants, it is possible to see a clear aversion from the Times New Roman font: only 11 per cent calls it well legible and 71 per cent categorises it as less legible. The non-dyslectic group did not show these kind of results. This group considered all three fonts relatively well legible since the majority of the percentages were on the agree-side. Also, the proportions are fairly similar: 60 to 70 per cent on the agree-side, 10 to 20 per cent on the disagree-side. Still, Times New Roman is the least preferred font for the non-dyslectics when it comes to legibility.

 When considering this data in relation to the reading speeds per font, it could be stated that the dyslectic participants seemed more aware of the degree to which the font would affect their reading speed. As discussed in the previous paragraph, Dyslexie yielded the fastest reading speeds for both groups. Surprisingly, when keeping in mind that the participants indicated Times New Roman as less legible than Arial, Times New Roman yielded slightly faster reading speeds than Arial. This shows that how the participants rate a font on legibility and their reading speed in that font thus does not necessarily correspond for the participants of this experiment.

 *Legibility* is an important criterion because a font that is easily legible does not only help ameliorate the decoding process of dyslectics, but it also helps the processing be more fluent for non-dyslectics. Thus, if the font is regarded as (very) well legible by a participant, this should also be reflected in the reading speed. As stated above, it can already be concluded that this is not the case in this investigation for Times New Roman and Arial. Christian Boer explained that the font Dyslexie is designed in a way that all letters are easily distinguishable from one another by differentiating them more than in a regular font. On the basis of this, I hypothesised that the font Dyslexie should be evaluated as more legible by the dyslectics in this experiment. The data dyslectic participants did indeed confirm this hypothesis, however the difference with the Arial font is little. Of course, this could also be the case for non-dyslectics even though this group normally has fewer problems distinguishing letters. This was not the case, as they indicated Arial as the font with the best legibility. Also, the same applies as in the previous paragraph: serif fonts are generally considered as less readable by dyslectics because of their serifs, which distract the dyslectic reader from the crucial form of the letter adding noise. Thus, it is normal that dyslectic participants categorise Times New Roman, a serif font, as less legible.

#### Scientific, childishness and professionality

 When looking at the data, it can be seen at first glance that the dyslectics do not consider Dyslexie as more childish (52 per cent) than the other fonts. On the contrary: Arial scores slightly higher on this criterium (55 per cent). This is not the case for the non-dyslectic participants. Their data shows that they find Dyslexie considerably more fit for a children’s book (60 per cent) than Arial (43 per cent). However, the dyslectic participants do not seem to present this judgement. This could be due to the fact that some of them could already have some insights or experience with the fact that some fonts can help people and thus are more open to new fonts. Also, the effect of the Dyslexie font could already be known by some of the participants, since 53 of the 180 participants stated that they had already some experience with the font. Equally, both dyslectic and non-dyslectic participants do not expect the Dyslexie font in a scientific article. Fifty-five per cent of the dyslectics disagree on categorising it as a font that occurs in a scientific article and sixty-three per cent of the non-dyslectics do as well. For both *scientific* and *children’s book* Arial and Dyslexie score similarly. Times New Roman, on the other hand, is clearly considered not fit for a children’s book. Almost 70 per cent of dyslectics disagree with categorising the font as something that they would expect in a children’s book and so do the non-dyslectics as well with 74 per cent. On the other hand, it is clearly considered as fit in a scientific article by the dyslectics (54% agrees) and the non-dyslectics (64% agrees).

 To gain a clearer view on what was tried to be inquired with the previous two criteria, the criterium *professional* was also used. The dyslectics categorised all three fonts as almost equally professional. This is clearly not the case for the non-dyslectics. Here, Dyslexie is clearly not favoured (57 per cent disagrees), similarly as for the scientific criterium. Also, Times New Roman is clearly favoured, since 67 per cent finds it professional.

The two criteria *This is a font that I would expect in a children’s book* and *in a scientific article*, test the prestige of the three fonts and to investigates if the font in question could be used and accepted in a day to day context for adults such as at work, at university or even in news articles. The opposition between a children’s book and a scientific article was used because the first one embodies the least serious and credible context while a scientific radiates professionalism and credibility. I hypothesised that, if a certain font is regarded as more childish, chances are greater that the user could be made fun of when using this font. On the contrary, users of a font that approaches the look of a scientific article would have higher chances of being taken seriously. These evaluation criteria were incorporated because the designer of the font, Christian Boer, told me that there was some tabu around using the font for some users who had bought the font. Some are scared to use it at work, even to the point that they fear they might get fired if their boss discovers they use this font. Others, often young adults, reject using the font because they fear that peers will make fun of them. I wanted to investigate if these feelings could be valid. I hypothesised that the Dyslexie font will be considered more childish not only because of the aforementioned testimonies but also because of the more experimental and differentiated forms. This was confirmed with the data that indicated that the non-dyslectic participants found the Dyslexie font more childish (60 per cent) than Arial (43 per cent). Thus, it can be stated that the fear that is present can be confirmed a bit with these data. However, this judgement is not as ardently present in the data of the dyslectic participants: only 52 per cent indicated the Dyslexie font as fit for a children’s book.

On the other side of the spectrum, I hypothesised Times New Roman to be to be regarded as the most scientific or professional font. This font is often used in classic canonical novels. Also, Times New Roman is part of the formatting of several style guidelines such as MLA. This was confirmed in the data in two criteria: almost 70 per cent of dyslectic participants do not identify Times New Roman as fitted for a children’s book, as well as the non-dyslectic participants with 74 per cent. In the scientific criterion 54% of the dyslectic participants agrees that Times New Roman is most fitted for this context and 64% of the non-dyslectics agrees. Both groups confirm the prestige that was hypothesised to be tied to this font.

 Thus, it can be concluded that the data confirms the hypotheses: Dyslexie is, in general, regarded as a more childish font. The non-dyslectic participants express this more strongly than the dyslectic participants. On the other hand, Times New Roman is regarded as a scientific and professional font.

#### Use the font yourself and read a book in it

 The next criterion, *The font is a font I would use myself*, is tied to and important because of the previous paragraph. First of all, it is important to know if the dyslectics would want to use the Dyslexie font. Secondly, regarding the non-dyslectics, it can give us insight into how these people feel about using the font. Also, it can show us how hard they would hold onto the fonts they already know such as Arial and Times New Roman.

 For this criterion, it is remarkable to see that there is an opposite tendency for the dyslectics in comparison to the non-dyslectics when it comes to the Dyslexie font. Fifty-five per cent of the dyslectics state that they would use this font themselves, making it the preferred font. Meanwhile, Dyslexie is the least preferred font in this criterion for the non-dyslectics with only 37 per cent agreeing. Also, with the dyslectic participants, the aversion to Times New Roman is again to be noted (58 per cent disagrees) while for the non-dyslectics this font and Arial score similarly. It can be concluded that Dyslexie does seem the more popular option to use for the dyslectics, for whom the font is obviously meant.

 *Read a book in the font* is tied to the previous criterium because it also inquires about the interest in the font. Here, the same tendencies are to be found for the dyslectic participants: Dyslexie is favoured, Arial a bit less and an aversion to Times New Roman becomes again apparent. Surprisingly, this is not the case for the non-dyslectic participants. It is striking that this group rated all fonts as neutral or equally as fit to read a book in. Form this it can be concluded that non-dyslectic readers could be open to passive use of the Dyslexie font, rather than active use which was enquired in the previous category. The dyslectic participants, on the other hand, show interest in the passive and active use of the font.

## Relative evaluation of the fonts

### Data relative evaluation of the fonts

#### General relative evaluation

The last bit of data was gathered with the question “Which font did you find best readable?”. Here, Arial could be seen as ‘the winner’, since almost half of the participants, 87 of the 180 (48%), chose this as the best legible font. Followed by ten votes less is Dyslexie; 77 of the 180 participants (43%) chose this font. Times New Roman is the least favoured: only 16 participants (9%) chose this font.

#### Dyslectic vs Non-dyslectic

As in all the previous paragraphs, the comparison of dyslectic and non-dyslectic participants in relation to this question is again made. In Table 13 the same tendency as in the general evaluation can be noticed. In both groups, Arial is preferred (by 45 percent of the dyslectics and 46 percent of the non-dyslectics). However, Dyslexie does, for both groups, score not much lower than Arial with 45 percent of the dyslectic participants preferring it and 42 percent of the non-dyslectic participants. Times New Roman is preferred by the fewest participants: only 3 percent of the dyslectics chose this font as the best legible font and 15 percent of the non-dyslectics.

|  |  |  |
| --- | --- | --- |
|  | Dyslectic (65) | Non-dyslectic (115) |
| Font | Dyslexie | Times New Roman | Arial | Dyslexie | Times New Roman | Arial |
| frequency | 29 (44.6%) | 2 (3%) | 34 (52%) | 48 (42%) | 17 (15%) | 53 (46%) |

Table 13 Absolute evaluation of the fonts, dyslectic participants vs non-dyslectic

### Analysis relative evaluation of the fonts



Figure 13 Relative evaluations of the fonts, dyslectic participants vs non-dyslectic

The last part of the survey enquired the participants which font they preferred. First of all the paradox described by Bloodsworth (1993) should be taken into account. Bloodsworth (1993) states that “style and preference are often prioritised over legibility” (Bloodsworth 1993: 5). Since Times New Roman is the least preferred font, the opposite tendency has already been noticed in the previous paragraphs in the case of Times New Roman. This font was often labelled as not pleasant and not well legible, but it did yield the best overall results for reading comprehension. On the other hand, it can be stated that Times New Roman was the favourite in the categories that indicate prestige, such as *professionalism* and *scientific*. So, in this aspect, Bloodsworth’s hypothesis is not confirmed. However, it is when the data of the reading speed is taken into account. For this, the font scores lower than Dyslexie (a font without, in my opinion, any special prestige) and thus confirms the hypothesis. However, the difference with the other fonts is small thus the confirmation is only faint. In general, taking both reading speed and reading comprehension into account, the results are contradictory. However, the paradox was illustrated by a remark at the end of the survey:

“I chose Times New Roman because it is my favourite font but it is a little small in this text and therefore less legible than Arial, but I did choose Times New Roman.”

Concerning the Dyslexie font, previous studies have found this: in Kuster et al.’s investigation (2018) the children indicated that they preferred Arial and Times New Roman over Dyslexie, while in the investigation of Sparrow et al. (2016), 70 per cent of the participants preferred the Dyslexie font. The data of this experiment is compared to these two contradictory findings. In both groups, Arial is slightly preferred over Dyslexie. I had hoped that the dyslectics would have shown more appreciation towards the accommodating font, but this was not the case. From this, it can be concluded that font preference is still a subjective choice and not necessarily related to the better or worse reading speed or comprehension that it causes. This concludes the analysis of the data.

# Conclusion and Reflection

The aim of this study was to, through the experiments, to obtain data that would give insight on how the Dyslexie font influences dyslectics and non-dyslectics participants. The data that was acquired through the experiment is threefold. There is data on, first, reading speed, second, the reading comprehension and, lastly, reader preference. It was assumed that these three types of data and the connection between them would grant this general insight. However, the reality proved itself different. The results are contradictory and ambiguous and the findings should be nuanced. In this paragraph, a conclusion and reflection are made.

Keeping all analyses in mind, does the font designed by Christian Boer succeed in accommodating dyslectics? In the case of the 180 participants of this experiment, and 65 dyslectic participants in particular, the answer is partially yes and partially no. For the reading speed, it was found that the Dyslexie font causes amelioration for people with and without dyslexia. This was also found by the Sparrow et al. (2016) and Marinus et al. (2016). The difference was, unfortunately, not significant. This can make one wonder how this investigation relates to the findings of De Leeuw (2010) and Kuster et al. (2018), who found no positive effects. However, it is difficult to compare these findings as the studies use several differing methods to measure reading speed. Calculating the reading speed on the basis of a read text can not be compared to calculating the reading speed on the basis of word reading tests such as, for example, the EMT test (Eén-Minuut-Test). This study wanted to test the speed in a natural context, namely a news article, because we ought it more relevant to the purpose of the font and the intention with which it was made. However, it would be interesting if several experiments applied the same method to gain comparable results. Another aspect of the data acquired regarding the reading speed, is that the influence of the font can be observed but not what causes it. This experiment can not give any insights in what characteristics of the font cause the enhanced reading speed. An experiment in which the conditions are (more) controlled and technological equipment such as, for example, eye tracking is used could give more details on the causes. Some studies like this have been done on the Dyslexie font, such as the one by Sparrow et al. (2016), but these never link the findings to other aspects such as reading comprehension and reader preference. An interdisciplinary approach, which incorporates aspects of neurological, psychological and linguistic experimentation, could achieve a detailed study of the reading speed.

Second, there is the data on reading comprehension. The positive effect of the Dyslexie font is present in the group of dyslectic participants. In contrary to the reading speed, this was absent for the non-dyslectics. They scored better in the Times New Roman font. A shortcoming of this experiment, in relation to the reading comprehension test, is that the experiment had to be conducted online. Due to this format, it was difficult to check the actual comprehension of the reader. The size of the experiment, i.e. obtaining as much participants as possible, was prioritised over the elaboration of a detailed reading comprehension test. The format of multiple choice with a limited amount of questions was chosen to facilitate the processing and analysis of the data. Also, this lowered the amount of effort a participant had to put into the survey, which would cause less people to stop the experiment. The experiment was also already considerably long and this would minimize unnecessary extra length to the survey.

The reader preference data was gathered from two surveys: the absolute evaluation and the relative evaluation. The Dyslexie font is considered as the most pleasant and legible font out of all three fonts by the dyslectic participants. Also, this group signals that they would prefer this font the most to read a book in and to use it themselves. When the participants had the opportunity to see all three fonts next to each other, Arial appeared to be the most preferred font. However, in both groups, Dyslexie was almost equally preferred. The same remark as on reading comprehension can be made. A format in which there would be more interaction with the participant could acquire more deeper insights on the opinion, such as for example an interview. The size of the experiment, however, made us prefer quantitative data over qualitative data. Since the majority of the studies on the Dyslexie font focus on a rather small group of participants, this study made several choices in function of obtaining a large group. A qualitative study would, however, be a very interesting contribution to the research on the Dyslexia font. Related to this, a critique on the absolute evaluation of the fonts can be made. The participants could only rate the fonts on eight criteria and only on a Likert-scale from one to five. This format gives little room for nuance and personal opinions. In hindsight, the design of the experiment would have been better if the Likert-scale was bigger (for example ranging from one to ten) and if there had been a section for each font in which the participant could leave a comment. Similarly, a comment section for the relative evaluation, in which the participants could tell about their choice, would have been useful. This would have made room for more nuance, however, the format of this experiment would still not be able to approximate the depth of a qualitative study. This experiment obtained data that can indicate tendencies in evaluation, which is also valuable and a possible starting point for further research.

Regarding the data on the participants, it should be noted that some extra information would have been useful in the light of this experiment. It was asked if the participants had any experience with the Dyslexie font. This question could have been elaborated to gain a more detailed view on the exact nature of the experience and how much the experience could influence this experiment. Also, this count as well for Arial and Times New Roman. Also, this experiment was a one time sample. It would be interesting if the participants could participate in an experiment in which habituation and the analysis of achievements on different moments in time are possible. In general, the habits and experiences of the participants with certain fonts could have received more attention. This could be investigated in further research.

Lastly, it should also be mentioned that the set of participants was not ideal. Because of the degree grade of education, the set contains a bias. An ideal investigation would be able to select people at random from a dataset. However, this was not possible for this experiment since we wanted to reach as much dyslectic people as possible and these are hard to find.

This study does not yield a satisfactory result because for each section, reading speed, reading comprehension and reader preference, the data points to different directions. In general, Dyslexie is the font that reads the fastest, Times New Roman is the font that yields the best reading comprehension and Arial is the most preferred font. The threefold design of this study was intended to grant a general view of the ‘best’ font. However, this can not be obtained because of these contradictory findings. It shows that the reality is more complicated than expected. On the other hand, it could also possibly indicate that reading speed, reading comprehension and reader preference are not as connected as assumed. Either way, I still think that each of the three parts of this investigation is equally important and relevant.

From this, I conclude that a study of the Dyslexie font, that studies reading speed as well as reading comprehension and reader preference in detail, would be a study of considerable extent. I find it crucial that dyslexia research is conducted in a multi-disciplinary way, since this would yield the most detailed data.

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# Appendix

## Appendix 1: Texts

**Text 1: 8 militairen steken een handje toe in West-Vlaamse woonzorgcentra**

8 militairen zijn over onze provincie ingeschakeld om mee te helpen in een aantal woonzorgcentra. Ze helpen in de Heilige Familie in Deerlijk, maar ook in het woonzorgcentrum De Stek van Sijsele bij Damme en in Mariaburcht in Dentergem. De woonzorgcentra kunnen wel wat hulp gebruiken, omdat er ook personeelsleden thuis zitten door corona.

Korporaal Bart Samaey is sinds 21 november aan de slag in de Heilige Familie in Deerlijk. Hij zal er blijven werken tot 4 december. Het kan daarna nog worden verlengd en dat vindt Samaey niet erg. "Ik vind het mooi dat ik iets kan doen", zegt hij.

Deerlijk in plaats van Afghanistan

Korporaal Samaey is ambulancier in het leger. Hij moet daarvoor vaak op missies in het buitenland, bijvoorbeeld in Afghanistan of Litouwen. Hij is ambulancier en helpt andere soldaten als ze een snee  in de vinger hebben, of een sportblessure, of zelfs een banale verkoudheid. "Mensen eten geven, wassen en op het toilet plaatsen had ik nog niet gedaan", lacht hij, "maar dat is nu mijn job geworden. Ik denk dat ze me eerst de mensen hebben gegeven die het gemakkelijkst te transporteren waren, maar intussen ben ik al een deel van het team. Het uniform moet ik niet dragen tijdens mijn nieuwe job, ik draag net hetzelfde als mijn collega's. Dat is overigens veel hygiënischer, die kleren werp ik dan net als de collega's 's avonds bij de was. Ik voel me hier gewaardeerd, de mensen zijn me dankbaar."

source: https://www.vrt.be/vrtnws/nl/2020/11/26/leger-woonzorgcentra-coronavirus-west-vlaanderen/

**Text 2: Deinze plaatst zitbank pal voor lingeriezaak: "Ik dacht dat het een grap was"**

In Deinze staat  in de winkelstraat een zitbank met een bijzonder uitzicht. Deinze probeert de Tolpoortstraat wat op te fleuren met bloembakken en bankjes, maar dit bankje staat gericht op de etalage van een lingeriezaak. De uitbaatster is er niet over te spreken.

De parkeerplaatsen in de Tolpoortstraat in Deinze zijn vervangen door bloembakken en zitbankjes. Alleen staat één zitbankje wel heel strategisch opgesteld. Wie op het bankje zit, kijkt binnen in lingeriezaak Martieline.

Uitbaatster Sofie Martens is er niet mee opgezet: "Ik dacht dat het een grap was. We probeerden de bank nog te verplaatsen, maar hij bleek vast te zitten. Bovendien vind ik het een erg lelijk exemplaar. "

Gratis amusement

Sofie Martens wijst ook nog op andere nadelen: "Als we hier de etalage aan het maken zijn en er zitten bejaarden op het bankje, dan krijgen wij zo'n vitrinegevoel", lacht ze.

De uitbaatster is ook blij dat haar paskamers achteraan in de winkel liggen en niet in het zicht: "Stel je voor dat de paszone vooraan zou liggen, het zou hier de hele dag gratis amusement zijn. Mensen passen wat, komen al eens uit de paskamer om in de spiegel te kijken. Gelukkig is dat niet het geval."

source: <https://www.vrt.be/vrtnws/nl/2020/06/25/deinze-plaatst-bankje-op-strategische-plaats-in-winkelstraat-vo/>

**Text 3: Koppel uit Zedelgem vreest dat ook 3e trouwdatum niet kan doorgaan**

Aline De Cokere en Dieter Bleyaert uit Zedelgem hebben hun trouw al 2 keer moeten uitstellen door de coronacrisis, maar ook de 3e trouwdatum komt nu in het gedrang door de 2e besmettingsgolf. "We hopen eindelijk te kunnen trouwen in oktober, maar hebben nog geen enkel perspectief", zegt Aline.

23 mei 2020 zou een memorabele datum worden voor Aline en Dieter uit Aartrijke bij Zedelgem, maar daar stak de coronacrisis een stokje voor. Het trouwfeest werd noodgedwongen uitgesteld naar 24 juli. En ook die datum moest het koppel schrappen. De 2 hopen nu te kunnen trouwen in oktober, maar vrezen ervoor. "We zijn afhankelijk van de coronacijfers en het ziet er momenteel niet goed uit. We blijven geduldig afwachten, maar er is voorlopig nog geen toekomstperspectief", getuigt bruid Aline op Radio 2 West-Vlaanderen.

"We beseffen dat er nog ergere zaken zijn dan ons trouwfeest dat niet kan doorgaan. We zijn enorm dankbaar dat we gezond en wel zijn. Maar het houdt ons natuurlijk wel bezig", gaat ze verder. "We zijn wel al voor de wet getrouwd. En dat hebben we met ons tweetjes gevierd op de oorspronkelijke datum. Maar we willen heel graag ons huwelijk vieren met al onze vrienden en familieleden. Zo'n groot trouwfeest vergt veel organisatie: de kerk, de pastoor, de zaal, de dj, de fotograaf, de gasten ... Wie weet hoe vaak we alles nog eens moeten omboeken?"

Gisterenavond heeft de regering de sociale bubbel drastisch ingeperkt. Niet-begeleide bijeenkomsten - zoals samenscholingen, uitstappen of ontmoetingen met familie of vrienden - zijn beperkt tot maximaal 10 personen. Dat geldt ook voor huwelijksfeesten

source: <https://www.vrt.be/vrtnws/nl/2020/07/28/koppel-aartrijke-derde-trouwdatum/>

## Appendix 2: Multiple Choice questions reading comprehension test

Text 1

1) Tijdens welke periode werkt korporaal Bart Samaey in de Heilige familie?

1. 21 december tot 4 januari
2. 21 november tot 4 januari
3. 21 november tot 4 december
4. Ik weet het niet.

2) Hoe zou u de ervaring van korporaal Bart Samaey als hulpverlener in het woonzorgcentrum omschrijven?

1. Hij vindt de job te moeilijk aangezien hij geen ervaring had
2. Hij voelt zich gewaardeerd en nuttig.
3. Hij voelt zich niet gewaardeerd in het woonzorgcentrum.
4. Ik weet het niet.

3) Welke toon vindt u dat dit artikel heeft?

1. positief
2. pessimistisch
3. beangstigend
4. Ik weet het niet

text 2

1) In welke straat werd de zitbank voor de lingeriezaak geplaatst?

1. In de Pollepelstraat.
2. In de Overpoortstraat.
3. In de Tolpoortstraat.
4. Ik weet het niet.

2) Wat bedoelt Sofie Martens met “vitrinegevoel”?

1. Dat ze de vitrine vaak aanraken wanneer ze de etalage aan het maken zijn.
2. Dat ze het gevoel hebben dat ze zelf in de etalage staan, net zoals paspoppen.
3. Dat hun etalage eerder lijkt op een vitrine dan een etalage.
4. Ik weet het niet.

3) Wat is het algemene gevoel van de uitbaatster van de lingeriewinkel bij het nieuwe bankje?

1. Ze vindt dat het bakje nogal ongelukkig geplaatst is.
2. Ze is tevreden met de nieuwe zitplaats voor eventuele klanten.
3. Ze is erg boos dat het bankje op deze manier geplaatst is.
4. Ik weet het niet.

text 3

1) Wat was de tweede geplande datum voor het huwelijk van Aline en Dieter?

1. 23 mei
2. 24 oktober
3. 24 juli
4. Ik weet het niet.

2) Wat is de houding van Aline en Dieter tegenover het feit dat ze hun huwelijksfeest al meerder malen moeten uitstellen hebben?

1. Ze zijn ongelukkig.
2. Ze vinden het vervelend maar kunnen het wel relativeren.
3. Ze zijn boos op de regering.
4. Ik weet het niet

3) Dit artikel kan je definiëren als:

1. Een getuigenis.
2. Een opiniestuk
3. Een post op social media.
4. Ik weet het niet.

## Appendix 3: Absolute evaluation fonts

Ik vind het bovenstaande lettertype…

1. Esthetisch (ik vind het er mooi uitzien)
2. Duidelijk (de letters zijn goed te herkennen)
3. Aangenaam om te lezen
4. Er professioneel uitzien
5. Een lettertype dat ik zelf zou gebruiken
6. Een lettertype waarin ik een boek zou willen lezen
7. Een lettertype dat ik in een wetenschappelijk artikel zou kunnen verwachten
8. Een lettertype dat ik in een kinderboek zou kunnen verwachten

Likert scale: 1 = akkoord, 5 = niet akkoord