Good Background Colors for Readers: A Study of People with and without Dyslexia

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ABSTRACT

The use of colors to enhance the reading of people with dyslexia have been broadly discussed and is often recommended, but evidence of the effectiveness of this approach is lacking. This paper presents a user study with 341 participants (89 with dyslexia) that measures the effect of using background colors on screen readability. Readability was measured via reading time and distance travelled by the mouse. Comprehension was used as a control variable. The results show that using certain background colors have a significant impact on people with and without dyslexia. Warm background colors, *Peach*, *Orange* and *Yellow*, significantly improved reading performance over cool background colors, *Blue*, *Blue Grey* and *Green*. These results provide evidence to the practice of using colored backgrounds to improve readability; people with and without dyslexia benefit, but people with dyslexia may especially benefit from the practice given the difficulty they have in reading in general.

Keywords

Background colors, Dyslexia, Readability, Reading Speed

Categories and Subject Descriptors

K.4.2 [**Computers and Society**]: Social Issues—*Assistive technologies for persons with disabilities*; K.3 [**Computers in Education**]: Computer Uses in Education—*Computer-assisted instruction*

1. INTRODUCTION

More than 10% of the population has dyslexia, a specific learning disability with a neurobiological origin [15, 17, 32]. The *World Federation of Neurology* defines dyslexia as a disorder in children who, despite conventional classroom experience, fail to attain the language skills of reading, writing, and spelling commensurate with their intellectual abilities [33].

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The use of different background colors to enhance reading performance of those with dyslexia has been broadly discussed in previous literature and has been recommended by institutions such as the *British Dyslexia Association* [4]. To the extent of our knowledge the existing recommendations are not based on objectives measures collected with large user studies. In this paper, we present the first study that measures the impact of ten background colors on the reading performance. The user study was carried out with a large number of participants (341) with and without dyslexia, allowing for a statistical comparison between groups.
The main contributions of this study are:

- Background colors have an impact on the readability of text for people with and without dyslexia, and the impact is comparable for both groups.
- Warm background colors such as *Peach*, *Orange*, or *Yellow* are beneficial for readability taking into consideration both reading performance and mouse distance. Also, cool background colors, in particular *Blue Grey*, *Blue*, and *Green*, decreased the text readability for both groups; however, this do not necessarily mean that such colors need to be avoided.
- When reading on screen, people with dyslexia present a significantly higher use of the mouse in terms of distance travelled by the mouse.

The next section focuses on dyslexia, reviews related work, and explains the relationship of dyslexia to visual stress syndrome (Meares-Irlen syndrome). Section 3 explains the experimental methodology and Section 4 presents the results, which are discussed in Section 5. In Section 6 we derive recommendations for dyslexic-friendly background colors and mention future lines of research.

2. DYSLEXIA AND COLORS

According to the *International Association of Dyslexia*, dyslexia is characterized by difficulties with accurate and/or fluent word recognition and 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 [20]. Therefore, in theory, dyslexia is not related to the color in which the text or the background is presented. However, there are a number of studies and recommendations regarding colors and dyslexia. One possible explanation for this is that visual stress syndrome (Meares-Irlen syndrome) is associated with dyslexia. In this section we explain both, (i) the previous work regarding color recommendations and dyslexia, and (ii) the relationship of dyslexia to Meares-Irlen syndrome.

2.1 Related Work

McCarthy and Swierenga stated that poor color selections are one of the key problems encountered by people with dyslexia when reading on a screen [21]. There are a number of studies that have recommended the use of certain fonts or background colors. According to Perron, high contrast creates so much vibration that it diminishes readability [23]. Likewise, Bradford recommends avoiding high contrast and suggests pairing off-black/off-white for font and background respectively to enhance Web accessibility for people with dyslexia [3]. In a user study carried out by Gregor and Newell [12, 13] mucky green/brown and blue/yellow pairs were chosen by people with dyslexia.

An eye-tracking study of 22 participants with dyslexia [28] showed that a black font over a cream background presented shorter fixation durations among the participants, being the most readable pair. The same experimental setting was later performed with a larger group of participants (92 people, 46 with dyslexia and 46 as a control group) giving comparable results [26]. Similarly, a cream background color is recommended by the *British Dyslexia Association* [4].

Our study advances previous work in two ways (i) we are using 10 background colors with black font similar to the color overlays used to treat Meares-Irlen syndrome, even if it is not a language based disorder, given their previous success in that target population (see Section 2.2); (ii) it is the first time that a mouse tracking measure is used to address text readability for participants with dyslexia; and (iii) the user study was carried out with a large number of participants with and without dyslexia allowing a statistical comparison between the groups.

2.2 Dyslexia and Meares-Irlen syndrome

Dyslexia rarely occurs alone. Dyslexia has a wide range of comorbities, that is, conditions that exist simultaneously but are independent to dyslexia. The most common ones are: dysgraphia, attention deficit disorder and attention deficit hyperactivity disorder, and visual stress syndrome (Meares-Irlen syndrome). Among the visual difficulties associated with dyslexia that could be alleviated by modifications of the visual display [10], the most studied is Meares-Irlen syndrome [18].

Meares-Irlen Syndrome is a perceptual processing disorder, meaning that it relates specifically to how the brain processes the visual information it receives. Unlike dyslexia, it is not a language-based disorder but it is comorbid with dyslexia.

Of individuals with dyslexia, 25.84% in Spanish-speakers [1] to 46% in Portuguese-speakers [14] have Meares-Irlen Syndrome. These estimations are of native speakers of Spanish and Portuguese, respectively. Meares-Irlen syndrome is characterized by symptoms of visual stress and visual perceptual distortions that are alleviated by using individually prescribed colored filters. Patients susceptible to pattern glare, perceptual distortions and discomfort from patterns, may have Meares-Irlen syndrome and are likely to find colored filters useful [11].

Kriss and Evans [18] compared colored overlays on a group of 32 children with dyslexia with a control group of same size. The differences between the two groups did not reach statistical significance. The authors conclude that Meares-Irlen syndrome is prevalent in the general population and possibly somewhat more common for people with dyslexia. Children with dyslexia seemed to benefit more from colored overlays than non-dyslexic children. The authors stress that Meares-Irlen syndrome and dyslexia are separate entities and are detected and treated in different ways [18].

Moreover, Jeanes *et al.* [16] showed how color overlays improved the reading performance of children in school without taking into consideration dyslexia or other visual difficulties. Gregor and Newell [13], and later Dickinson *et al.* [7] have shown that visual changes in the presentation of text may alleviate some of the problems generated by dyslexia and visual comorbidities.

3. METHODOLOGY

To study the effect of background colors on screen readability, we conducted a user study where 341 participants (89 with dyslexia) read 10 comparable texts with varying background colors. Readability was measured via reading speed and a mouse-tracking measure, while comprehension was used as a controlled variable measured by comprehension tests.

3.1 Experimental Design

3.1.1 Independent variables

In our experimental design, *Background Color* served as an **independent variable** with 10 levels. The text color used in all samples was black (f00000). Following we present each of the levels of *Background Color* followed by the RGB color values, the hex color value; and the luminosity contrast ratio[1]). Since all the color contrasts are greater than 7:1 they all meet the WCAG[5] color contrast requirements for AAA.

- *Blue:* RGB(150, 173, 252); #96ADFC; 9.68:1.
- *Blue Grey:* RGB(219, 225, 241) #DBE1F1; 16.05:1.
- *Green:* RGB(219, 225, 241) #A8F29A; 15.83:1.
- *Grey:* RGB(168, 242, 154) #D8D3D6; 14.21:1.
- *Orange:* RGB(216, 211, 214) #EDDD6E; 15.17:1.
- *Peach:* RGB(237, 221, 110) #EDD1B0; 14.35:1.
- *Purple:* RGB(237, 209, 176) #B987DC; 7.56:1.
- *Red:* RGB(185, 135, 220) #E0A6AA; 10.2:1.
- *Turquoise:* RGB(224, 166, 170) #A5F7E1; 16.99:1.
- *Yellow:* RGB(248, 253, 137) #F8FD89; 19.4:1.

We chose to study these colors because they have been recommended and studied in previous literature about dyslexia [4, 12, 26] and Meares-Irlen syndrome, which is comorbid with dyslexia [1, 14]. See Section 5 for a comparison of our results with previous studies.

[1]Color Contrast Tester available at: https://www.joedolson.com/tools/color-contrast.php

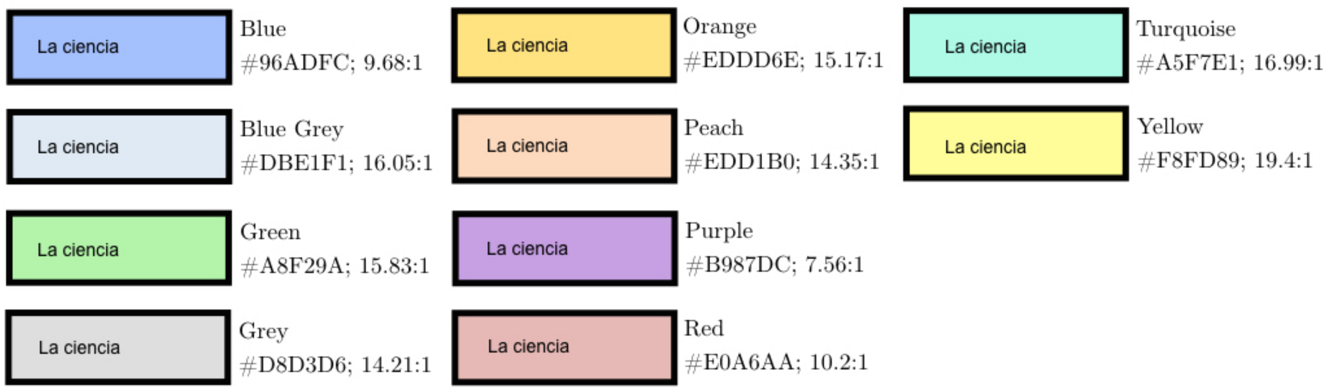

Figure 1: The 10 background colors used in the experiment as independent variables using black font including their Hex color values and the luminosity contrast ratio between the black font and the background color: *Blue*, *Blue Grey*, *Green*, *Grey*, *Orange*, *Peach*, *Purple*, *Red*, *Turquoise*, **and** *Yellow***.**

3.1.2 Dependent Variables

For quantifying readability, we use three **dependent measures**: *Reading Time* and *Mouse Distance*. The latter one was extracted using mouse-tracking. To control **Comprehension** of the text we use two comprehension questions as *control variables*.

To track mouse movements we used an an open source, client-server architecture mouse tracking tool called smt2 [19].[2]. This software allowed us to log mouse movements at fixed-time intervals. This process does not interfere with the user's browsing experience or introduce delays associated with data capture.

- *Reading Time:* Shorter reading durations are preferred to longer ones as faster reading is related to more readable text. Therefore, we use *Reading Time*, *i.e.* the time it takes a participant to completely read one text sample, as a measure of readability.

- *Mouse Distance:* The total number of pixels that the mouse travelled over the text. Having a computer with a mouse was a requirement for the study so no finger movements were recorded as mouse movements. Mouse movements were possible but not required during the reading of the text (except for pushing the "ok" button when the participant finished reading the text). The main measure to address readability is *Reading Time* and *Mouse Distance* can be treated as a secondary readability indicator. A user study with 90 participants [22] found that the more complex the text was, the more mouse tracking movements the participants made. Hence, we can conclude that shorter mouse distances could be related to higher text readability.

3.1.3 Control variable

To check that the text was not only read, but also understood, we used two literal questions, that is, questions that can be answered straight from the text. We used multiple-choice questions with three possible choices: one correct choice, and two wrong choices. We use these comprehension questions as a *control variables* to guarantee that the data analyzed in this study were valid. If the reader did not choose the correct answer, the corresponding text was discarded from the analysis.

3.1.4 Design

We used a *within-subject* design, that is, all the participants contributed to all the conditions reading 10 different texts with all 10 different background colors. We counterbalanced the colors to avoid sequence effects, hence there were 10 different variants of the experiment where the order in which a certain background color appeared was not repeated. Therefore, the data were evenly distributed with respect to text order and color combinations .

We also controlled having a balanced participant representation of all the experimental variants. Each of the 10 variants was undertaken by no less than 33 participants and no more than 35 participants (34.1 participants x 10 variants equals our 341 participants). The distribution of the groups -with and without dyslexia- contributing to each of the variants was also controlled. Participants with dyslexia contributed to all the variants, and their distribution ranged from 16.13% to 25.71%.

3.2 Participants

Overall, 341 participants undertook the experiment, including 89 people (69 female, 20 male) with dyslexia or at risk of having dyslexia (Group Dyslexia). Their ages ranged from 18 to 60 ($\bar{x}$ = 38.38, s = 11.02). The control group (Group Control) had 252 people (195 female, 57 male). Their ages ranged from 18 to 60 ($\bar{x}$ = 37.79, s = 10.31). They were all Spanish native speakers, although 160 were bilingual (50% in group Control and 38.20% in Group Dyslexia) in Catalan, Galician, Basque, and English.

Participants were recruited through a public call that dyslexia associations distributed to their members; 66 participants had a confirmed diagnosis of dyslexia including the date the place where they were diagnosed; 23 subjects were at risk of having dyslexia (under observation by profession-

[2]Available at: https://smt.speedzinemedia.com/downloads.php

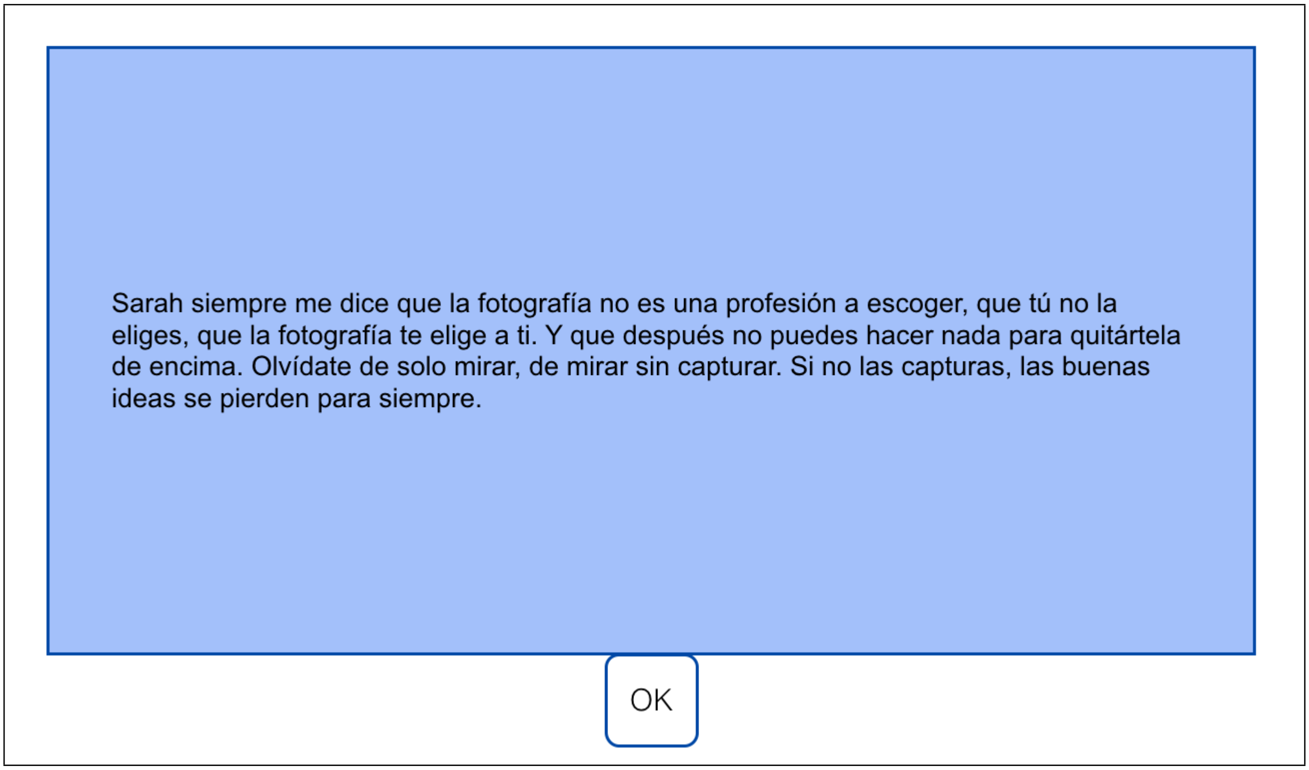

Figure 2: Sample slide used in the study with background color *Blue*.

als) or suspected to have dyslexia. Note that all the participants were adults and finding adults with confirmed diagnosis of dyslexia is more challenging than finding children with a confirmed diagnosis. Participants from the control group were also volunteers responding to the call for volunteers made through dyslexia associations as well as family and friends from the group with dyslexia. Participants took the experiment from different Spanish speaking countries; there were participants from Spain (212), Argentina (76), Mexico (16),Chile (9), Venezuela (5), USA (5), Peru (4), Colombia (2), and Panama (2).

Overall, the participants presented a high education profile as 83.28% had a college degree or higher: primary education (6 participants), secondary education (23), professional education (28), college (66), university (131), masters (62), and Ph.D. (25).

It is worth noting that Meares-Irlen syndrome remains undiagnosed in Spanish speaking countries. We specifically asked our participants if they were diagnosed with any visual stress syndromes. Only one of them, who had previously lived in the United Kingdom, was diagnosed with Meares-Irlen syndrome in addition to dyslexia.

3.3 Materials

To isolate the effects of the background color presentation, the texts need to be comparable in complexity. In this section, we describe how we designed the study material.

3.3.1 Texts

All the texts used in the experiment meet the comparability requirement because they all share parameters commonly used to compute readability [9]. All the texts were extracted from a chapter of the same book, *Impostores ('The Impostors')* , by Lucas Sánchez [30]. Each paragraph shared the following characteristics: (i) same genre; (ii) same style; (iii) same number of words (55 words)[3]; and (iv) absence of numerical expressions and acronyms because people with dyslexia encounter problems with such words [6, 27]. See Figure 2 for an example of one of the texts used.

3.3.2 Text Presentation

Text presentation has an effect on the reading speed of people with dyslexia [13], hence we used the same layout for all the texts (except for the *Background Color* condition): The texts were left-justified [4], using an 18-point sized [29] *Arial* font type [25]. The font color was black, the most frequently used on the Web.

3.3.3 Comprehension Control Questions

After the participants read the texts, there were two literal comprehension control questions. The order of the correct answer was counterbalanced. An example of one of these questions is given below.

- *The neighbors of the story...*
  Los vecinos de la historia...
  - *were happy when the tree was cut down.*
    se alegraron cuando cortaron el árbol.
  - *liked the tree very much.*
    les gustaba mucho el árbol.

[3]If the paragraph did not have that number of words we slightly modified it to match the number of words.

Group Dyslexia	*Reading Time*			*Group Control*	*Reading Time*		
Color	$\tilde{x}$	$\bar{x} \pm s$	%	Color	$\tilde{x}$	$\bar{x} \pm s$	%
Peach	13.72	14.85 ± 6.29	100	Peach	11.32	12.28 ± 5.09	100
Orange	20.19	15.33 ± 6.02	103	Orange	11.78	12.32 ± 4.07	100
Yellow	15.07	16.30 ± 6.06	109	Yellow	12.81	13.43 ± 4.52	109
Purple	16.58	17.21 ± 6.28	115	Purple	14.03	14.68 ± 5.38	119
Red	17.18	17.47 ± 5.96	117	Red	13.90	14.97 ± 6.05	121
Turquoise	17.47	17.59 ± 5.99	118	Turquoise	13.64	14.54 ± 4.76	118
Grey	17.48	18.05 ± 5.95	121	Grey	14.88	16.03 ± 5.97	130
Blue	17.84	19.42 ± 7.61	130	Blue	15.12	16.24 ± 5.71	132
Green	18.78	19.42 ± 7.18	130	Green	14.81	16.45 ± 6.77	133
Blue Grey	20.19	21.57 ± 6.93	145	Blue Grey	18.15	18.82 ± 6.00	153

Table 1: Median, mean and standard deviation of *Reading Time* in seconds. Colors are sorted by the mean $\bar{x}$. We include the relative percentage for *Reading Time*, our main readability measure, with respect to the smallest average value, *Peach*.

- *talked and babbled with the tree.*
  hablaban y balbuceaban con el árbol.

3.4 Procedure

We sent an announcement of the study to the main associations of dyslexia in countries with large Spanish-speaking populations, including the United States. Interested potential participants contacted us, and after we checked their participation requirements (age, native language, and technical requirements, *i.e.* having a laptop or desktop computer with the Chrome browser installed as well as the use of mouse), we set up a date to supervise the study. We met the participants on-line. After they signed the on-line consent form, we gave them specific instructions and they completed the study. They were asked to read the 10 texts in silence and complete the comprehension control questions. While answering the questions they could not look back on the text. Each session lasted from 10 to 15 minutes long.

4. RESULTS

In the first step we cleaned up the data considering the answers of the comprehension questions. We discarded the data of 4.9% of the participants (17) due to failing the comprehension test.

We use the Shapiro-Wilk test for checking if the data fits a normal distribution. The test showed that none of the data sets (10 for each group) were normally distributed for *Reading Time* and *Mouse Distance*. As our data set was not normal, we include the median and box plots for all our measures in addition to the mean and the standard deviation. For the same reason, to study the effects of the dependent variables (repeated measures) we used the two-way Friedman's non-parametric test for repeated measures plus a complete pairwise Wilcoxon rank sum post-hoc comparison test with a Bonferroni correction that includes the adjustment of the significance level. In the post-hoc tests we used the Bonferroni adjustment [2] because it is the most conservative approach in comparison with other adjustment methods. Finally, we used the Spearman's rank-order correlation for nonparametric data to understand the strength of the association between groups and the main indicator of dyslexia in Spanish, *Reading Time* [31] and *Mouse Distance*.

We used the R Statistical Software 2.14.1 [24] for our analysis, with the standard condition of $p < 0.05$ for significant results. We only report post-hoc test results when significant effects were found.

4.1 Reading Time

Table 1 shows the main statistical measures[4] of the main readability indicator *Reading Time* for participants with and without dyslexia in each of the *Background Color* conditions.

There was a significant effect of *Background Color* on *Reading Time* ($\chi^2(9) = 1154.81,\ p < 0.001$).

- **Between Groups:** Participants with dyslexia had significantly longer reading times ($\bar{x} = 17.73$, $s = 20.28$ seconds) than the participants without dyslexia ($\bar{x} = 14.98$, $s = 20.17$ seconds, $p < 0.001$).

  For *Reading Time* the Spearman's correlation coefficient between groups is $\rho = 0.964$, and it is statistically significant ($p < 0.001$).

- For **Group Dyslexia** there was a significant effect of *Background Color* on *Reading Time* ($\chi^2(9) = 299.16,\ p < 0.001$) (Table 1, Figure 3). The results of the post-hoc tests show that:
  - *Peach* had the shortest mean reading time. Participants had significantly shorter reading times using *Peach* than *Blue Grey* ($p < 0.001$), *Green* ($p < 0.001$), *Blue* ($p < 0.001$), *Grey* ($p = 0.002$), *Turquoise* ($p = 0.026$), and *Red* ($p = 0.035$).
  - *Orange* had the second shortest mean reading time. Participants had significantly shorter reading times using *Orange* than *Blue Grey* ($p < 0.001$), *Green* ($p = 0.001$), *Blue* ($p = 0.002$), and *Grey* ($p = 0.002$).
  - Similarly, *Yellow* had the third shortest reading time, significantly shorter than using *Blue Grey* ($p < 0.001$), *Green* ($p = 0.029$), and *Blue* ($p = 0.040$).
  - *Blue Grey* had the longest reading time. This background color lead to significantly longer reading times than using *Peach* ($p < 0.001$), *Orange* ($p < 0.001$), *Yellow* ($p < 0.001$), *Purple*

[4]We use $\bar{x}$ for the mean, $\tilde{x}$ for the median, and s for the standard deviation.

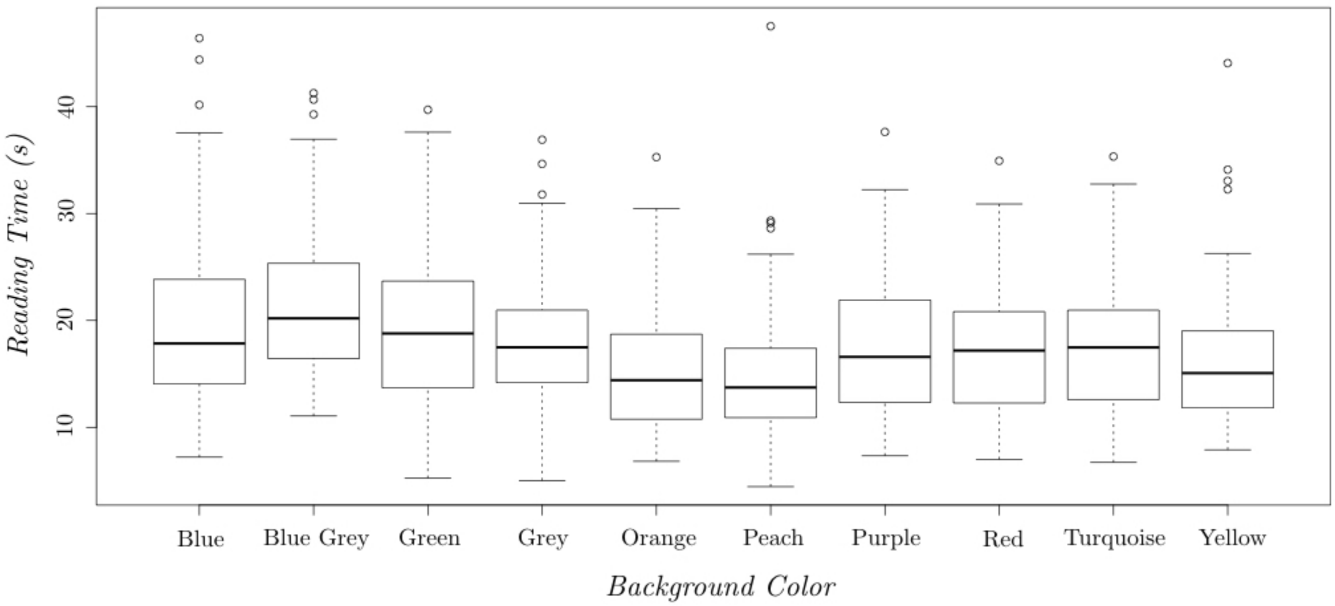

Figure 3: *Reading Time* **box plots by** *Background Color* **for Group Dyslexia.**

($p = 0.001$), *Red* ($p = 0.004$), and *Turquoise* ($p = 0.005$).

- Likewise, in **Group Control** there was a significant effect of *Background Color* on *Reading Time* ($\chi^2(9) = 859.37,\ p < 0.001$) (Table 1, Figure 4). The results of the post-hoc tests show that:
  - *Peach* had the shortest reading time, significantly shorter than the rest (all with $p < 0.005$) except *Orange*, which had the second shortest duration.
  - *Orange* had the second shortest reading time, significantly shorter than the rest of the background colors ($p < 0.001$) except for *Peach* and *Yellow*, having *Yellow* the third shortest reading time.
  - *Yellow* had the third shortest reading time, significantly shorter than *Purple* ($p = 0.046$), *Red* ($p = 0.032$), *Grey* ($p < 0.001$), *Blue* ($p < 0.001$), *Green* ($p < 0.001$), and *Blue Grey* ($p < 0.001$).
  - *Turquoise* had the fourth shortest reading time, significantly shorter than *Grey* ($p = 0.030$), *Blue* ($p = 0.009$), *Green* ($p = 0.033$), and *Blue Grey* ($p < 0.001$).
  - *Blue Grey* had the longest reading time, significantly longer than the rest: *Peach* ($p < 0.001$), *Orange* ($p < 0.001$), *Yellow* ($p < 0.001$), *Purple* ($p < 0.001$), *Red* ($p < 0.001$), *Turquoise* ($p < 0.001$), *Grey* ($p < 0.001$), *Blue* ($p < 0.001$), and *Green* ($p < 0.001$).
  - *Blue* had the second longest reading time, significantly longer than *Peach* ($p < 0.001$), *Orange* ($p < 0.001$), *Yellow* ($p < 0.001$), *Purple* ($p = 0.022$), *Red* ($p = 0.046$), and *Turquoise* ($p = 0.010$).

4.2 Mouse Distance

There was a significant effect of *Background Color* on *Mouse Distance* ($\chi^2(9) = 215.47,\ p < 0.001$).

- **Between Groups:** Participants with dyslexia had significantly longer *Mouse Distance* ($\bar{x} = 1954.64$, $s = 262.62$ pixels) than the participants without dyslexia ($\bar{x} = 1546.90$, $s = 285.54$ pixels), $p = 0.015$).

  For *Mouse Distance* between groups, the Spearman's correlation coefficient is $\rho = 0.794$, and it is statistically significant ($p = 0.010$).

- For **Group Dyslexia** there was a significant effect of *Background Color* on *Mouse Distance* ($\chi^2(9) = 24.66,\ p = 0.003$). The results of the post-hoc tests show that:
  - *Blue Grey* had the longest mean *Mouse Distance* time and lead to significantly longer distances than: *Grey* ($p = 0.026$), *Orange* ($p = 0.039$), and *Red* ($p = 0.010$).

- For **Group Control** there was a significant effect of *Background Color Mouse Distance* ($\chi^2(9) = 196.01,\ p < 0.001$).

  The results of the post-hoc tests show that:
  - *Blue Grey* also had the longest *Mouse Distance* mean and lead to significantly longer distances than the rest of the background colors (all with a $p - value < 0.001$). *Blue* had the second longest *Mouse Distance* and participants reading over *Blue* had significantly longer mouses distances than *Grey* ($p = 0.033$) and *Red* ($p = 0.008$).

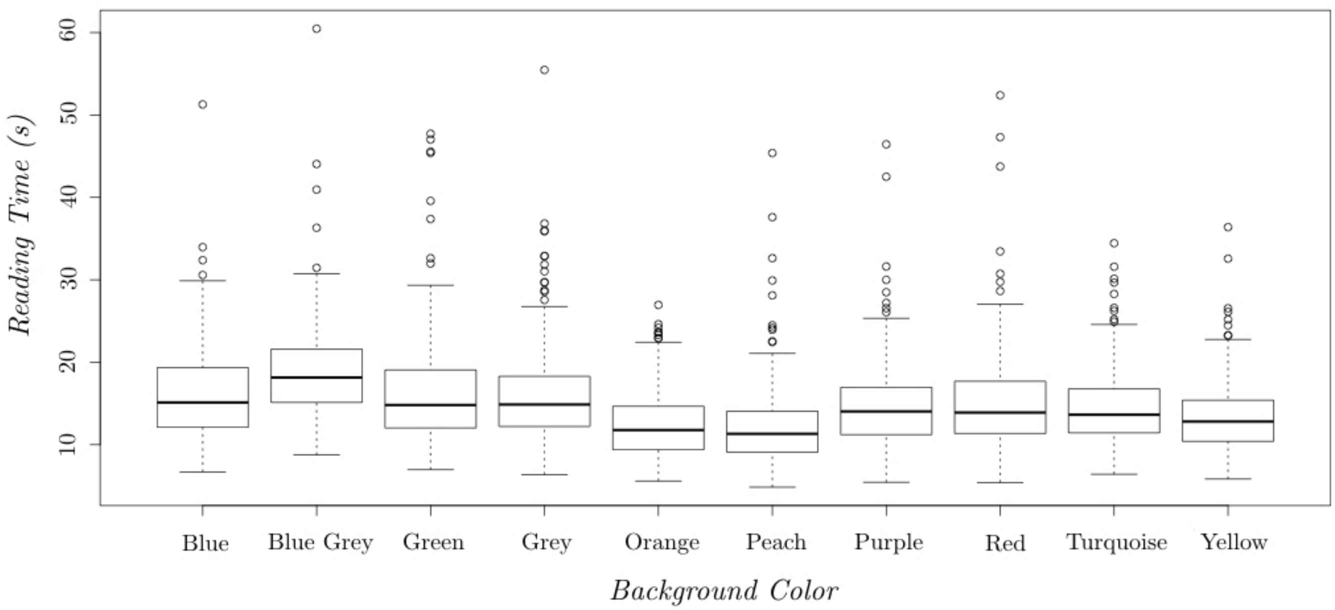

Figure 4: *Reading Time* **box plots by** *Background Color* **for Group Control.**

5. DISCUSSION

First, our results on reading performance provide evidence that background colors have an impact on readability. Second, these results are consistent with previous studies and most of the current text design recommendations for people with dyslexia. *Peach*, *Orange*, and *Yellow* background colors with black fonts lead to shorter reading times. These are similar to the "cream" color recommended by the *British Dyslexia Association* [4] which is used on their website. [5] It is also consistent with previous research using eye-tracking data with 92 people (46 with dyslexia) where the shortest fixation duration mean was collected when participants read black text over a cream background color [26].

Overall, if we group the colors as *warm colors* and *cool colors* we can observe a consistent behavior of the participants for all measures. *Warm colors*, *i.e.* *Peach*, *Orange*, and *Yellow* lead to significantly faster readings and less mouse movements, while *cool colors*, *Blue Grey*, *Blue*, and *Green*, lead to significantly longer reading times and more concentration of mouse movements. These results do not necessarily mean that *warm colors* are recommended for people with and without dyslexia. Normally, warm colors are used to stimulate observers. For instance, the human retina has a higher response to yellow hues than to any other colors.[6] To the contrary, cool colors are generally used to calm and relax the viewer. Some readers might prefer a cool color rather than a warm color if that color relaxes the reader. Further studies would need to explore the interaction between reading performance and reading preferences to make a sound background color recommendation.

Another conclusion that could be derived from this experiment is that both participants with and without dyslexia behave consistently against similar background color stimuli. For both groups, *warm colors* (*Peach*, *Orange*, and *Yellow*) lead to faster reading. Likewise, *cool colors*, especially *Blue Grey* and *Blue*, lead to significantly shorter readings for both groups. In fact, the correlations between groups for *Reading Time* and *Mouse Distance* measures are strong and significant, $\rho = 0.964$ ($p < 0.001$) and $\rho = 0.794$ ($p = 0.010$) respectively. This is consistent with previous literature, as there is a common agreement in specific studies about dyslexia and accessibility that the application of dyslexic-accessible practices, *i.e.* *Sans Serif* fonts or the use of larger font sizes, benefits readability for users without dyslexia [8, 21, 26].

People with dyslexia also present significantly more mouse movements (*Mouse Distance*) when reading text than people without dyslexia. Even if this was not the focus of this study, to the extent of our knowledge, this is the first result reported on this.

6. CONCLUSIONS AND FUTURE WORK

The main conclusions are:

- Background colors have an impact on text readability for people with and without dyslexia, and the impact is comparable for both groups.
- Warm background colors such as *Peach*, *Orange* or *Yellow* are beneficial for readability, taking into consideration both reading performance and mouse tracking measures. Also, cool background colors, in particular *Blue Grey*, *Blue*, and *Green*, decreased the text readability for both group.
- When reading on screen, people with dyslexia present a significantly higher use of the mouse in terms of the distance travelled by the mouse.

In future work we plan to address the current limitations of this study, taking into account other measures such as

[5] http://www.bdadyslexia.org.uk/

[6] http://www.scribblelive.com/blog/2011/12/07/the-use-of-yellow-in-data-design/

the user's preference. We plan to compare the most beneficial background colors (*Peach*, *Orange* and *Yellow*) with the most common background colors used on the Web such as white or off-white. Since the current study only used back font, we will also explore other font and background combinations used in previous literature.

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