

# Dyslexia and Web Accessibility: Synergies and Challenges

Luz Rello

Human-Computer Interaction Institute  
School of Computer Science  
Carnegie Mellon University  
luzrelo@cs.cmu.edu

## ABSTRACT

This paper reviews the main challenges of studying dyslexia for web accessibility. These are: (1) measuring the impact of dyslexia in the population; (2) the limitations of the up-to-date studies; and (3) including dyslexia in the Web accessibility guidelines. While some aspects are already addressed by the guidelines, we propose the inclusion of simple recommendations for typeface and font size that would benefit both people with and without dyslexia. We also suggest a change in the current methodologies to overcome up-to-date research limitations using larger and more representative datasets.

## Categories and Subject Descriptors

K.4.2 [Computers and Society]: Social Issues—*Assistive technologies for persons with disabilities*; H.5.2 [Information Interfaces and Presentation]: User Interfaces—*Standardization*

## Keywords

Dyslexia, web accessibility guidelines, best practices.

## 1. WHY DYSLEXIA IS SO IMPORTANT AND YET IMPOSSIBLE TO MEASURE

**The Paradox of Dyslexia.** Some people with dyslexia seem to have very successful lives, specially entrepreneurs such as the chef Jamie Oliver or the Ikea founder, Ingvar Kamprad. Around 20% of the UK's business self-starters [15] and 35% of company founders in the USA have this condition [16]. But very unfortunately, dyslexia is not about being a genius. Intelligent children fail at school not because they are lazy or absent minded; sometimes it is because they have dyslexia and they do not know, and most of the time people around them do not know either. It is extremely difficult for a person with dyslexia to figure out that he or

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she has a language problem because they cannot perceive if they are reading right or wrong, they cannot perceive their writing errors either. Since there is only one way they can access to written language, they cannot be compared with others. Academic failure is one of its most frequent indicators, having around 15% of school failure in the EU, and around 25% in Spain [7].

There is no doubt that dyslexia is very important in our society, yet we do not know how many people with dyslexia are out there. Worldwide, there are 642 million people with hearing impairments and 285 million people have vision impairments. However, there are no statistics on how many people with dyslexia exist. What does make this so challenging? There are at least three main reasons: (1) manifestations of dyslexia depends on the language, (2) its diagnosis is difficult, and (3) it normally occurs together with other conditions.

**Language Dependency.** First, manifestations of dyslexia are only possible on languages with writing systems. There are around 6,900 languages in this world and around one third of them –estimations vary– still do not have writing systems [14]. And second, among the languages that have writing systems, even if research agrees in the neurological universality of dyslexia, its manifestations are different across languages, which makes its detection even more challenging [32].

**A Hidden Disability.** Diagnosing dyslexia is not trivial. There is not a universal diagnose of dyslexia for all languages. Even in the UK, a country where dyslexia is exemplary treated in comparison with other countries, only 5% of the individuals with dyslexia are diagnosed and given appropriate help; it is estimated that over 85% of adult illiterates have dyslexia [6]. While in an English speaking country a child that read slower but accurate might not been diagnosed with dyslexia; in Spain it could be diagnosed as dyslexic. In languages with shallow orthographies, as Spanish, where the grapheme to phoneme correspondence is regular, manifestations of dyslexia are more related to reading speed than to reading accuracy [31]. As a matter of fact, dyslexia has been called a *hidden* disability due to the difficulty of detection in these languages [32].

We tried to make an estimation of dyslexia in the English and Spanish Web using written errors but the number we reached was a too low lower bound (0.63% for English and 0.43 for Spanish) [24] compared to other estimations of dyslexia for English (10-17.5%) [11] and Spanish (8.6 to

11%) [4]. Note how different these estimations are even for the same languages; they highly depend on the criteria or the models to define dyslexia. Even if there is a fair agreement on the definition of dyslexia, this definition is too vague when addressing dyslexia in different languages. We are still far from knowing how many people have dyslexia and how this condition impacts their lives, such as school performance even in countries with high alphabetization rates.

**Almost Never Alone.** At the same time, dyslexia rarely happens alone. Dyslexia has a wide range of comorbidities, that is, conditions that exist simultaneously but are independent to dyslexia. The most common ones are: dysgraphia, attention deficit disorder, attention deficit hyperactivity disorder, and visual stress syndrome (Meares-Irlen syndrome). For instance, visual stress syndrome is characterized by symptoms of visual stress and visual perceptual distortions that are alleviated by using individually prescribed colored filters. While it is a completed different condition children with dyslexia seemed to benefit more from colored overlays than non-dyslexic children, suggesting that this symptom might be more common among population with dyslexia [13].

## 2. WHY RESEARCH SEEMS NOT TO BE PROGRESSING

The fact that none of the solutions proposed are definite for all people with dyslexia probably explains why there are not any established guidelines. While it is clear that subtitles or alternate text for images benefit people with hearing or visual impairments, there are very few practices that were found to benefit the majority of people with dyslexia across different situations.

Following we present some reasons why there is not a golden key for dyslexia. These are due to the great amount of aspects related to text readability and comprehension, as well as to the variability of dyslexia.

**Readability is not What it Seems.** To the contrary to regular readers, in the case of dyslexia readability is not necessarily related to comprehension. These two terms - readability and comprehension- that are normally used interchangeably in literature does not apply to dyslexia. For instance, we made an experiment that presented a text with very low lexical quality -16% of word error rate- to people with and without dyslexia. While both groups took longer to read -worse readability-, the comprehension of people with dyslexia was significantly higher than the ones without dyslexia. That is, the low readability of the text did not affect the comprehension of dyslexic readers; moreover, their comprehension was higher than in regular readers. This is the only condition that, to the best of our knowledge, made people with dyslexia read better than people without dyslexia. However, this shows that addressing readability for dyslexia needs a completely different approach [23].

**Comprehension is not the Key.** There are a lot aspects that affect comprehension and many of them are subjective and highly dependent on each person, which makes text comprehensibility in terms of accessibility harder to approach. First it has to be noted that even if poor comprehension is a characteristic of dyslexia, it is not a direct

consequence of dyslexia. A person with dyslexia can perfectly understand oral text. There are many studies that have tried to explain their low comprehension. It could be due to an overload on working memory produced by the greater processing load that a person with dyslexia needs to decode a text. However, text comprehension also depends on factors that are subject dependent such as knowledge, education, degree of attention, or previous readings. Moreover, text comprehension can be also related to other elements within the text, such as figures or images. Even if comprehension is not necessarily related to readability under all conditions, it cannot be studied independently from readability when approaching text accessibility, since the main function of language is to communicate a message and to fulfill communication that message needs to be understood.

**Too many Factors for Controlled Experiments.** Readability is related to a great number of textual features. Font size, typeface, word length, numerical representations and even the number of new entities mentioned in a text has an impact on the readability of a text. Only a few of these factors have been explored in relationship with dyslexia. Moreover, most of the times, these parameters have been studied isolated. There are very few studies that have approached the interrelations of some of these parameters and their impact on reading text on the Web [29, 30], and these are not enough to know the impact and the interrelations of the factors that impact readability.

**More Sensitive Readers but Similar to All.** A recurrent result in studies is that text presentation and text content matters. For instance, texts with larger fonts are more readable than texts with smaller fonts for readers with dyslexia [2, 21, 29, 30]. However, it is striking that all the text presentation conditions, that we are aware of, benefit both groups, readers with and without dyslexia. This was also true for 12 experiments and 11 sub-experiments using eye tracking [23] and for the benefits of using multimodal documents [22] among others. In this sense readers with dyslexia are actually not that different from regular readers, with the difference that they are more sensible to textual conditions. The effects of textual conditions found on people with dyslexia are just higher. For instance, if comprehension of regular readers decreased significantly using a 10-points font size in Wikipedia, this comprehension decreases even more for people with dyslexia [29]. Regarding text content parameters, the effects on people with dyslexia are even higher than in regular readers. In another experiment we found that more frequent words made people with dyslexia read significantly faster, but we could not find effects for the control group. However, maybe a larger sample could lead us to find significant effects in regular readers [26].

**Individual Differences.** Manifestations of dyslexia also vary from subject to subject. Each person overcomes dyslexia in a different way depending on their way of learning and on other cognitive abilities [9]. We have seen how the same participant is over the average in one eye tracking experiment and within the average under other textual condition [23]. Previous research have suggested that every person experiences, to certain degree, the difficulties of dyslexia, being dyslexia a continuum condition among all people [5].

**Text Customization, Really?.** Probably due to all the individual differences and the lack of knowledge about the interaction of the textual parameters, self “text customization” has been extensively pointed out as a solution [10, 20, 23]. That is, suggesting the user to customize the text until he or she finds the appropriate settings. Even if we have defend that ourselves, we are not totally convinced. The main reason is because we found that only half of the participants with dyslexia -and without dyslexia- are able to guess correctly which text parameters lead them to an objective faster reading [28]. We believe the user should be encouraged to customize the text, but also an accessible text for the majority could be a good point to start with.

#### **An Approach to Overcome Current Limitations?.**

The small number of participants that lab controlled experiments allow, explains the limitations and the disconnection among the current studies, as well as the strength of individual differences among participants. For instance, in our experiments we only found normal distributions in the data from people without dyslexia; nevertheless, we never found normal distributions in the data coming from participants with dyslexia [23]. On the other hand, most of the results of previous lab studies only rely on qualitative data and sometimes, the lack of sufficient data prevent from applying tests for statistical significance.

One possible solution to advance current limitations would be to approach dyslexia in large scale studies, for instance, using web users as participants through social media, using crowdsourcing, or involving a reasonable number of schools. A very large scale study using web users would allow to study more textual parameters and the interactions between them, as well as measuring the prevalence of dyslexia in the Web. Probably, an exploration with a larger population would allow to cluster reading behaviors that now are considered as “individual differences”, and bring further possibilities of customizing the text according to the user needs. The possibility of having large datasets would open the door to apply statistical machine learning models [27].

### **3. WHY DYSLEXIA IS NOT YET PART OF THE ACCESSIBILITY GUIDELINES**

**Is Dyslexia a Disability?.** Another issue is that there is not agreement in the consideration of dyslexia as a *disability*. The International Dyslexia Association, as most of psychology literature, defines dyslexia as a specific *learning disability* [12, 17, 18] while in some cognitive neuroscience studies dyslexia is referred as a specific reading disability [32]. However, in the standard definitions of the *International Statistical Classification of Diseases (ICD-10)* [33] and the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)* [1], dyslexia is listed as a reading and spelling *disorder (ICD-10)* or a reading disorder and a disorder of written expression (*DSM-IV*). In Spanish literature, dyslexia is hardly ever referred as a disability but as a *difficulty* or as a *disorder* regarding learning and reading [4]. The first challenge is where to place dyslexia in the WACG 2.0 [3] since it is not clear whether dyslexia is a cognitive disability.

**Not too Many but Enough.** Literature reviews point out that there are not to many accessibility studies on dyslexia

[19, 30]. However, there are already a decent number of studies on dyslexia and accessibility. In fact, the same issues are being studied repeated times such as the effect of font size and typeface. The problem is that these studies are not comparable, nor incremental, and in most the times, they do not complement each other. The way to measure text accessibility regarding dyslexia is not established as well as there is not an established methodology to compare user studies. There is not a state of the art to compare with. Most of the studies rely on qualitative data which highly depends on the methodology of the study itself. Each study come out with a solution that is irremediably attached to a very particular setting. Probably, this lack of consistency in the methodology could have prevent the inclusion of guidelines for dyslexia in the *WACG 2.0* [3].

#### **A Small Change with a Big Impact.**

There are two facts: (1) people with dyslexia read poorer than people without dyslexia in many ways: reading speed, reading accuracy, or comprehension; and (2) the text presentations and the text content have a significant impact on the readability of users with dyslexia. Even if readers with dyslexia are trained and diagnosed they still benefit from a more accessible text presentation.

There are two text presentations parameters that the majority of the empirical and qualitative user studies recommend: using a roman *sans serif* typeface –such as *Arial*– [2, 8, 25], and using bigger font sizes [2, 21, 29]. These two recommendations could be easily included in the accessibility guidelines. Web users with dyslexia would significantly benefit from them, as well as users without dyslexia, since these two specifically features also increased the reading performance of users without dyslexia [25, 29].

Large text is covered by the WACG in the use of relative font sizes. The minimum size for large print is 14 points and the maximum standard font size is 18 points. By enlarging the minimum –and the maximum– web text would be more readable for all, people with and without dyslexia.

Regarding the typeface the WACG recommends to avoid using fonts with “extraordinarily thin strokes or unusual features and characteristics that reduce the familiarity of their letter forms are harder to read”. This is consistent with our recommendation about using a roman *sans serif* typeface.

It is worth noting that the WCAG-related solutions for other print disabilities, such as using a screen reader to read content aloud is a helpful solution for readers with dyslexia.

### **4. CONCLUSIONS**

Even if it not clear what is the exact impact of dyslexia in this world, dyslexia is a real problem. Even if the proposed solutions do not seem to really work for all situations, there are enough scientific evidence to, at least, set a small number of useful guidelines. The limitations of current approaches could be overcome by changing the methodology to be able to work with more data. In addition to the guidelines related to the language understandability in the WACG 2.0 [3], we would like to point out two recommendations about font size (larger than the current recommendations, around 18 points for a 17-inches screen) and typeface (more specific than the current recommendations, *sans serif* and non-italic typefaces). These recommendations do not only make the Web significantly more readable for people with dyslexia, but also for regular readers at the same time.

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