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A snapshot of the first encounters of visually disabled users with the Web

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ABSTRACT

Navigating the Web is particularly challenging for disabled users who are not familiar with the idiosyncrasies of the Web and have to rely on assistive technologies. We provide insights on the adaptation process of novice visually disabled users through a snapshot that depicts their first encounters with the Web during a period of 2 months. We discover that, as the sessions go on, last resort tactics are replaced by more sophisticated exploration tactics, which suggests that users not only become more skilled, but also more independent and autonomous. We observe that at later stages, tasks are more effectively accomplished at the expenses of reduced efficiency. We propose 2 explanations for this phenomenon: at later stages users may be more prone to misuse tactics from a larger repertoire or alternatively, they may feel more confident and less thoughtful. Design implications suggest that, initially, users should be provided with mechanisms to recover from failure, while interventions at later stages should not interfere with the learning process.

1. Introduction

Adaptive behaviour is a ubiquitous trait in the animal kingdom. It enables individuals to adjust their behavioural responses to the stimuli received from the environment. As a result, the relationship with the environment becomes more beneficial in terms of energy, time or resources expenditure. Adaptive behaviour is thus one of the factors that increase survival expectancies. Humans are not an exception as we constantly try to increase our fitness to the environment we live in.

The World Wide Web is an environment where users consume and produce information, communicate and socialise. The interface to perform such activities is not always straightforward to operate though. It is especially cumbersome for those whose interaction is constrained by their abilities (e.g. visually disabled users) or devices (e.g. mobile phones) and those who are not familiar with it. The interaction problems encountered by visually disabled users in the Web environment are primarily triggered by poorly designed websites in terms of information architecture (Hochheiser & Lazar, 2010), usability (Leporini & Paternó, 2004) and accessibility (Caldwell, Cooper, Reid, & Vanderheiden, 2008).

Since the Web is eminently a visual environment visually disabled users employ assistive technologies to be able to interact with Web content. Visually disabled users can be roughly classified in 2 groups: visually impaired and blind users. Visually impaired users, who are typically users with low vision, use screen magnifiers that augment content, while blind users employ screen readers that talk out loud the content of websites. If the visual impairment is severe some users employ screen readers jointly with screen magnifiers. In addition to being constrained by their abilities and design flaws, if visually disabled individuals are not familiar with the Web and its idiosyncrasies, the problems that emerge can severely hinder the interaction and consequently bring about frustration on users (Lazar, Allen, Kleinman, & Malarkey, 2007). Our goal is to explore how visually disabled users address these problematic situations in order to suggest interventions that help their adaptation to the Web environment.

Several efforts have been devoted to address the accessibility barriers encountered by people with disabilities on the Web. International legislation[1] mostly draws from the guidelines proposed by standardisation bodies such as the W3C, see for example the Web Content Accessibility Guidelines 2.0 (Caldwell et al., 2008). However, research suggests that users still find a number of accessibility related problems even if guidelines are satisfied (Power, Freire, Petrie,

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[1] Policies Relating to Web Accessibility. Available at http://www.w3.org/WAI/Policy/.

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& Swallow, 2012). As a reaction to such difficulties, users try to better adjust to the Web environment by getting familiar with procedures that enable them to overcome the encountered obstacles. This process may be understood as *learning*[2] since users gain factual and especially procedural knowledge to cope with challenges.

The traditional view on skill gaining supports this perspective in that novice users employ problem-solving strategies, whereas skilled users show automated strategies (Card, Newell, & Moran, 1983). According to Newell and Simon (1972) the evolution from the novice to the skilled dimension materialises by gaining search control knowledge in the problem space. However, this sort of automated behaviour only happens in restrictive situations: simple tasks with a low level of variability that require small cognitive effort (and require thus more perceptual-motor effort). Under these constraints, the evolution of the users' performance is regular and thus predictable by the Power Law of Practice (Snoody, 1926).

Adaptive behaviour, and especially coping are tools to overcome challenging situations. When users tackle such situations, their internal conditions tend to be exceeded and can result in anxiety. Therefore, the goal of the actions taken by users is to alleviate stressful situations while at the same time addressing the event that causes disruption (Lazarus & Folkman, 1984). Our perspective on user adaptation to Web environments posits that users learn from and adapt to every action they take on the Web. Adaptive human behaviour occurs in complex and highly variable tasks such as the ones that take place on the World Wide Web. These actions are purposeful (Newell, 1990), goal-oriented and are carried out either consciously or unconsciously.

The goal of this study is to explore how novice visually disabled users adapt to the Web environment and learn to cope with encountered challenges in this process. To do so, we identify how adaptive behaviour mechanisms evolve over time and analyse the relationship of this evolution with navigation and performance metrics. Specifically, we provide insights about the following aspects:

- We analyse the skill acquisition process of visually disabled users who are not familiar with the Web.
- We describe how users acquire skills by coping with difficulties and overcoming the problems encountered on the Web.
- We identify the mechanisms by which novice users acquire confidence and become competent users.
- We discuss how interventions could be applied in order to smooth out the adaptation and learning process.

2. Background

According to standarisation bodies learnability is a quality of the product that falls under usability (ISO/IEC 9126-1, 2001; ISO/IEC 25010, 2011) and is defined as *the degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use*. Even if it is included in standard quality models, there is no unified way of measuring learnability (Grossman, Fitzmaurice, & Attar, 2009). The literature about the learnability of applications and systems is scarce and in the past it was mainly focused on word processor use (Mack, Lewis, & Carroll, 1983; Rieman, 1996).

In this section we describe the axes that inform our analysis on the adaptation of visually disabled users to Web environments: Section 2.1 highlights the role of expertise in learning how to interact with software applications; the consideration of *time* as a key dimension to analyse user adaptation is emphasised in Section 2.2; finally, Section 2.3 describes the influence that the aforementioned axis have with the interaction of those who are visually disabled.

2.1. Factors that influence the learning process of software

Carroll and Rosson (1987) describe how the eagerness to action and prior experience determine the learning process of software. While poor interface design can be blamed for problematic computer use, eagerness to action and prior experience constitute a paradox on interface operation rather than a design problem, namely *the active user paradox*. There are two paradoxes that constitute the active user paradox: *the production paradox* and the *assimilation paradox*.

The production paradox establishes that users stick to their operating procedures even if more efficient techniques are available: in the case of novice users, they prefer to adopt exploratory trial and error strategies instead of being provided with guidance, while skilled users prefer to stick to the methods they already use. In both cases, users strike a balance between the time taken to learn new procedures and the hypothetical increase of performance that these procedures bring about. In order to encourage users to learn and use new software procedures and functionalities that may improve their performance some design guidelines have been proposed:

- Reinforce users with rewards such as achievement, satisfying curiosity or providing sense of control over the environment.
- Remove the sense of risk when operating the interface by providing simulations of the effect of certain actions.
- Disclosing complex and error-prone functionalities as the expertise level increases.

The assimilation paradox posits that individuals apply what they already know in order to interpret new situations, which is a useful strategy when the new situations resemble to previously experienced ones. Nevertheless, wrong assessments of isomorfic situations can lead users to erroneous procedures and prevent them from using available functionalities they have at hand. Therefore, novice users are inclined to interact with an interface rather than learning it. As a result, their little knowledge leads them to erroneous inferences about the effects of the interaction with the interface. Similarly, prior knowledge inhibits skilled users from learning. Design guidelines to overcome assimilation propose arguable solutions like developing interfaces that mimic exactly the functionalities of the metaphors used (e.g. a word processor should look like a notebook).

Fu and Gray (2004) found that the reduction of the required cognitive effort is what leads users to adopt generic procedures to interact, which is in line with the active user paradox. This entails that, in the long run, users will require more adaptive efforts as the available functionalities – which boost efficiency – are not used. This phenomenon occurs even when users are aware of the existence of optimal procedures, which casts some doubt on the rationality principle (Card et al., 1983). However, it was found that this strategy leads to a suboptimal yet stable performance, which indicates that users prefer to avoid disruptive situations at the expenses of being less efficient.

2.2. The time factor

Adaptation is a process that inherently occurs and evolves over time. It is not possible to observe it as a punctual event but as a series of events across time. Among the disciplines that study evolutionary human behaviour, those concerned with the shortest temporal scale of observation (e.g. behavioural ecology) view

[2] All the instances of 'learning' refer to 'procedural learning' throughout the paper.