A Chrome extension to help people with dyslexia

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ABSTRACT

Even if the World Wide Web is one of the main content and service providers, unfortunately, these contents and services are not really available for everyone. People affected by impairments often have difficulties in navigating Web pages for a wide range of reasons. In this paper, we focus on people affected by dyslexia. These users experience difficulties in reading acquisition, despite normal intelligence and adequate access to conventional instruction. For this reason, we have created *Help me read!*, a Chrome extension that allows to change many features of a Web page. Furthermore, it allows to isolate and enlarge one word at a time. This feature is crucial as it allows people with dyslexia to focus on each single word, thus overcoming one of their main difficulties.

CCS CONCEPTS

• **Human-centered computing** → **Accessibility technologies**; **Accessibility systems and tools**;

KEYWORDS

web browser, web pages, dyslexia, accessibility

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1 INTRODUCTION

In the Digital Revolution Era, one of the key aspects of inclusiveness is Web accessibility [15, 19, 20]. Indeed, people with visual, auditory impairments or cognitive and learning disabilities, may experience difficulties while navigating the Web [12]. Web accessibility would allow users with disabilities to browse the Internet without encountering barriers in accessing the desired content. In order to provide some common standards for the accessibility of websites, the Web Content Accessibility Guidelines (WCAG) have been released. This set of recommendations offers a framework for Web development to make digital content accessible to everyone.

In this context, one of the most crucial challenges is addressing the needs of people with cognitive and learning disabilities, as there is a wide variation in capabilities and limitations of this population. It ought to lead to a greater emphasis on configurability in order to allow the users to shape their presentation preferences [29].

In particular, dyslexia embodies one of the most common neurodevelopmental disorders and, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), it falls within a category of Specific Learning Disorder (SLD) [11]. Dyslexia, currently referred to as SLD with impairment in reading, is characterized by problems with accurate and/or fluent word recognition, poor decoding and reading comprehension [26]. There are different dimensions of dyslexia and several factors have been indicated as contributing to this learning disorder. However, it is important to emphasize that the impact of dyslexia extends far beyond problems with written language [16]; it influences the educational performance, as it impacts cognitive processes, i.e. memory, speed of processing, time management, coordination and automaticity [26].

People with dyslexia may struggle also with Web navigation. The key issues are related to confusing page layout, unclear navigation, poor color selection, the size of graphics and texts, and complicated language and terminology [13][18]. Tools enabling the customization of some elements of the websites can be of a great help for people with dyslexia, improving the accessibility and usability also for a standard user [24].

In this context, we present here a Google Chrome extension, named *Help Me Read!*, created with the aim of facilitating the Web navigation for people with dyslexia. Our solution allows the users to change color, font size, line-spacing and other web page features in real time. Moreover, it includes an *easy reading mode*, which allows highlighting a single word, isolating and enlarging it, so it is easier to focus on decoding one word at a time and overcome one of the main dyslexia-related difficulties.

This article is organized as follows. Section 2 overviews related work. In Section 3, we provide the implementation details of our solution, whereas in Section 4 we report the outcome of preliminary tests involving interested users. Finally, we conclude in Section 5.

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2 RELATED WORKS

Other works in literature address the problem of helping users with dyslexia, in many cases through the use of serious game paradigm [14, 17, 22, 23, 25, 27, 28]. As an example, DYSL-X [28] is a game where a robot dog has to fight against a gang of criminal cats. To help Diesel, the game asks the players to recognize letters.

Letterprins [27] is a game designed to improve the reading development of children with reading disorder. The game asks the children to pronounce letters or words, while a caregiver has to indicate the correctness of the child's answers. Jellys [22] is a video game for the training of visual attention and auditory rhythm.

Games are also used for screening risk of dyslexia [17, 23] to avoid a problem of the children being diagnosed after they have failed school, even if dyslexia is not related to general intelligence.

All these works present interesting results, but the use of the serious game paradigm is more suitable for children than for adults and for training activities. In this work, we are focused not only on children but also on adults with dyslexia. We want to help users during their normal web surfing, an activity which may have various goals, from information seeking to entertainment.

Other browser extensions were implemented to help users with dyslexia to read the Web pages [1–5, 7, 9]. Most of them allow to change the aspect of the Web pages to facilitate the reading: e.g., the font (Dyslexia Friendly [5], Dyslexia Reader Chrome [2], Dyslexia Unscrambled [1], Open Dyslexic Font [7], Easy Reading [4] and Helperbird [9]) and the colors of the text and the background or their contrast (Dyslexia Friendly, Dyslexia Reader Chrome, Dyslexia Unscrambled and Helperbird). Dyslexia Reader Chrome and Dyslexia Unscrumbled allow changing line or word spacing, while Helperbird allows zooming in the Web page.

Only few extensions, e.g., Helperbird, allow the users to configure the Web page according to their preferences (i.e., they allow to choose the font and not only to apply a predefined font like Open Dyslexic). Moreover, most extensions are available only in English, which can be a barrier for non-native English speaking users.

To the best of our knowledge, no extension allows to focus on each word individually. The most similar features are implemented by Dyslexia Friendly and Helperbird, which superimpose a ruler on the page to show the line currently indicated by the mouse pointer.

3 IMPLEMENTATION

We have created a tool that can facilitate Internet browsing for people with reading difficulties, allowing them to read Web contents more easily. The aim is to facilitate the comprehension of the text and, consequently, to improve the accessibility of the WWW.

The main features of the tool can be summarized as follows:

- allowing to modify some of the aspects of the visualized Web page such as background and text color, line spacing, etc.;
- offering an *easy reading mode* that is designed to help the users with reading difficulties to read words;
- allowing the users to save the chosen preferences.

Help Me Read! is an extension for the Chrome browser that provides the user with various functionalities to improve the visual aspect of Web pages. Some of these functionalities are similar to those provided by other Chrome extensions; yet, we provide a more complete customization of the Web page and the possibility to save the preferences. The most important novelty of our extension is, however, the *easy reading mode* which provides a tool that facilitates reading and is not offered by any other extension for this browser[1].

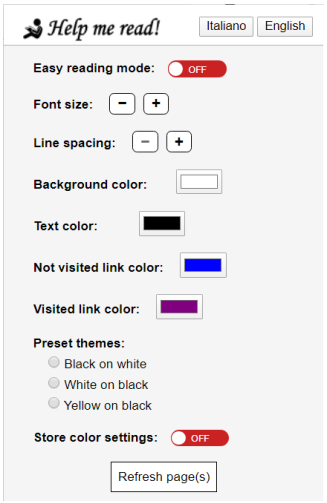

Figure 1: Pop-up interface of the *Help Me Read!* extension.

All the main web browsers available on the market (i.e., Google Chrome, Mozilla Firefox, Safari, Opera, etc.) can be integrated with extensions and plug-ins specifically created for them. To develop the *Help Me Read!* extension, we have chosen the Google Chrome browser, inasmuch it is the most popular browser according to the latest 2019 usage statistics [8].

The initial design of the extension involved the parents of an 8 years old girl affected by dyslexia who experiences difficulties in reading acquisition. We did not want to develop something specific for children, so we asked them to report the encountered difficulties during reading and learning activities, but we considered the requirements only partially due to the girl's age. They reported that existing training tools cannot be used with any web page, but usually contained a set of predefined texts which are used as training set. Our *Help Me Read!* extension has been designed to be usable on any website with readable text, regardless of its structure and style sheet properties. For this reason, we do not limit the support only to the valid Web page. We developed the functionalities in the most general way to maximize the applicability of our extension. Indeed, a big portion of the websites available on the Internet - even nowadays - does not use correctly the HTML syntax.

The user interface is shown in Figure 1 and was implemented using HTML and CSS languages; the communication logic instead was developed using JavaScript in association with the Google APIs and jQuery libraries. *Help Me Read!* interacts with the DOM of the current Web page to modify its graphical aspects. Then, the saved preferences are applied to all the Web pages opened in the browser.

3.1 Available Functionalities

The first action required from the users after the installation of the browser's extension is selection of a preferred language from the

[1] A video showing our extension at work can be downloaded at http://bit.ly/2RV5NJn

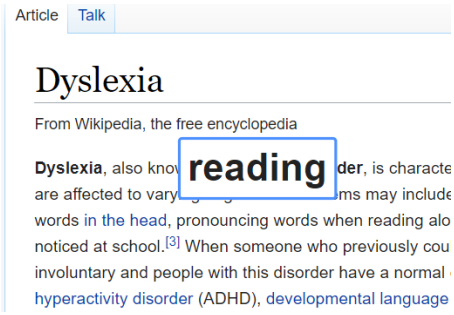

Figure 2: Functioning of the *easy reading mode.*

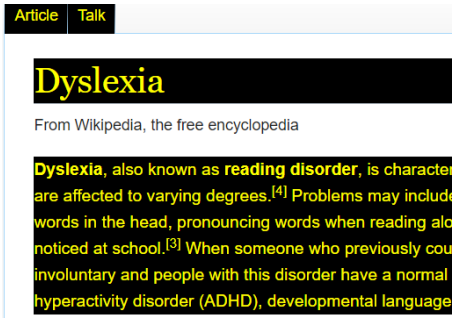

Figure 3: Example of the *yellow on black* theme.

available ones[2]. Nevertheless, the language can be changed at any time, even after the first activation. Then all the options provided by *Help Me Read!* become available.

3.1.1 Easy reading mode. The most important and useful functionality is the *easy reading mode*, that can be considered as the main difference between the introduced *Help Me Read!* and other extensions available in the Chrome Web Store. This feature must be activated for each Web page of interest of the user; it allows to highlight one specific word of a text and to isolate it from the others. This is obtained by putting the word in a close-up view that enlarges and emphasizes it, leaving the rest of the surrounding text in the background (see Figure 2). We opted for this modality since people affected by dyslexia tend to have difficulties in focusing on one word when it is surrounded by other textual content. Therefore, the close-up view can ease the processing of that word.

The user can select where to start by pressing the CTRL button of the keyboard and clicking with the mouse on the word itself. This combination has been chosen to preserve the common interaction that the users have with a Web page, i.e., clicking on a link. After the selection of the first word, the user can move to the next one by pressing the Tab button. In this way, one word at a time is highlighted, leaving to the user the possibility to choose the time that he/she needs to properly read the word.

3.1.2 Customization of font size and spacing. Another functionality which helps people with reading difficulties is the possibility to change and enlarge the font size and line spacing. Both of these functionalities are implemented changing the CSS values of the considered page using jQuery.

The users can enlarge (or potentially reduce) the font size as they wish. Regarding the spacing, instead, some preliminary controls at the moment of the first opening are executed. If the spacing's property is not defined, a default value is set on the basis of the font size and a proportion called Golden Ratio [6]. The spacing cannot be reduced more than the initial value.

3.1.3 Customization of background, text and links color. The possibility to change the employed colors in a Web page is one of the key features of the considered typology of extensions. *Help Me Read!* allows the user to choose the color of the background, of the text, of the visited and not yet visited links, as depicted in Figure 1.

[2]At the moment, the available languages are Italian and English, but we plan on expanding this list in the future.

Colors are chosen using a palette. Since this action requires some time, this choice is propagated to all the current and future tabs of the browser. This is specifically designed to allow the users to see all the Web pages already rendered according to their preferences.

3.1.4 Preset Themes. To help the user in choosing the color scheme, *Help Me Read!* offers some preset themes that can be selected without modifying each of the previously presented parameters. The three available themes are:

- *black over white*: it offers the highest possible contrast by setting the background to white and text to black. For the link colors, we opted to keep the conventional colors defined by the W3C: blue for the unvisited links and purple for the visited ones.
- *white over black*: it does not stress the sight during reading.
- *yellow over black*: according to a study of the Psychology department of the University of Austin (USA) [10], this theme is one of the five most readable themes (see Figure 3).

Also in this case, the selection of a preset theme is applied to all the current and future tabs of the browser.

3.1.5 Reset settings. The extension allows to restore the original rendering of the Web page. The *reset pages* function resets the color scheme settings, the font size, the spacing and deactivates the *easy reading mode.*

4 USERS' FEEDBACK

We tested the extension with some tens of websites to test all the functionalities, even in the case of not valid HTML code. Afterwards, we conducted a preliminary user study to test the efficacy of *Help Me Read!* in helping the users to read Web contents.

4.1 Methodology

At the time of the administration of the survey, the extension has not been published in the Chrome Web Store yet. We decided to distribute it through a Web page that included the extension file and detailed instructions on how to install and uninstall it. At present, *Help Me Read!* is available in the Chrome Web Store under the web accessibility extensions area.

We asked the users to answer a questionnaire after having used the extension. The structure of the survey is simple and contains single answer questions, 5-point Likert scale questions, multiple

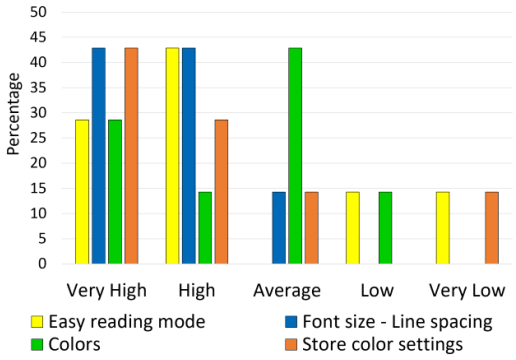

Figure 4: Perceived utility level of functionalities.

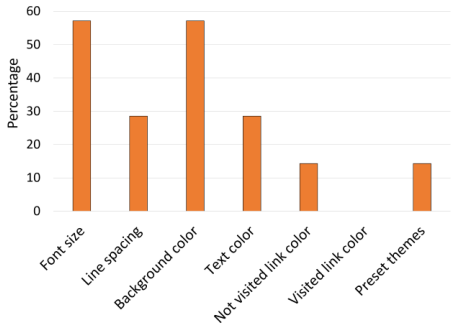

Figure 5: Usage share of functionalities.

answer questions and open answer questions. It starts with a section collecting demographic data of the users. Subsequently, we administered questions related to the user experience with our extension. We aimed at verifying if the extension helps to improve the readability of Web pages for people with reading difficulties.

We contacted many associations dedicated to helping people with dyslexia, asking for their collaboration in spreading the survey. We reached out to the Italian Dyslexic Association, the Italian Dyslexic Foundation and the Inclusion and disabilities office of the University of Padua. We also used Facebook to reach groups or pages dedicated to the topic of dyslexia. We collected 7 answers to our questionnaire. Although the number is limited, we must consider that the extension was not published at the time we distributed the survey, therefore it required certain effort to be installed. Moreover, we must consider that, according to data published by the Italian Ministry of Education [21], people affected by dyslexia make up less than 3.2% of the Italian population.

4.2 Demographic Data

The initial part of the survey aimed at gathering some personal information about the respondents: the age distribution of the participants is mainly concentrated under 26 years old (4 out of 7), while gender distribution is almost equal between male (4 out of 7) and female (3 out of 7) . Six participants declare to have a level of instruction of at least high school. All the respondents admit to use Internet everyday. They evaluate their Web navigation skills as sufficient (1 out of 7) or good (6 out of 7).

4.3 Discussion of the Results

The main part of the survey concerns our extension, its usability and effectiveness of the implemented functionalities.

It must be noted that all the participants declared they have never used a browser extension before to improve their reading experience. Therefore, their answers evaluated the use of *Help Me Read!* with respect to their common habits and cannot be considered in comparison with alternative extensions.

As the most useful feature the participants pointed out the possibility to modify the font size and the line spacing: 3 users evaluated its level of utility as very high and 3 as high (see Figure 4).

The possibility to change the color of the background, text or links has been perceived as less important by the respondents; only two of them considered these functionalities to be very useful in facilitating reading of the Web contents. However, at the same time, changing the color of the background turned out to be - together with customization of the font size - the most used functionality, as declared by the users and depicted in Figure 5.

As indicated by the obtained results, the least interesting functionalities of the proposed extension appear to be: the possibility to change the link colors, and to choose one of the preset themes. Only two of the preset themes were used by two of the respondents to increase the contrast of the Web page (themes "black on white" and "yellow on black").

A positive feedback has been collected regarding the new functionality, *easy reading mode*, that is considered to be useful in facilitating reading of the Web pages by almost all of the participants, as shown in Figure 4: 2 users rated it as very high and 3 as high. The results show that people with dyslexia find it easier to read words isolated from the rest of the content. Moreover, to the question "Did the *easy reading mode* simplify the reading?" only one participant gave a negative answer.

Last but not least, the unique feature that does not change the aspect of a Web page, namely "Store color settings", has been indicated as useful by the respondents. It allows them to permanently save the settings of the color changes, in order to have them available and retrievable in the future.

5 CONCLUSION

In this work, we have focused on accessibility issues faced by people affected by dyslexia when browsing the Web. To support these users, we have created *Help Me Read!*, a Chrome extension that allows to personalize the visualization of text, links and other Web page features, as well as to highlight one word at a time, in order to facilitate reading process for people with dyslexia. Preliminary qualitative tests performed with a small group of users provided very encouraging results.

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