Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 67 (2015) 150 – 159

Procedia Computer Science

6th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Infoexclusion (DSAI 2015)

WebHelpDyslexia: A Browser Extension to Adapt Web Content for People With Dyslexia

Luis Otávio de Avelar, Guilherme Camillo Rezende, André Pimenta Freire*

Universidade Federal de Lavras, Departamento de Ciência da Computação
Campus Universitário, Caixa Postal 3037, Lavras, MG 37200-000, Brazil

Abstract

The Web is an essential resource widely used by many organizations, affecting the lives of countless people. Thus, it is essential to ensure that Websites are accessible in order for people with disabilities to enjoy all its benefits. Many studies have been dedicated to investigate Web accessibility issues for users with visual or motor disabilities. However, comparatively fewer studies have addressed accessibility for users with specific learning difficulties such as dyslexia. Furthermore, few tools provide support for dyslexic users during reading and browsing in Web content. The present study involved the design and implementation of a prototype extension for a Web browser that offers customization features of Web pages, based on requirements from problems encountered by users with dyslexia in related studies in the literature. The research involved the design, implementation and a preliminary user evaluation involving users with dyslexia in two iterative cycles. The implemented prototype included features to adjust layout characteristics of text and other features identified by means of feedback from users to aid concentration and dealing with difficult words, such as a "reading ruler". The results obtained from this study highlighted the importance of providing further support in user agents to help dyslexic users and provide tools to help with linguistic issues.

Peer-review under responsibility of organizing committee of the 6th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion (DSAI 2015)

Keywords: Web accessibility; Dyslexia; Content adaptation

* Corresponding author. Tel.: +55 35 3829-1939; fax: +55 35 3829-1545.
E-mail address: apfreire@dcc.ufla.br

Peer-review under responsibility of organizing committee of the 6th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion (DSAI 2015)
doi:10.1016/j.procs.2015.09.259

1. Introduction

The development and the widespread use of the Web have brought changes in people's habits, making it an essential technology for day-to-day activities. The Web offers countless services and resources that can make several daily tasks easier, and is present at all areas of society.

In this context, it is fundamental that the Web be made accessible to all people, regardless of any limitations of special needs they may have. Web accessibility is an essential aspect to enable social inclusion. More accessible websites enable equal access to information and opportunities for people with disabilities, such as physical, visual, auditory, neurological, cognitive, or people with specific learning difficulties (such as dyslexia) and older people[8].

Many efforts have been dedicated to making the Web more accessible to disabled people. There are many important studies about Web accessibility, involving especially blind, partially sighted and users with serious cognitive disabilities. However, there are relatively fewer studies on the accessibility of Web sites for users with dyslexia, especially studies with empirical evidence to help understand what are the needs and difficulties of those users when navigating the Web[9].

Dyslexia is a specific learning difficulty, characterized by difficulties in activities related to reading and writing. Its symptoms are specific to each individual and usually persist for life[7]. During school time, it can considerably jeopardize learning if not treated adequately. However, dyslexic people have a great potential to achieve success in their activities and to contribute effectively in society and in different organizations, by developing a number of abilities, especially those related to arts, design and innovation[4].

Websites can have barriers that impact the experience of dyslexic people[10, 21]. In a study conducted by the Disability Rights Commission[5], dyslexic users had problems to complete 17% of the tasks attempted on websites, more than users with motor and auditory disabilities, who failed to complete 15% of attempted tasks. In order to make their access to Websites easier, dyslexic users may use tools that provide assistance when reading and navigating on the Web, making it more pleasurable and less prone to errors.

Text formatting and layout features in Websites represent a great deal of problems encountered by dyslexic users on the Web. Some tools dedicated to help those users can provide features to customize specific elements on Web pages according to users needs. However, there is still a lack of integrated tools that provide dyslexic users with the appropriate set of adjustments according to a diversity of user needs, especially in Portuguese language, the official language in Brazil.

The main goal of the work reported in this paper was to investigate the needs of dyslexic users when using the Web reported in literature, and based on the requirements elicited, to implement a prototype of a browser extension for Google Chrome to offer features to help the navigation of dyslexic users – the WebHelpDyslexia[2]. The work presented involved a User-Centred Design with two iterations and preliminary formative evaluations with users.

This paper is organized as follows. Section 2 presents a literature review on Web accessibility and dyslexia. Section 3 presents the development process phases. Section 4 details WebHelpDyslexia and its main features. Finally, Section 5 presents conclusions and future work.

2. Web Accessibility and Dyslexia

The Web Accessibility Initiative[23] considers that Web accessibility means that disabled people can use the Web effectively. According to their definition, this means they can perceive, understand, navigate and interact with the Web, as well as contributing to its growth.

When comparing with other user groups, there is comparatively less knowledge about the problems encountered by dyslexic users. Many studies have considered users with cognitive disabilities as a group, but fewer studies have addressed dyslexic users specifically[7].

Freire *et al*.[6] conducted a study with 13 dyslexic participants on 16 websites, with participants with ages ranging from 16 and 49 years using a think-aloud protocol. The study identified 693 accessibility and usability problems related to difficulties in navigation, information architecture, text presentation, content organization, difficult language, large amounts of information, feature malfunctioning and difficulties scanning for items on pages.

Al-Wabil *et al*.[1] investigated navigation problems encountered by dyslexic users on the Web. In that study, 10 users diagnosed with dyslexia were interviewed after being presented with examples of web pages and asked to

discuss the navigation aspects of each page. At the end of the study, the authors identified a number of problems that cause frustration and disorient dyslexic users when using Websites.

Rello *et al*.[12] conducted a study with 44 participants, males and females, with ages between 13 and 37 years of age, being 22 participants with dyslexia and 22 part of a control group, who read a text with two stories, divided in 36 parts, each with a different layout. An eye-tracking system was used to analyse the study, followed by semi-structured interviews and a questionnaire. A set of layout recommendations was proposed as a result, but the authors highlighted that the content of texts also presented barriers to users, as well as layout issues.

In another study, Rello *et al*.[13] studied 28 people with dyslexia, comparing font size and line spacing and how they interfered on reading speed, comprehension and text legibility on the Web. Each participant was asked to read the 3 first paragraphs of 6 texts from Wikipedia about animals, with font sizes varying among 10, 12, 14, 18, 22 and 26 points and line spacing varying among 0.8, 1.0, 1.4 and 1.8 lines. Each participant was asked to read the texts and fill in a comprehension questionnaire. The reading process was recorded by an eye-tracker, in order to allow for measures of the fixation times in any specific point in a page. The results showed that the font size did make a difference in reading speed, comprehension and legibility. However, line spacing did not have a significant difference. The recommended font size from the study's result was 18 points.

In a study on the impact of using more frequently used words and the length of words in texts, Rello *et al*.[14] investigated the legibility and comprehension of text in different conditions. The study was based on tests with 46 participants (males and females), being half of the participants diagnosed with dyslexia, performing two tests: one using common words and the other substituting long words with shorter synonyms. The results showed that more frequently used words improved the legibility of texts, especially for dyslexic people. This reinforced the idea that text simplification could help improve the experience of dyslexic users on websites.

In another research study conducted by Rello et al.[15], they compared two text simplification strategies for people with dyslexia: substituting all complex words by synonyms and bringing up synonyms for complex works but substituting them only at the users' request. The two strategies were compared by a group of 96 participants, 47 dyslexic users and a control group of 49. The study did not find any significant improvement on legibility and comprehension by the techniques used.

Santana *et al*.[20] performed an analysis on the browser plugin Firefixia for Firefox, developed to help dyslexic users on the Web. The test involved 4 participants with dyslexia, males, with ages between 18 and 62 years of age, using the think-aloud protocol. The users indicated that many of the features were interesting to help in their tasks. The first version of WebHelpDyslexia incorporated many features that were also implemented by Firefia. Firefixia implemented features to change font size and type, text alignment, line and character spacing, foreground and background colour, link and visited link colours, text length, including borders in page elements and removing italics.

In a study to investigate the best fonts for dyslexic users, Rello and Baeza-Yates[16] tested twelve fonts with 42 participants with dyslexia: Arial, Arial Italics, Computer Modern Unicode, Courier, Garamond, Helvetica, Myriad, OpenDyslexic, OpenDyslexic Italics, Times, Times Italic and Verdana. Participants were asked to read twelve texts whilst being observed with eye tracking, one with each font, but with the same genre, number of words, length and absence of numerical expressions, acronyms and foreign words. The study concluded that the font type had an impact on dyslexic people. The best font types in terms of reading performance were Helvetica, Courier, Arial, Verdana and Computer Modern Unicode. The study also pointed out that italics fonts had a negative impact on reading.

In terms of tools to adapt Web content for users with dyslexia, there are many browser plugins that help with specific features. However, they do not offer a combination of features to make it easier for dyslexic users to cater for different needs. Along with Firefixia[20], other specific tools for dyslexic users include DysWebxia[17] and AT Bar[22].

Rello and Barbosa[18] analysed some of the main aspects of tools to help dyslexic users, specialized or not. They analysed Kindle, iBooks, Firefixia, SeeWord, IDEAL eBook Reader and Text4All. From the mapped functionalities, they summarized the main features provided by those tools: changing font type, size, brightness, colour, letter spacing, word spacing, line spacing, paragraph spacing, column width, synonyms and text to speech. None of the analysed software systems provided all features that would be necessary for dyslexic people with different needs.

3. Development process

3.1. Requirements

Requirements for the development of the WebHelpDyslexia extension were gathered mainly from a literature review of studies involving dyslexic users. Priority was given to studies that performed empirical evaluations with such users, in which accessibility problems were analysed to identify the main characteristics of websites that could affect positively or negatively the interaction of users with dyslexia. We also analysed studies that published sets of guidelines for writing more accessible texts for people with dyslexia developed by specialists.

The analysis of related studies, especially those with empirical data, was very important to help to identify the main features to be implemented in the extension, as well as to define the parameters such as font size and types, foreground and background colours, paragraph alignment and spacing, among others.

Requirements were also gathered by means of two iterative development cycles involving preliminary evaluations with dyslexic users. By means of those tests, we collected other requirements for improvements in the functionalities, as well as suggestions of new functionalities. The main feature identified by suggestions from users was the "reading ruler", to help users concentrate when reading by fading the text and leaving only a few lines highlighted to avoid users losing their concentration.

3.2. Design and implementation

The extension was developed using HTML (HyperText Markup Language), CSS (Cascading Style Sheets) and JavaScript. Those technologies were used as they are the standard for developing extensions for the Google Chrome browser.

The implementation involved the creation of a configurations file named manifest.json, used by the browser to install the extension. This file was written in the JSON format (JavaScript Object Notation), containing properties such as the name of the extension, version, description, declaration of files used and requests for accessing browser elements used by the extension. The extension included classes for initializing, creating the user interface and implementing the functionalities. Google Chrome did not allow the creation of a "native" toolbar. Thus, the toolbar was inserted at the top of each page by means of code injection using JavaScript.

The extension adds extra code to original pages. This way, it was very important to pay special attention to HTML elements and to style sheets in order to preserve the characteristics of the original page and to make sure users could read them.

3.3. User evaluation

The evaluation of the implemented prototype with dyslexic users was performed in two occasions, one in each iterative development cycle. We performed formative evaluations with two participants, in order to obtain feedback about the existing features and to gather suggestions for future versions.

Participants were recruited from the Centre of Distance Learning of the authors' institution and by announcements in social networks. The evaluations were performed remotely, due to difficulties recruiting participants locally. The problem with finding participants diagnosed with dyslexia is more difficult due to low availability of professionals and services for the diagnosis of dyslexia[19]. The evaluations conducted in this study were performed remotely, as the participants did not live in the same town.

Two participants took part in the study, both female, with ages 38 and 19. Both considered themselves as experienced users, having been using the Web for 13 and 9 years, respectively. The participants were undergraduate students at two different universities, and used the Web extensively to search for study materials.

In the evaluations, both participants were asked to perform three reading tasks with texts of varying difficulty levels. After performing the tasks, they were asked to report which features of the extension were used and any difficulties and suggestions they might have.

4. WebHelpDyslexia – features and evaluation

WebHelpDyslexia was developed as an extension to Google Chrome™, freely available for download at the Google Play Store. In this section, we describe the main features developed in the first version of the prototype. Fig. 1 illustrates the main features contained in the tool bar, with Section 1 containing buttons for font type and size, Section 2 with features to remove bold, italic and changing foreground and background colours, Sections 3 and 4 to change paragraph alignment and spacing, Section 5 for word highlighting, Section 6 for synonyms and reading ruler, and Sections 7 and 8 to reset the changes and to close the toolbar.

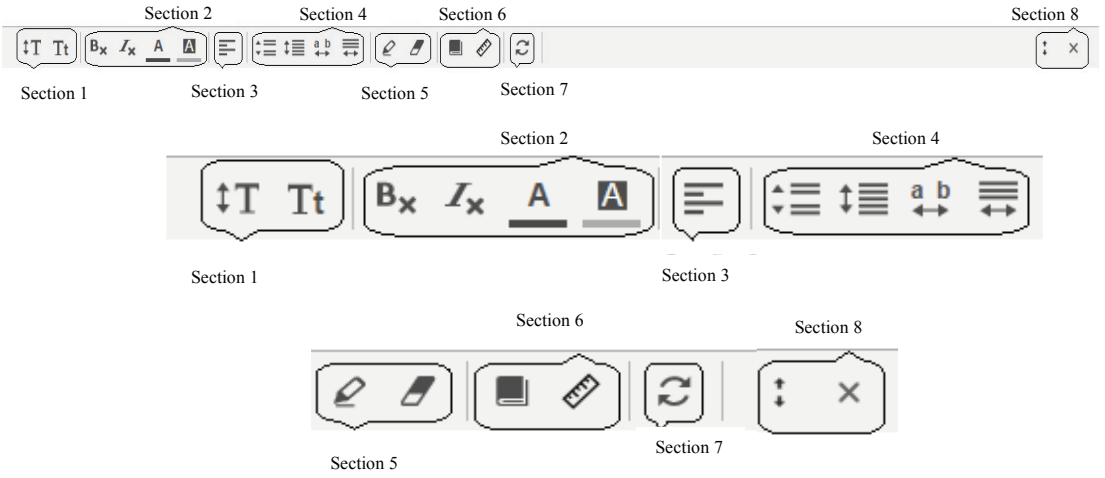


Fig. 1. WebHelpDyslexia tool bar and sections for character layout settings, paragraph settings, word highlighting, reset and tool bar features .

4.1. Font type, size, decoration and colour

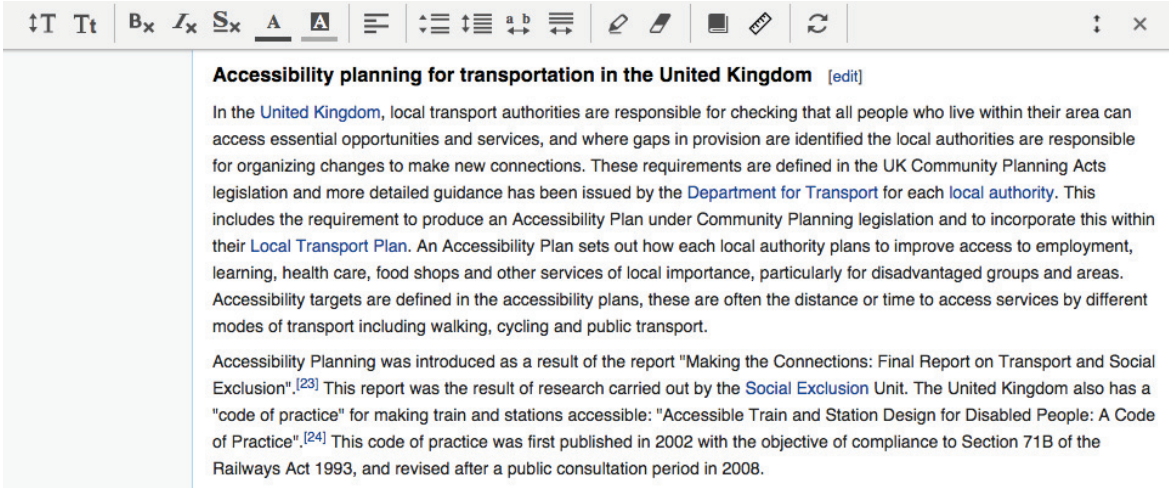
The extension enables users to changes in size ranging between 12 and 26 points. The use of text with small font sizes in websites was among the main problems encountered by dyslexic users in empirical studies[1,5,6] . In a study conducted by Rello *et al.*[13], the authors found that font sizes 18, 22 and 26 had the best improvement in text legibility and comprehension for users with dyslexia.

The typeface of text can also be altered by the extension, including the options: Open Dyslexic, Comic Sans, Arial, Verdana, Georgia, Tahoma e Trebuchet MS. Priority was given to fonts sans serif. Fonts with too much decoration can make reading more complex. For example, dyslexic users could mistake the letter "g" for the number "8" using Times New Roman[3].

The extension also enables removing italics, bold and underlining. In a study conducted by Freire et al.[6], the use of italics was a frequent cause of problems for dyslexic people when reading texts on the web. The use of italics can cause visual effects in which the words seem to be blending together, and this effect can be aggravated when small fonts are used[3,4,11].

Another important adaptation in texts for dyslexic users implemented was the changes in foreground and background colours. The extension allows changes in those colours for all the text on web pages. Problems related to inadequate combinations between foreground and background colours were highlighted in studies conducted by Freire et al.[6] and by the Disability Rights Commission of Great Britain[5]. Dyslexic users may find great difficult reading black text on white background. For some users, this configuration can cause visual effects, such as letters seeming to move on the page or losing the focus[4,6]. Some guidelines[3,11] recommend using darker text colours on a pale lighter background, such as a dark blue on a crème background. In a study conducted by Rello et al.[12], the most frequently used colour combination by dyslexic users was black text on yellow background.

Fig. 2 presents an example of text about transportation accessibility before using the WebHelpDyslexia extension. In the example, text is presented in small size, in long paragraphs with little spacing. Fig 3. shows the same excerpt of this page after changing the font size and type and changing the colour foreground to blue and the colour background to crème.

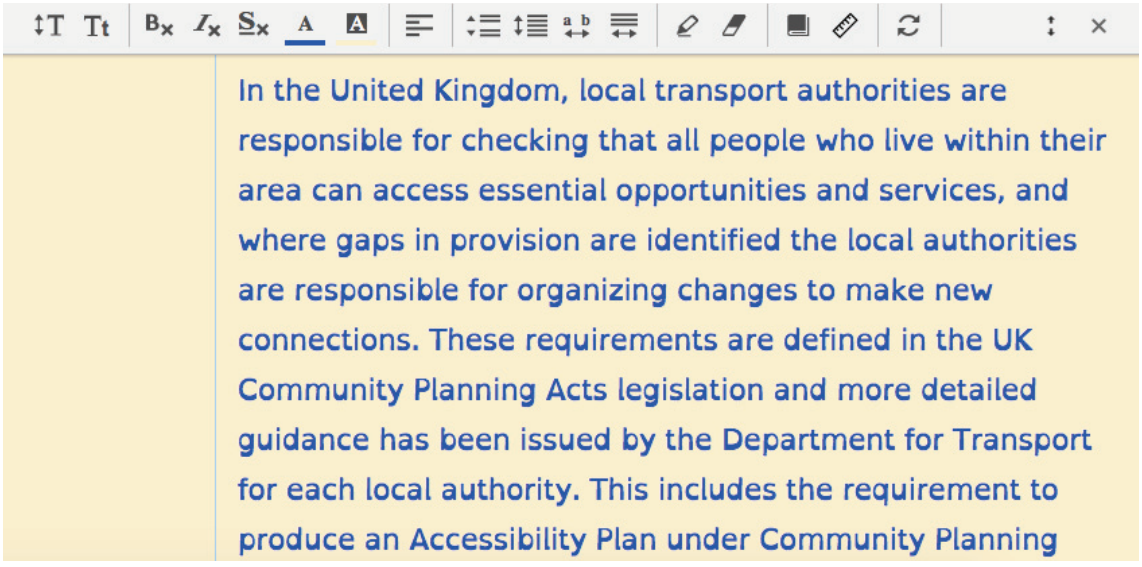


Accessibility planning for transportation in the United Kingdom [edit]

In the United Kingdom, local transport authorities are responsible for checking that all people who live within their area can access essential opportunities and services, and where gaps in provision are identified the local authorities are responsible for organizing changes to make new connections. These requirements are defined in the UK Community Planning Acts legislation and more detailed guidance has been issued by the Department for Transport for each local authority. This includes the requirement to produce an Accessibility Plan under Community Planning legislation and to incorporate this within their Local Transport Plan. An Accessibility Plan sets out how each local authority plans to improve access to employment, learning, health care, food shops and other services of local importance, particularly for disadvantaged groups and areas. Accessibility targets are defined in the accessibility plans, these are often the distance or time to access services by different modes of transport including walking, cycling and public transport.

Accessibility Planning was introduced as a result of the report "Making the Connections: Final Report on Transport and Social Exclusion".[23] This report was the result of research carried out by the Social Exclusion Unit. The United Kingdom also has a "code of practice" for making train and stations accessible: "Accessible Train and Station Design for Disabled People: A Code of Practice".[24] This code of practice was first published in 2002 with the objective of compliance to Section 71B of the Railways Act 1993, and revised after a public consultation period in 2008.

Fig. 2. Example of text about transportation accessibility before using the WebHelpDyslexia extension. Text with small size, long paragraphs with little spacing.



In the United Kingdom, local transport authorities are responsible for checking that all people who live within their area can access essential opportunities and services, and where gaps in provision are identified the local authorities are responsible for organizing changes to make new connections. These requirements are defined in the UK Community Planning Acts legislation and more detailed guidance has been issued by the Department for Transport for each local authority. This includes the requirement to produce an Accessibility Plan under Community Planning

Fig. 3. Example of text about transportation accessibility after using the WebHelpDyslexia extension. Text with bigger font size, foreground colour set to blue and background colour set to crème.

4.2. Paragraph alignment and text spacing

Changes to paragraph and text spacing and alignment were another set of important features implemented on WebHelpDyslexia. The first of such features enabled removing text justification and making text left aligned. In a

study conducted by Santana *et al*.[20], dyslexic users highlighted the importance of the feature to make texts aligned at left on websites, using their Firefixia tool. Justified text may create irregular spacing between words, which may cause visual disturbances for dyslexic users. Those disturbances may make reading very difficult for users with dyslexia, as they may become lost[3,4,11].

WebHelpDyslexia also enables users to change character spacing within paragraphs, with options of 0%, 7% and 14%. In a study with dyslexic users, Rello *et al*.[12] found that character spacing of 7% had the best results for users. The extension also enables users to change line spacing, with options of 1, 1.2, 1.4 and 1.8 lines, and space between paragraphs of 0.5, 1 and 2 lines. Inadequate paragraph spacing was one of the main issues encountered by dyslexic users in one study of Websites[6]. Appropriate spacing between paragraphs is important to delimit the text and make reading easier[11]. From the study conducted by Rello *et al*.[12], the authors recommended using 2 lines between paragraphs.

The tool also enables users to choose the length of lines in paragraphs, to avoid having very long lines that may make it harder for them to read. The extension offers options for lines with 44, 66 and 77 characters per line. Long lines may make it difficult for some dyslexic users to read[11], as they may find it difficult to keep on track of the line they are reading at the moment.

In Fig. 4, we present an example of the use of the features to space out lines and paragraphs with WebHelpDyslexia. In this figure, the text shown originally in Fig. 2 is adapted to have more space between lines and paragraphs.

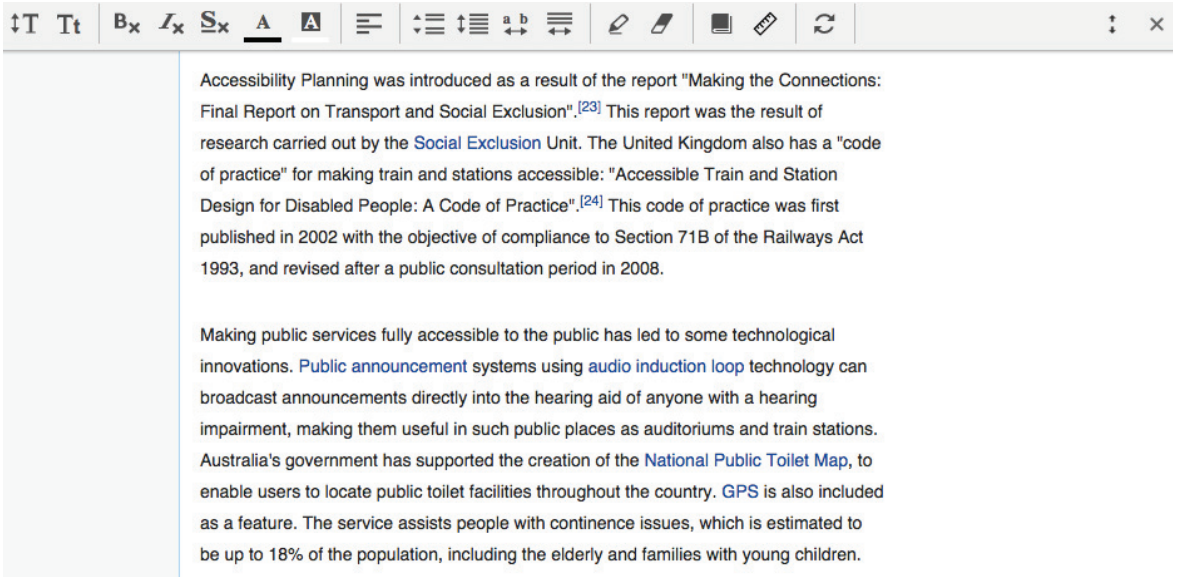


Fig. 4. Example of text about transportation accessibility after using the WebHelpDyslexia extension. Text with larger spacing between lines and paragraphs, and shorter line lengths.

4.3. Text highlighting and "reading ruler"

Providing features to help dyslexic users highlight text help them significantly to have a better comprehension of text[14]. This can help users mark important parts of text and have better ability to skim-read text when they need to find important parts they have read before. WebHelpDyslexia enables users to choose the colour they want to use to highlight parts of text they find important, as shown in Fig. 5.

One of the features that was pointed out by users in the preliminary evaluations as most useful was the "reading ruler". This feature fades the page being read by users and leaves only one part visible for reading. This feature was suggested in the first development iteration cycles by one of the participants, who said "it would be nice if I could use a feature to help me concentrate on the part of the text I'm reading now. When doing this on paper, I often use a

ruler, to help me keep track of the line I am at the moment". Fig. 5 also illustrates the "reading ruler" being used, with only three lines (or more or less, as set by the user) shown at a time, following the mouse, to help users concentrate on the text.

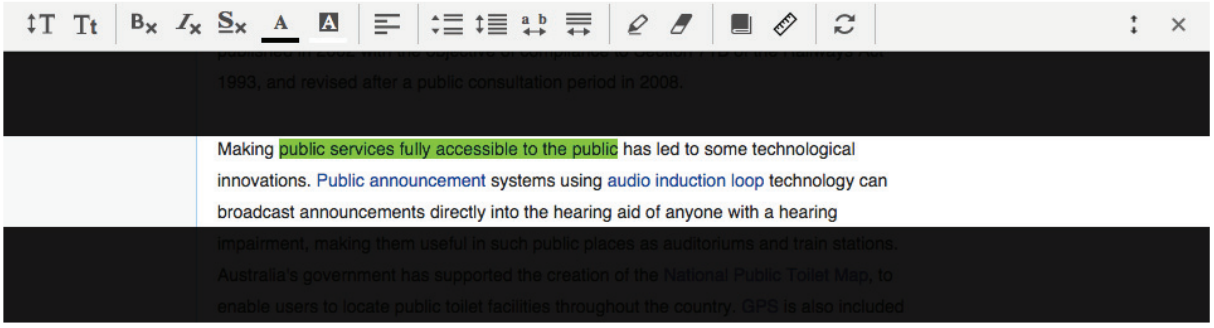


Fig. 5. Example of text with highlighting and reading ruler showing three lines at a time to help with concentration.

4.4. Synonyms search

As pointed out by a previous study by Rello *et al*.[15], replacing difficult words by easier synonyms can help people with dyslexia better comprehend texts. In the second iteration of the development of WebHelpDyslexia, we implemented a preliminary prototype of a synonyms search to help understand difficult words used in text. In the current version, the extension is able to search for words in their original form in a database and show synonyms. Fig. 6 shows the use of the feature with synonyms (in Portuguese) to the word "similar".

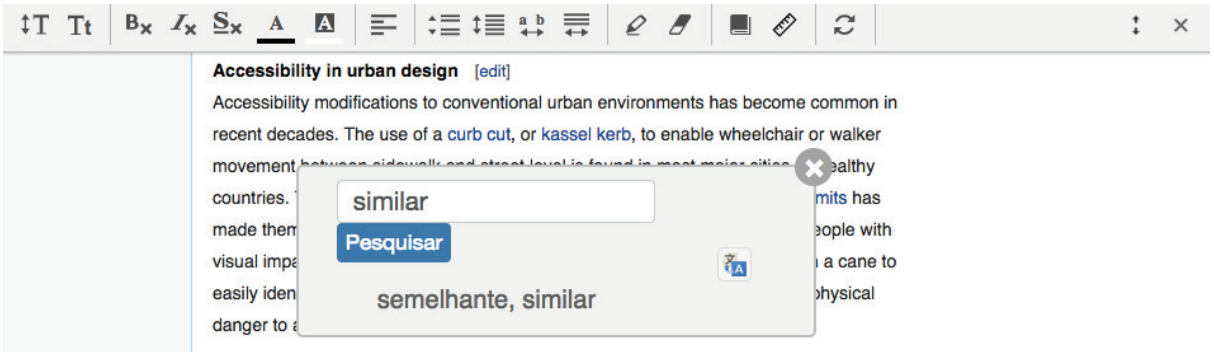


Fig. 6. Synonyms dictionary search for the word "similar".

4.5. Results from formative preliminary user evaluation

The evaluation performed with dyslexic users had a formative nature, and aimed at helping to identify how dyslexic users would use the implemented features and to point to future research to develop and improve the features available in the tool.

In the first cycle, Participant 1 gave important suggestions to include features to highlight text and the "reading ruler", to help with concentration when reading parts of text and to avoid becoming lost. In the second cycle of evaluation with the second user, Participant 2 reported difficulties installing the extension, but reported that the new features were useful to help with the tasks. In particular, there was very positive feedback for the "reading ruler" implemented following the feedback from the Participant 1. She said that using the extension helped her to focus on her reading and to avoid becoming lost in the text.

The features implemented in the two iterative cycles of development of WebHelpDyslexia helped provide important features in one extension to a commonly used Web browser for dyslexic users. Having those features in a single extension can have an important impact on the ease of reading for dyslexic users. Students and pupils in universities and schools, as well as professionals who use the Web as a tool for their work can use the extension to enhance their interaction.

By building this tool, we expect to deepen into the research performed to investigate which features best help users with dyslexia, and to confirm whether the results of studies conducted in other countries, mainly in Spain and English-speaking countries, are applicable to the Brazilian scenario.

The present study had a limitation with regards to the sample size of users involved in the evaluation. Although the current study involved few users in a formative evaluation to help identify the requirements and improvements in the system, future studies will involve summative evaluations with more users with and without dyslexia to verify how the use of such system can improve interactions with Websites.

4.6. Comparison of WebHelpDyslexia and other tools

WebHelpDyslexia presented new features that were not implemented in other similar tools to help dyslexic users, mainly the "reading ruler" and text highlighting features that are not available in all similar systems for Web reading. This feature is currently provided by the software ScreenRuler† as a separate reading software. From the features analysed by Rello and Barbosa[18] in similar systems, WebHelpDyslexia implements features to change font type and size, change in colour, character, line and paragraph spacing, changes in column width and suggestions of synonyms. However, the current version has not yet implemented features to provide text-to-speech functions, word spacing and adaptation of brightness. We intend to improve new versions of the extension to include text-to-speech features in Brazilian Portuguese and to improve the synonym suggestion feature to enable finding words in different forms.

5. Conclusions and Future Work

This paper presented the development of the WebHelpDyslexia, a browser extension to help people with dyslexia adapt Web content to make it easier to read. The implemented extension was based on an extensive literature review of studies with guidelines for making Web content more accessible for people with dyslexia and on empirical studies that investigated problems encountered by dyslexic people on the Web and adaptations that can help them read better.

The implemented tool included features to change font size, font type, remove text decoration such as italics, bold and underlining, changing foreground and background colours, change paragraph spacing, length and alignment, highlighting text, fading text to focus on specific parts and searching for synonyms for words.

Preliminary evaluations with dyslexic users showed that the features to help concentrate when reading (especially the "reading ruler") were considered very useful. Other features to change text layout, such as colour, size and spacing were also considered important by different users, according to their specific needs.

We could observe that having a tool with important features for dyslexic users can have a significant impact for them, as having to download different tools in their Web browsers can be difficult and unproductive. The use of such tools can help significantly in educational and professional contexts to improve the reading performance of dyslexic users.

As future work, we intend to perform more in-depth evaluations with a broader range of dyslexic users performing other tasks on Websites. The use of the tool by other user groups should also be investigated, especially people with Irlen Syndrome, low vision and older users. We also intend to improve the implementation of the existing features, including more features to help with linguistic issues and implement speech synthesis in Brazilian Portuguese.

---

† Available online at http://www.clarosoftware.com/screenruler

Acknowledgements

Thanks to CNPq (process 448521/2014-8), FAPEMIG (process APQ-00319-14) and CAPES for funding this work. We also would like to thank the participants for their most valuable contribution in the usability evaluations of the prototype.

References

1. Al-Wabil, A.; Zaphiris, P.; Wilson, S. Web navigation for individuals with dyslexia: an exploratory study. In: *Proceedings of the 4th international conference on Universal access in human computer interaction: coping with diversity*. Berlin, Heidelberg: Springer-Verlag, 2007. (UAHCI'07), p. 593–602.
2. Avelar, L. O. *Sistema de Apoio à Leitura e Navegação em Sites Web para Usuários com Dislexia*. Final Year Undergradutate Project. Universidade Federal de Lavras, 2013. Available online at http://www.bsi.ufla.br/wp-content/uploads/2013/10/SISTEMA-DE-APOIO-%C3%80-LEITURA-E-NAVEGA%C3%87%C3%83O-EM-SITES-WEB-PARA-USU%C3%81RIOS-COM-DISLEXIA.pdf, last accessed on 10th January 2014.
3. Bradford, J. *Designing web pages for dyslexic readers*. 2005. Available online at: http://www.dyslexia-parent.com/mag35.html. Last accessed 10th January 2015.
4. British Dyslexia Association. *Good practice guidelines for supporting employees with dyslexia in the workplace*. 2009. Available online at: http://www.nafd.org.uk/media/150667/bda%20employer%20code_of_practice.pdf, last accessed 10th January 2015.
5. Disability Rights Commission. *The web: access and inclusion for disabled people: A formal investigation conducted by the disability rights commission*. Stationery Office, 2004.
6. Freire, A. P.; Petrie, H.; Power, C. Empirical results from an evaluationof the accessibility of websites by dyslexic users. In: *Proceedings of the Workshop on Accessible Design in the Digital World*. Lisboa, Portugal: CEUR-WS.org, 2011. (CEUR Workshop Proceedings), p. 41–53.
7. Handler, S. M., Fierson, W. M. Learning disabilities, dyslexia and vision. *Pediatrics* 2011;**127**,3:818-856.
8. Henry, S. L.; Arch, A. Social Factors in Developing a Web Accessibility Business Case for Your Organization. 2005. Disponível em: http://www.w3.org/WAI/bcase/soc, last accessed on 10th January 2014.
9. McCarthy, J. E.; Swirenga, S. J. What we know about dyslexia and web accessibility: a research review. *Univers. Access Inf. Soc*. 2010; 9,2:147–152.
10. Kalyvioti, K., Mikropoulos, T. A. Virtual Environments and Dyslexia: A Literature Review. In: Proceedings of 5th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion, DSAI 2013. *Procedia Computer Science* 2014; 27:138-147.
11. Rainger, P. *A dyslexic perspective on e-content accessibility*. JISC TechDis, 2003. Available online at: http://www.jisctechdis.ac.uk/techdis/resources/ detail/learnersmatter/Jan03_Dyslexia. Last accessed 10th January 2015.
12. Rello, L., Kanvinde, G., Baeza-Yates, R. Layout guidelines for web text and a web service to improve accessibility for dyslexics. In: *Proceedings of the International Cross-Disciplinary Conference on Web Accessibility*. New York, NY, USA: ACM, 2012. (W4A '12), p. 36:1–36:9.
13. Rello, L., Pielot, M.; Marcos, M.-C.; Carlini, R. Size matters (spacing not): 18 points for a dyslexic-friendly wikipedia. In: *Proceedings of the 10th International Cross-Disciplinary Conference on Web Accessibility*. New York, NY, USA: ACM, 2013. (W4A '13), p. 17:1–17:4.
14. Rello, L., Saggion, H., Baeza-Yates, R. Keyword Highlighting Improves Comprehension for People with Dyslexia. In: *Proceedings of the 3rd Workshop on Predicting and Improving Text Readability for Target Reader Populations (PITR),* Gothenburg, Sweden. 2014. p. 30-37.
15. Rello, L., Baeza-Yates, R.; Bott, S.; Saggion, H. Simplify or help?: text simplification strategies for people with dyslexia. In: *Proceedings of the 10th International Cross-Disciplinary Conference on Web Accessibility*. New York, NY, USA: ACM, 2013. (W4A '13), p. 15:1–15:10.
16. Rello, L., and Baeza-Yates, R. Good fonts for dyslexia. *Proceedings of the 15th International ACM SIGACCESS Conference on Computers and Accessibility*. ACM, 2013, p. 14.
17. Rello, L., Bayarri, C., Gòrriz, A., Baeza-Yates, R., Gupta, S., Kanvinde, G., Saggion, H., Bott, S., Carlini, R., Topac, V. Dyswebxia 2.0!: more accessible text for people with dyslexia. In: *Proceedings of the 10th International Cross-Disciplinary Conference on Web Accessibility*. New York, NY, USA: ACM, 2013. (W4A '13), p. 25:1–25:2.
18. Rello, L., Barbosa S. D. J. 2013. Do People with Dyslexia Need Special Reading Software?. *Human-Computer Interaction – INTERACT 2013, Workshop on Rethinking Universal Accessibility: A broader approach considering the digital gap*. Cape Town, South Africa, 2013.
19. Salles, J. F., Parente, M. A. M. P., Machado, S. S. As dislexias de desenvolvimento: aspectos neuropsicológicos e cognitivos. *Interações* 2004;**9**,109–132.
20. Santana, V. F., Oliveira, R., Almeida, L. D. A.; Ito, M. Firefixia: an accessibility web browser customization toolbar for people with dyslexia. In: *Proceedings of the 10th International Cross-Disciplinary Conference on Web Accessibility*. New York, NY, USA: ACM, 2013. (W4A '13), p. 16:1–16:4.
21. Skiada, R., Soroniati, E., Gardeli, A., Zissis, D. EasyLexia: A Mobile Application for Children with Learning Difficulties. In: Proceedings of 5th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion, DSAI 2013. *Procedia Computer Science* 2014; **27**:218-228.
22. Wald, M., Draffan, E. A. *ATBar*. Available online at www.atbar.org. Last accessed 10th January 2015.
23. Web Accessibility Initiative. *Introduction to Web Accessibility*. 2005. Available online at: http://www.w3.org/WAI/intro/accessibility.php. Last accessed 10th January 2015.