Identifying the relevant individual attributes for a successful non-visual mobile experience

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ABSTRACT

Motivation – To understand the individual differences with the greatest impact on a blind user's mobile interaction effectiveness and learning abilities.

Research approach – We performed a semi-structured interview to 10 specialized professionals (psychologists, occupational therapists, rehabilitation technicians, IT teacher) working closely with blind users.

Findings/Design – Results suggest that peripheral sensitivity, spatial ability, blindness onset age, age, intelligence and memory are the characteristics affecting user capabilities the most.

Research limitations/Implications – This study offers a wide view on the possible influencing attributes. Empirical studies are required to dissect the impact of each characteristic in mobile blind users' performance.

Originality/Value – We contribute with an understanding of the individual differences among the blind population that may affect mobile interaction.

Take away message – Individual differences among the blind have greater impact than those between sighted users. Understanding these differences is mandatory.

Keywords

Individual Differences, Blind, Mobile Accessibility.

INTRODUCTION

Mobile devices present opportunities beyond our imagination and it is difficult not to be amazed with mobile computing's recent growth. Most, mobile user interfaces are designed to fit a common user model, shaped with a few adaptable and adaptive mechanisms. However, no two persons are alike. We can usually ignore this diversity as we have the capability to adapt to the devices and, without noticing, become experts in interfaces that were probably misadjusted to begin with.

However, this adaptation is not always within the user's reach. One of the most neglected groups is the blind. Blindness is due to a variety of causes. Diabetes is responsible for 8% of legal blindness *making it the leading cause of new cases of blindness in adults 20-74 years of age*. This is significant since diabetic retinopathy is often accompanied by peripheral neuropathy which also impairs the sense of touch. *The prevalence of blindness is much higher for the elderly* (Levesque, 2005). It is estimated that 1.1% of the elderly are legally blind compared to 0.055% of the young (20 and under). About 82% of all people who are visually impaired are age 50 and older (although they represent only 19% of the world's population) (World Health Organization, 2009). Impairment cause, blindness onset age, age, cognitive, motor and sensory abilities are characteristics that may diverge between users (Figure 1).

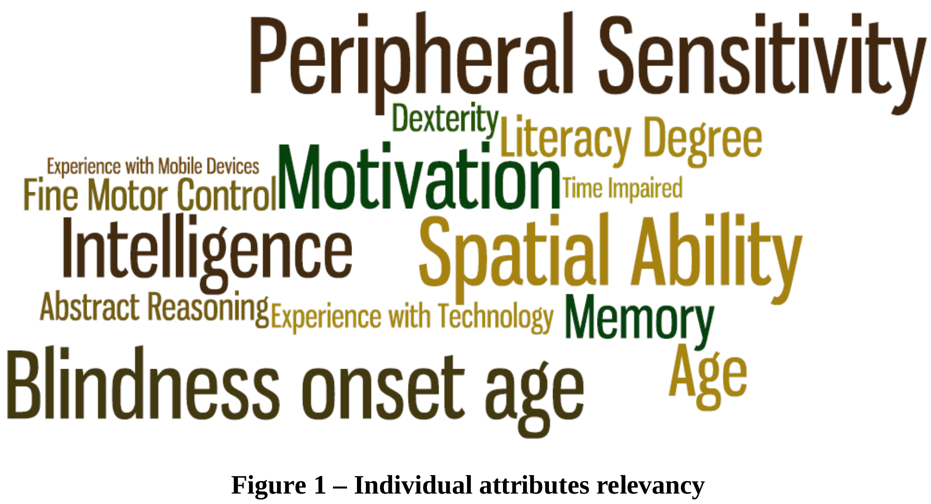

Figure 1 – Individual attributes relevancy

The enormous diversity found among these particular group turns the "stereotypical blind" idea inadequate. Regardless, all are presented with the same methods and opportunities ignoring their capacities and needs. Moreover, interaction with mobile devices is highly visually demanding which increases the difficulties. Even mobile assistive technologies for the blind have a narrow and stereotypical perspective over the difficulties faced by their users. A blind user is presented with screen reading software to overcome the inability to see onscreen information. However, these solutions go only half-way. In the absence of sight other aptitudes/limitations stand up.

To empower these users, a deeper understanding of their capabilities and how they relate with technology is mandatory. In this paper, we present a study to identify the characteristics that diverge among blind users and have an impact in their successes and failures.

INDIVIDUAL ATTRIBUTES AMONGST THE BLIND

The capability-demand theory builds on the concepts of user capability and product demand and aims to analyze user-product compatibility, i.e. *an assessment and comparison of the sensory, cognitive and motor demand made by a product in relation to the ability levels of the expected user population* (Persad, 2007). We embrace the capability-demand theory and aim to assert relations between users and devices, and ultimately aim at a match between individual capabilities and product demands. This way, we will provide both the tools for mobile designers, showing which designs are most effective and inclusive, and for blind users, identifying for each one, the most appropriate interfaces.

The aforementioned theory settles on two main components: the capabilities of the user and the demands imposed by the product. We aim to relate both and model the interactions between them. Beforehand, we must find and understand which are the promising characteristics (capabilities and demands) to consider, those which have an impact in a blind user's success when dealing with technology.

Herein, we focus on the users and contribute with the set of individual characteristics that have major influence in the interaction with mobile devices. To achieve this goal, we resorted to those with experience in dealing with divergent blind users, their particular characteristics and their relationship with the devices.

Procedure

Each participant partook in a 30 to 60 minutes in-person semi-structured interview. The interview covered four different topics: 1) the diversity among the population and the impact of those differences in relation to the differences between sighted people; 2) individual differences and their impact in interaction effectiveness, and learnability; 3) how are individual capabilities and limitations assessed/identified and how, if possible, are they overcame; 4) how are individual differences related and what type of action they have most influence on.

Participants

We recruited 10 specialized professionals working daily with blind users. All of them work with the target population for at least 5 years and had contact with a minimum of 50 blind individuals. The sample was composed by 3 psychologists, 2 occupational therapists, 1 IT teacher, and 4 rehabilitation technicians. Two psychologists work at Portuguese formation and support institutions for the blind while the remaining one works in a governmental department for the education of young blind people. Curiously, all these three individuals are also blind offering a different perspective and insight to their opinions. The rehabilitation technicians cover different cognitive, sensorial and motor perspectives and perform work with the target group from the most basic needs like orientation, motility, eating, dressing, posture while the rehabilitation technicians offer advanced formation in computers, telephone operator, carpentry, weave, among others. The IT teacher also works in a governmental department and works closely with children and their adaptation to technology and assistive components. Overall, the participants were recruited from five different institutions.

Analysis

We analyzed transcribed interviews to identify individual attributes functionally distinguishing blind users, how they relate between each other and at what levels they affect interaction. We used open and axial coding to analyze responses (Strauss, 1998).

Results

The interviewed professionals have contact with the users in different contexts. However, it was interesting to notice that their opinions regarding individual differences and their impact on technology are alike.

Diversity among the Blind

We focus on the blind population due to the extra load these users face when dealing with interfaces created to be visually explored. These particular users are extremely challenged when interacting with recent interfaces, even in the presence of assistive technologies. Particularly, considering mobile devices, a blind person can use screen reading software to overcome the barriers imposed by the absence of visual feedback. However, this auditory feedback, in a graphical user interface, is far from its visual counterpart. The inefficiencies are even more visible if

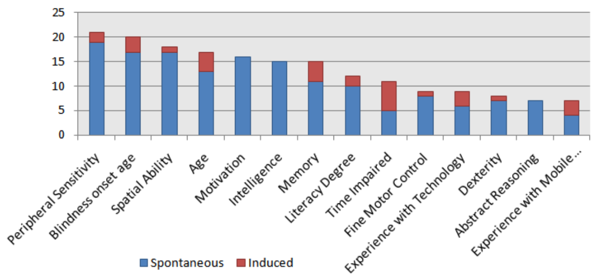

Figure 2 – Spontaneous and induced references to relevant individual characteristics

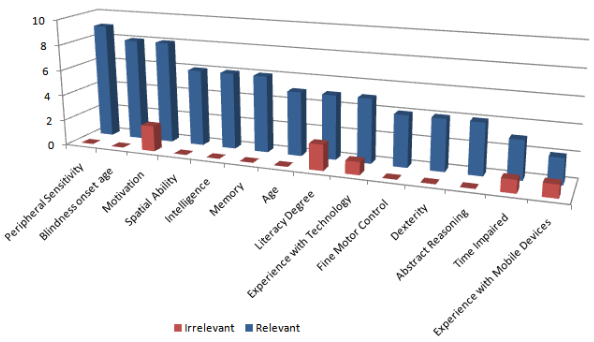

Figure 3 – Attributes relevancy

we look to the devices physical properties and cues. A blind user has no information in respect to layout, key/action or screen area/action association.

On the extraordinary demands imposed to blind users, one of the interviewees stated:

> ***The blind person is subject to higher efforts as it has less information sources or less chances of repetition.***

The general idea among the interviewees is that blind users face extraordinary barriers when dealing with technology, justifying the efforts to improve their access to the interfaces and devices.

What is also true is that the blind population is highly different, as aforementioned. This opinion was shared by all the interviewees. Most of them illustrated these differences with examples of people with contrasting levels of technological expertise. These differences were attributed to several different aspects among sensory, demographics, cognitive and motor dimensions. What was also stated was that this divergence among people has greater impact between blind users than between sighted people. Allied with the barriers imposed by devices and their interfaces, a particular individual characteristic may isolate a person technology-wise. Some participants revealed cases of extremely successful blind people as well as others with several functional limitations. As an example, a participant stated the following, alerting to the impact of individual differences among the blind as more significant:

> ***Regarding technologies, the variations between individuals have effects with extra significance than in sighted people. The intellectual variation, as an example, has a higher impact.***

Mobile-wise Relevant Individual Attributes

It was consensual among the participants that the blind population is highly heterogeneous and that this heterogeneity has greater impact in functional abilities than among sighted people. The main goal of the study was to identify these differences.

Overall, twenty-two characteristics were mentioned by the participants. Figure 1 presents a tag cloud outlining the most mentioned individual attributes. Peripheral sensitivity, motivation, spatial ability, blindness onset age, intelligence, memory and age stand out as the most relevant ones.

Peripheral sensitivity in the blind population can vary widely from person to person. One of the main reasons for this is that 82% of the blind are more than 50 years old and that there is an exponential decrease in tactile sensitivity with age (World Health Organization, 2009). Furthermore, clinical states that lead to blindness, such as diabetic retinopathy, may also have other collateral damages, one of them being peripheral neuropathy, a decrease in peripheral sensitivity. Current mobile solutions for blind users resort to the usage of screen readers, replacing the visual feedback by its auditory representation. However, the feedback is restricted to the information presented onscreen. Thus, besides the effort to memorize the keypad layout, interaction is dependent on keypad recognition abilities, giving the sense of touch the upmost relevance in the absence of visual feedback. Still, there is no understanding of which is the best device for a particular user and his touch capabilities, thus restricting the user experience and an informed design of more inclusive mobile keypads.

The **Motivation** and the attitude towards blindness are relevant as they may implicate all the other characteristics and the evolution the person presents after acquiring the impairment. All the participants said that while a person is in grief to what the loss of vision is concerned, failure is guaranteed. The **Age** of the blind person is relevant as, besides the possible differences in technological and educational background, may also implicate different motivation and cognition levels. **Intelligence** and **Memory** are cognitive characteristics that define user capabilities independently of the task.

Spatial Ability is defined as the ability to manipulate or transform the image of spatial patterns into other arrangements. A practical implication of the spatial abilities a user detains relates to how easily, in the absence of vision, he can jump from key to key in a keypad. The mental models about a physical spatial pattern may have great influence in how one can use devices. However, these abilities are also visible in virtual representations (desktop icons and their placement, web page layouts, or even menu hierarchies) (Pilgrim, 2007). The **blindness onset age** affects the spatial abilities. They are different depending on if the person has a previous mental representation or if it is congenitally blind and no mental cues are available.

Figure 2 presents the positive references made to the attributes, whether they were spontaneously mentioned or induced by the interviewer. The chart includes duplicates and shows the relevancy the participants attributed to each feature. Other characteristics were mentioned but we have omitted those with less than 5 mentions. Peripheral sensitivity, blindness onset age, spatial ability, age, motivation/attitude, intelligence and memory were the most referenced. Age, memory and time impaired were the ones that when induced had greater acceptance, i.e., the participants felt they were relevant although they did not mention is spontaneously. Some justified the omission of these characteristics with their obvious nature. Motivation, Intelligence and Abstract Reasoning were spontaneously mentioned several times but those who did not mention them voluntarily did not have an opinion about their impact. Motivation, Literacy Degree, Experience with Technology/Devices and Time Impaired were mentioned as irrelevant (whether spontaneously or when induced) by some of the participants (Figure 3).

Relation between attributes

The mentioned features are not restricted to sensorial, motor, cognitive or even user profile contexts. Further, some of them influence each other: blindness onset age was said to influence spatial ability, dexterity, motivation and technologic experience; motivation influencing technologic experience; age having influence in peripheral sensitivity, motivation, memory and technologic experience; literacy degree influencing spatial ability and technologic experience (Figure 4). This is relevant as an instantiation of the capability-demand theory will likely explore the most meaningful and of broader spectrum characteristics.

Attribute Layer

It is also relevant to notice that the pointed attributes and characteristics influence user's ability at different levels. On one hand, they are spanned along the different components of the human processing model (perception, cognition and motility), while when considering product demands, implications are also visible at different layers: hardware and software. As an example, a participant said:

> ***At the basic level, previous technologic and mobile experience does not have a great impact. It is relevant when one starts to explore the functionalities.***

From the set of most relevant features, on the user side, we distinguish two different groups: the ones related with the physical properties of the devices (hardware) and the ones related with the concepts (software). Peripheral sensitivity, spatial ability, dexterity, fine

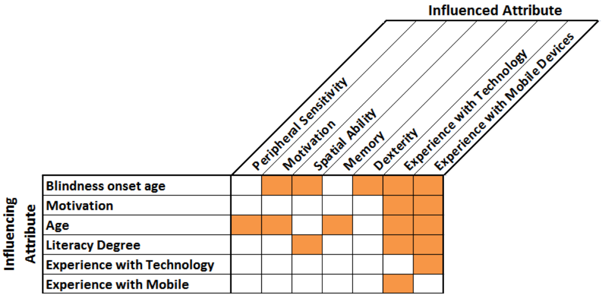

Figure 4 – Relations/Implications between attributes

motor control and experience with mobile devices were identified as having implications with the physical relation with the devices. The cognitive characteristics, which also include spatial ability, were the ones associated with the interface concepts (e.g., menus, text-entry schemes, etc...). Motivation, age, blindness onset age, literacy degree, and experience with technology were classified as global characteristics likely to influence the other features (as seen in Figure 4) and both the physical and abstract layers.

CONCLUSIONS AND FUTURE WORK

The blind user group is highly divergent and their individual differences have great impact on their interaction abilities. However, even mobile solutions for the blind overlook this evidence. The study herein presented laid the groundwork for more inclusive mobile interfaces by identifying the individual attributes influencing performance the most. Next, we will relate low-level user characteristics with different mobile interaction modalities demands. In possession of a thorough characterization of how different users relate to different interaction modalities, we will derive a model that allows us to make predictions regarding the performance of particular user/modality pairs.

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