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Rodriguez Vazquez, Silvia

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Silvia Rodríguez Vázquez
Cod.eX Research Group, TIM/FTI - University of Geneva
40, Bd. du Pont d'Arve - CH-1211 Geneva 4 - Switzerland
Silvia.Rodriguez@unige.ch

ABSTRACT
The Web is an open network accessed by people across countries, languages and cultures, irrespective of their functional diversity. Over the last two decades, interest about web accessibility issues has significantly increased among web professionals, but people with disabilities still encounter significant difficulties when browsing the Internet. In the particular case of blind users, the use of assistive technologies such as screen readers is key to navigate and interact with web content. Although research efforts made until now have led to a better understanding of visually-impaired users' browsing behavior and, hence, the definition of web design best practices for an improved user experience by this population group, the particularities of websites with multiple language versions have been mostly overlooked. This communication paper seeks to shed light on the major challenges faced by visually-impaired users when accessing the multilingual web, as well as on why and how the web localization community should contribute to a more accessible web for all.

Categories and Subject Descriptors
H.5.3 **[Group and Organization Interfaces]**: Web-based interaction. H.5.4 **[Hypertext/Hypermedia]**: User issues. K.4.2 [**Computers and Society**]: Social Issues – *Handicapped persons/special needs*. K.7.4 **[The Computing profession]**: Occupations.

General Terms
Design, Human Factors, Languages, Theory, Verification.

Keywords
Web accessibility, visually-impaired users, multilingual web, web localization, assistive technology (AT).

1. INTRODUCTION AND BACKGROUND
The number of Internet users worldwide has increased tenfold from the beginning of the century up to present [8], along with the complexity level of the documents stored in the vast World Wide Web. Over that same period of time, non-visual web access has also experienced significant improvements and enabled non-sighted users to retrieve information from the Web [2]. It is a widespread belief that this positive trend is mainly founded on (i) the refinement of the W3C Web Content Accessibility Guidelines (WCAG) and (ii) the advances achieved as regards assistive technology (AT).

The WCAG 2.0 [5] are organized around four principles −the web must be *perceivable*, *operable*, *understandable* and *robust*. The document includes 12 different guidelines and 61 associated success criteria that should be met in order to render web content accessible. While the WCAG 2.0 specifically target web developers and designers, existing work suggests that these professionals either find them too abstract or too time-consuming to implement, or lack the time and knowledge to do it [7]. Although automated solutions that could bridge this gap exist, relying on accessibility evaluation tools alone has not yet proved fully effective [17]. All the above might explain why adherence to accessibility criteria is still lower than expected [6].

Assistive or user-side technologies facilitate the use of computers by people with impairments. Screen readers are a well-known example of these, since they are often used by blind users to read information through synthesized speech or braille. In the case of the Web, this software does not only read web textual content, but it also announces to the user the existence of other non-textual elements, such as images or videos. Most commercially-available screen readers allow users to customize and use keyboard shortcuts to navigate between specific elements of a website, e.g., headings, links or form fields [16]. However, a WCAG 2.0 non-compliant website can drastically reduce the assistive technology performance level, thus hampering a smooth access to web content and turning the latter into a rather frustrating experience [1].

Our work looks at understanding if visually-impaired users' general browsing behavior, difficulties and error-handling strategies when interacting with multilingual websites differ from those already defined in reported studies with monolingual websites. Furthermore, in the present work we also aim at outlining the potential positive effects that could result from the involvement of web localization professionals in the achievement of an accessible multilingual web.

2. RESEARCH MOTIVATION
An in-depth comprehension of end users' behavioral patterns when browsing the web appears crucial to encourage progress in web accessibility research. A review of the literature indicates that multiple studies have been already undertaken with that purpose. Results yielded from a remote comparative study conducted by Bigham et al. [3] indicated that blind users were less likely to visit complex pages with dynamic content and performed a higher number of probes than sighted participants. In Michailidou et al. [11], conclusions drawn from the analysis of this last user group browsing patterns, applying eye-tracking methods, have been

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presented as a guide for designing web pages that can be accessed effortlessly and efficiently by both visually-impaired and sighted people.

Most recent work has directly focused on observations of screen reader users' routines to overcome obstacles derived from the inaccessible Web. While Borodin et al. [4] discovered common blind users' reactions upon content changes and the need to find desired content, Lunn et al. [10] carried out a large scale study to establish a coping strategy framework using thematic analysis that could be used as the basis for developing behavior-driven transcoding techniques[1]. A total of 48 coping strategies emerged from the analysis and authors formed six groupings, namely: *candidate chunk discovery strategy* −to identify areas of the page that contain the information that users are interested in−, *masthead avoidance strategy* −to avoid the frustration of listening to same content in every page of a website−, *clustered element strategy* −to find elements users know should be located close to each other−, *probing strategy* −to look for candidate links and select those they think will take them to the desire page−, *backtracking strategy* −to recover from states where they are lost in the web−, and *withdrawal strategy* −to give up due to frustration or ask for help (*ibid*). Nonetheless, to the best of our knowledge, no explicit reference has been made to the specificities of multilingual websites and how visually-impaired users who speak different languages interact with them through their assistive technology.

In addition, as argued by Asakawa [1], we support the assumption that maintaining the accessibility level while updating content can be a challenging endeavor. Within the multilingual web development process, the localization −linguistic and cultural adaptation− of text and non-text web content unavoidably involves not only constant asynchronous updates in different languages, but also the active participation of new actors in the web product life cycle such as translators, terminologists and localization engineers who might not be aware of accessibility-related recommendations. In fact, although shared interests between web localization and accessibility have been previously brought to the forefront by both industry and academia [9,12], we believe that more research efforts need to be devoted to continue that path of study, since the localization community seems to still lack the knowledge and training required on the matter.

3. MULTILINGUAL WEB BROWSING

The study presented in this section extends prior work by considering the particularities of the multilingual web from an accessibility perspective, concretely focusing on screen reader users.

3.1 Method and Participants

Direct discussions with four visually-impaired users (see Table 1) were held in the form of semi-structured exploratory interviews of approximately one hour length with a view to provide a better understanding of how this user group perceives web pages available in more than one language.

Two of the four participants were interviewed in their working environment, so evidence gathered from informal observations was also considered during data analysis. Users would spontaneously bring up examples of previously visited multilingual websites to illustrate what they believed good and bad accessibility-oriented web design practices that proved to be of added-value to the discussions. Based on Lunn et al. [10] browsing behavior analysis framework, we asked participants a set of open-ended questions covering two main thematic axes: (i) what were the difficulties they had, if any, when browsing multilingual websites and (ii) what were they doing in those cases to overcome the accessibility problem(s) found, if anything.

Table 1. Interviewed Participants' Profile and AT used

#	Sex	Occupation	Vision	AT
P1	M	Unemployed	Severely Blind	ZoomText, VoiceOver
P2	F	Freelance professional translator	Totally Blind	JAWS, VoiceOver
P3	M	Braille library employee	Totally Blind	JAWS, VoiceOver
P4	M	Civil servant, accessibility consultant	Totally Blind	JAWS, VoiceOver

One participant was from Spain and fluent in French, and the other three were of Swiss origin (French native-speakers). Swiss participants reported to also speak German and English, with the exception of P2, who also had an advanced knowledge of Italian. All four interviewees indicated that they use commercial screen readers on a daily basis −JAWS and ZoomText for desktop computers and VoiceOver for their mobile devices.

3.2 Main Difficulties and Coping Strategies

Overall, there seems to be no apparent differences between monolingual and multilingual website browsing by screen reader users. However, the analysis of all recorded notes led to the identification of three major accessibility obstacles explicitly associated with multilingual websites which were acknowledged by all four participants.

Language Selector. The primary connection element between different language interface pages of a website is the language selector. Visually-impaired users seem to prefer simple links with the language name (e.g. 'English', 'Français', 'Español') as opposed to drop-down menu lists or images with embedded links, which often impose accessibility barriers. When having problems to locate the language selector, users would follow a candidate chunk discovery strategy −as per Lunn et al. [10] terminology−, tabbing through a list of links and looking for the desired language name. Two participants made special reference to the use of flags without an appropriate text alternative as a recurrent difficulty when trying to switch between language versions. As a coping strategy, users would guess which languages the content might be available in and would type the corresponding language code or name in the URL by directly moving to the address bar through a quick key screen reader command. This trial and error approach, which requires a significant time investment, could be avoided if good internationalization and localization practices were implemented, since a language list is also preferred against the use of flags.

Untranslated Content. Participants agreed when pointing at finding unexpected excerpts of text in a different language from the chosen one in a website as the most uncomfortable situation lived during interaction with the multilingual web. Despite fluently speaking more than one language, interviewees did not like the fact of listening to text written in a given language with

[1] In the current research context, transcoding is understood as the transformation of web content so that it can be accessed on a diverse range of tools, including mobile devices, screen readers and devices using low bandwidth connections [10].

the accent of another one (often the language selected in the screen reader voice profile). All four participants recalled several examples, mostly referring to quotes, proper names and image text alternatives. The coping strategy in most of the cases was going over that element several times in an attempt to understand the content. A couple of interviewees also acknowledged to have visited websites where, in spite of the existence of the language selector, content was always read in the same language. With the exception of text equivalent for images, which need to be considered as translatable elements during the localization process and thus are a translation-related issue [13], these difficulties could have been solved by correctly using the language attribute on the `html` element, as recommended in success criteria 3.1.1 and 3.1.2 [5].

User-Side Technology Issues. Even if the aforementioned success criteria are met, language obstacles can still appear. Participants interviewed recognized that an inappropriate use of their screen reader might sometimes be the cause of wrong web content interpretation. Language switch is possible through a screen reader shortcut, but they agreed that language availability also depends on the assistive technology version. It was interesting to note that, when audio interaction becomes impossible, they seem to adopt a withdrawal strategy and assume, in most cases, that the accessibility problem is related to their AT, and that it is not the result of bad web design. One participant, for instance, acknowledged that he was comfortable with English being read as French (his mother tongue) but not with other languages, such as Italian, for which he would change the screen reader voice settings.

4. LOCALIZING WITH ACCESSIBILITY IN MIND: A PROMISING APPROACH

The exploratory interviews reported in the section above were conducted as a complement to other data collection approaches already adopted in our previous work on web accessibility and localization. On one hand, results from an initial survey targeting web accessibility experts suggested that no standardized assessment procedure exist when checking multilingual web accessibility and that little consideration is given to culture-embedded elements and textual content [15]. On the other hand, conclusions drawn from several experimental studies carried out with web localization students and professionals showed that having at least basic knowledge on web accessibility can help localizers maintain the web accessibility level achieved in the source web document, as well as identify and amend potential accessibility problems in the target web product [13,14].

Based on all data gathered until present, we argue that localization best practices can benefit accessibility and viceversa. Although we are aware of the limitations of the study presented in this paper, we could conclude that major multilingual browsing difficulties highlighted by interviewees represent localization problems that, if solved, could lead to a more accessible multilingual web, such as avoiding the use of flags as a language selection mechanism and appropriately locating all translatable elements of a page, including text alternatives for images. As future work, we foresee to apply user-based testing methods with accessible and non-accessible multilingual websites previously analyzed from a web localization perspective.

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